

Taxonomic study on the photid amphipods (Senticaudata, Corophiida, Photoidea, Photidae) from Korean waters, with descriptions of a new genus and seven new species

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Abstract

In this paper, seven new species of the family Photidae from Korean waters are described and illustrated in detail. Among them, *Exiliphotis petila* **sp. nov.** is a monotype of the newly reported *Exiliphotis* **gen. nov.**, which is characterized by slenderer and more elongate pereopods 5–7 than those of other genera of the family Photidae. The genus *Latigammaropsis* is reported for the first time from Korean waters based on the description of *Latigammaropsis careocavata* **sp. nov.**, which is differentiated from other *Gammaropsis* group by having weakly sexual dimorphic gnathopods 2, those have simple palmar margins in both sexes. Three new species of *Photis* are also described: *Photis bronca* **sp. nov.**, *Photis posterolobus* **sp. nov.**, and *Photis longicarpus* **sp. nov.** The formerly misidentified *Photis longicaudata* from Japan and China as well as the Korean material could be classified as a new species, *P. bronca* **sp. nov.** For that, the syntypes of *P. longicaudata* were re-examined, and lectotype and paralectotypes were newly designated in this study. *Photis bronca* **sp. nov.** is characterized by quadrate tooth on the palmar margin medially on gnathopod 2 in both sexes. *Photis posterolobus* **sp. nov.** shows a pointed posterior lobe on the ischium and a well-developed process of the propodus on male gnathopod 2. *Photis longicarpus* **sp. nov.** can be distinguished from other species of the genus by very elongate carpus of male gnathopod 1. Two new species belonging to the genus *Podocerosopsis* are also reported: *Podocerosopsis insinuomanus* **sp. nov.** has a strongly bisinuous palmar margin

on male gnathopod 2, and *Podocerospis pseudoclavapes* **sp. nov.** differs from the closely related species of *Podocerospis clavapes* by different shape of the palmar margin and shorter dactylus of male gnathopod 2. Additionally, a key to the Korean species of Photidae is provided.

Keywords

Exiliphotis petila, Korea, *Latigammaropsis careocavata*, lectotype, morphology, *Photis bronca*, *Photis longicaudata*, *Photis longicarpus*, *Photis posterolobus*, *Podocerospis insinuomanus*, *Podocerospis pseudoclavapes*, taxonomy

Introduction

The family Photidae was first proposed by Boeck (1871) as a subfamily Photinae, belonging to Gammaridea Latreille, 1802, to encompass the genera *Photis* Krøyer, 1842, *Microprotopus* Norman, 1866, and *Xenoclea* Boeck, 1870. The Photinae was raised to family level by Boeck (1872). He erected three subfamilies: the Leptocheirinae Boeck, 1970 with the genera *Leptocheirus* Zaddach, 1844 and *Goesia* Boeck, 1970; the Photinae with the genera *Photis*, *Microprotopus* and *Xenoclea*; and the Microdeutopinae Boeck, 1870 with the genera *Microdeutopus* Costa, 1853, *Aora* Krøyer, 1842, *Autonoe* Bruzelius, 1849, *Protomedeia* Krøyer, 1842, *Gammaropsis* Lilljeborg, 1854, and *Podocerospis* Boeck, 1870 (Boeck 1872). Sars (1883) united the Leptocheirinae and Photinae into Photidae including *Prilocheirus* (*Leptocheirus*), *Photis*, *Microprotopus*, and *Xenoclea*. Later, Stebbing (1888) rejected the subfamily concept and re-established the Photidae, including all genera of the previous subfamilies except for *Goesia* and *Xenoclea*. For a while, all taxa of the Photidae were included in the Isaeidae, which was originally conceived by Dana (1853) and later revised by Barnard (1969). However, a subsequent work by Barnard (1973) suggested a huge superfamily Corophioidea consisting of the families Ampithoidae, Biancolinidae, Cheluridae, Corophiidae, Ischyroceridae, and Podoceridae, where most of the genera related to the photids were being incorporated into the Corophiidae. Later, Barnard and Karaman (1991) insisted on the large group of Corophioidea, all members of which are sharing a fleshy telson, and the photids were still included into the Corophiidae. On the other hand, Bousfield (1973, 1978) had maintained the separation of the following families under the Corophioidea: Aoridae, Ampithoidae, Biancolinidae, Cheluridae, Corophiidae, Isaeidae, Ischyroceridae, Photidae, and Podoceridae. Myers and Lowry (2003) revised the higher-level classification for the suborder Corophioidea and suggested the new superfamily Photoidea consisting of Ischyroceridae, Kamakidae, and Photidae. At that time, the family Photidae included *Ampelisciphotis*, *Audulla*, *Dodophotis*, *Falcigammaropsis*, *Gammaropsis*, *Megamphopus*, *Microphotis*, *Papuaphotis*, *Photis*, and *Posophotis* (Myers and Lowry 2003). Recently, Lowry and Myers (2013) suggested the new suborder Senticaudata based on a cladistic analysis using morphological characters. The superfamily Photoidea is positioned under the parvorder Caprellidira. To date, the Photidae, under the Senticaudata, consists of 17 genera including more than 220 nominate species distributed worldwide (Jung et al. 2017).

In the Far East, the taxonomic studies on the Photidae have been carried out by Bulytscheva (1952), Gurjanova (1938, 1951, 1955), Hirayama (1984), Kudryashov and Tzvetkova (1975), Nagata (1961, 1965), and Ren (1992, 2000, 2006). Despite their species-richness, only five species belonging to three genera have been recorded from Korean waters: *Gammaropsis longipropodi* Hirayama, 1984; *Gammaropsis utinomii* (Nagata, 1961); *Photis stridulus* Jung et al., 2017; *Photis longicaudata* (Spence Bate & Westwood, 1862); and *Podocерopsis clavapes* Jung et al., 2017 (Kim et al. 2005; Kim and Lee 2010; Jung et al. 2017). Additionally, the specimens previously described under the name of *P. longicaudata* in the Far East (Nagata 1965; Hirayama 1984; Kim et al. 2005; Ren 2006) shows several differences to the original description and the specimens reported from the North Sea and the Mediterranean Sea (Bate and Westwood 1863; Sars 1894; Stebbing 1906), so it is doubtful that the material from the Far East belongs to the same species of the North Sea.

As a part of ongoing taxonomical studies on the photid amphipods from Korean waters, seven new species are reported with diagnoses, detailed descriptions, and illustrations. A new monotypic genus *Exiliphotis* gen. nov. is established based on *Exiliphotis petila* sp. nov., and the genus *Latigammaropsis* Myers, 1995 is reported for the first time from Korean waters by the description of *Latigammaropsis careocavata* sp. nov. Three new species of the genus *Photis* Krøyer, 1842 are described: *Photis bronca* sp. nov., *Photis posterolobus* sp. nov., and *Photis longicarpus* sp. nov. Among them, *P. bronca* sp. nov. represents a revised species that has been misidentified as *P. longicaudata* in the Far East, including Japan, China, and Korea (Nagata 1965; Hirayama 1984; Kim et al. 2005; Ren 2006). Two new species belonging to the genus *Podocерopsis* Boeck, 1861 are also described: *Podocерopsis insinuomanus* sp. nov. and *Podocерopsis pseudoclavapes* sp. nov. Additionally, a key to Korean photid species is also provided.

Materials and methods

Collected specimens were initially fixed in 80 % ethyl alcohol in the field and later preserved in 95 % ethyl alcohol after sorting in the laboratory. Specimens were stained with lignin pink. Their appendages were dissected under a stereomicroscope in petri dishes or excavated microscopic slides filled with glycerol using dissection forceps and needles (Leica M205). Specimens were mounted onto temporary slides using a glycerol-ethanol mixed solution. The illustrations made with a pencil under a light microscope (Leica DMLB) with the aid of a drawing tube. Later on, the drawings were scanned, digitally vectorized, and arranged in plates using the methods described by Coleman (2003, 2009). The examined material is deposited in the collection of the National Institute of Biological Resources (NIBR) of Korea. The syntype series of *Photis longicaudata* deposited in The Natural History Museum, London were examined for comparison to *Photis bronca* sp. nov. Further on, a lectotype and paralectotypes of *P. longicaudata* were designated based on the present study.

Systematic accounts

Order Amphipoda Latreille, 1816

Suborder Senticaudata Lowry & Myers, 2013

Infraorder Corophiida Leach, 1814

Superfamily Photoidea Boeck, 1871

Family Photidae Boeck, 1871

Genus *Exiliphotis* gen. nov.

<http://zoobank.org/BD79F0AE-7A22-4BD8-9E3E-C46579A1AE67>

Korean name: Ga-neun-da-ri-but-eun-kko-ri-yeop-sae-u-sok

Type species. *Exiliphotis petila* sp. nov. (original designation by monotypy)

Etymology. The composite epithet of the generic name, *Exiliphotis*, is a combination of the Latin word *exilis* and the generic name of *Photis*. This name refers to slender and elongate pereopods 5–7 with a noticeably narrower basis than those of other photid species. Gender is feminine.

Diagnosis. Antenna 1 peduncle 2nd article 2.0× as long as 1st article; accessory flagellum uniarticulated, vestigial. Gnathopod 1 carpus broad, 2.0× as long as wide, 0.8× as long as basis, propodus as long and as wide as carpus, posterior margin more convex than anterior margin, free from carpal lobe proximally, palmar margin convex, not defined distinctively; dactylus elongate, 0.8× as long as propodus. Gnathopod 2 subequal to gnathopod 1; carpus 0.7× as long as basis and that of gnathopod 1; propodus as long as basis, 1.6× as long as carpus, posterior margin convex, not free from carpal lobe proximally, palmar margin oblique, strongly bisinuated; dactylus 0.7× as long as propodus, exceeding palm. Pereopod 5 coxa bilobed, as long and 1.5× as wide as that of pereopod 4, anterior lobe 0.9× as wide as basis; basis subovoid, 1.3× as wide as that of pereopod 4, half as wide as long; merus and carpus not lobed. Pereopod 6 similar to pereopod 5 except for coxa. Pereopod 7 1.3× as long as pereopod 6; basis subrectangular, as wide and 1.2× as long as that of pereopod 6; merus slender, 0.8× as long as basis, slightly lobed posterodistally; carpus not lobate, 0.7× as long as merus; propodus 1.9× as long as carpus. Pleonal epimera 2 and 3 subrectangular, rounded ventrally. Uropod 1 peduncle without distoventral spine; both rami 0.6× as long as peduncle, terminated by rounded apex bearing robust seta. Uropod 2 0.7× as long as uropod 1; both rami 0.9× as long as peduncle, terminated by rounded apex bearing robust seta. Uropod 3 0.7× as long as uropod 2, inner ramus half as long as outer ramus, diminished distally; outer ramus as long as peduncle, biarticulated, 2nd article vestigial, with 2 elongate setae subapically. Telson trapezoidal in dorsal view, 2.1× as wide as long, distal margin not acute, with 1 terminal spine on each side.

Remarks. *Exiliphotis* gen. nov. is similar to *Graciliphotis* Myers, 2009 in having relatively short coxae, which differs from those of other photids (Myers 2009). However, *Exiliphotis* gen. nov. notably differs from *Graciliphotis* by the following differences: gnathopods 1 and 2 carpal lobes are slightly shorter and stouter; pereopods 5–7 are

almost linear and elongate, particularly their basis are narrowly expanded; uropods 1 and 2 rami are terminated by the rounded apex bearing one small robust seta; uropod 3 is about half as long as in *Graciliphotis*, 0.7 times as long as uropod 2; uropod 3 outer ramus is biarticulated (uniarticulated in *Graciliphotis*); and uropod 3 inner ramus is half as long as the outer ramus, while it is vestigial in *Graciliphotis* (Myers 2009).

***Exiliphotis petila* sp. nov.**

<http://zoobank.org/FF232410-A5DE-41CD-B040-0FEF54FA5FC1>

Figs 1–3

Korean name: Ga-neun-da-ri-but-eun-kko-ri-yeop-sae-u

Etymology. The epithet of the specific name, *petila*, is originated from the Latin word *petilus*. This name refers to the shape of pereopod 5 coxa and basis, and pereopods 6 and 7 basis, which are slenderer than those of other photid amphipods.

Material examined. Holotype: ♂ (3.7 mm), NIBRIV0000806532. Daegwantal-do Island, Jeju-do, South Korea (33°43'38"N, 126°20'13"E), 21 Nov 2012, grab sampler (about 36 m depth), by Prof. HY Soh.

Description. Holotype male. Head (Fig. 1A) 0.9× as long as pereonites 1–3 combined; lateral cephalic lobe produced anteriorly, apex rounded; eye circular, large, occupying most of lateral cephalic lobe; antennal sinus deep.

Antenna 1 (Fig. 1B, C) 0.7× as long as body; peduncle 1st article stout, 0.7× as long as head; without robust seta posteriodistally; 2nd article 2.0× as long as 1st article; 3rd article 0.8× as long as 2nd article; accessory flagellum uniarticulated, vestigial; flagellum 2.0× as long as peduncle 3rd article, composed of nine articles (terminal article rudimentary).

Antenna 2 (Fig. 1D) 1.1× as long as antenna 1; peduncle 4th article 0.7× as long as 2nd article of antenna 1; 5th article as long as 4th article; flagellum 1.9× as long as peduncle 5th article, composed of ten articles (terminal article rudimentary).

Upper lip (Fig. 1E) convex anteriorly, with notch in the middle, covered with minute setae.

Lower lip (Fig. 1F) inner lobe subovoid, outer lobe apex rounded, covered with minute setae; mandibular process well developed.

Mandibles (Fig. 1G–I) with 1/2 and 4-dentate incisor, 4-dentate lacinia mobilis, and four raker setae on left mandible; with 5-dentate incisor, minutely dentate lacinia mobilis, and three raker setae on right mandible; molar well developed, triturative, with seven setae along the distal margin of right mandible; palp asymmetrical, composed of three articles, 3rd article distally rounded, 0.8× as long as 2nd article, with setae extending along most of posteriodistal margin.

Maxilla 1 (Fig. 2A) inner lobe small, without seta; outer lobe with ten dentate setae on apical margin; palp biarticulated, 2nd article slightly dilated distally, with five dentate setae apically and five simple setae subapically.

Maxilla 2 (Fig. 2B) inner lobe with an oblique row of five weakly plumose setae on surface; outer lobe larger than inner lobe, expanded distally.

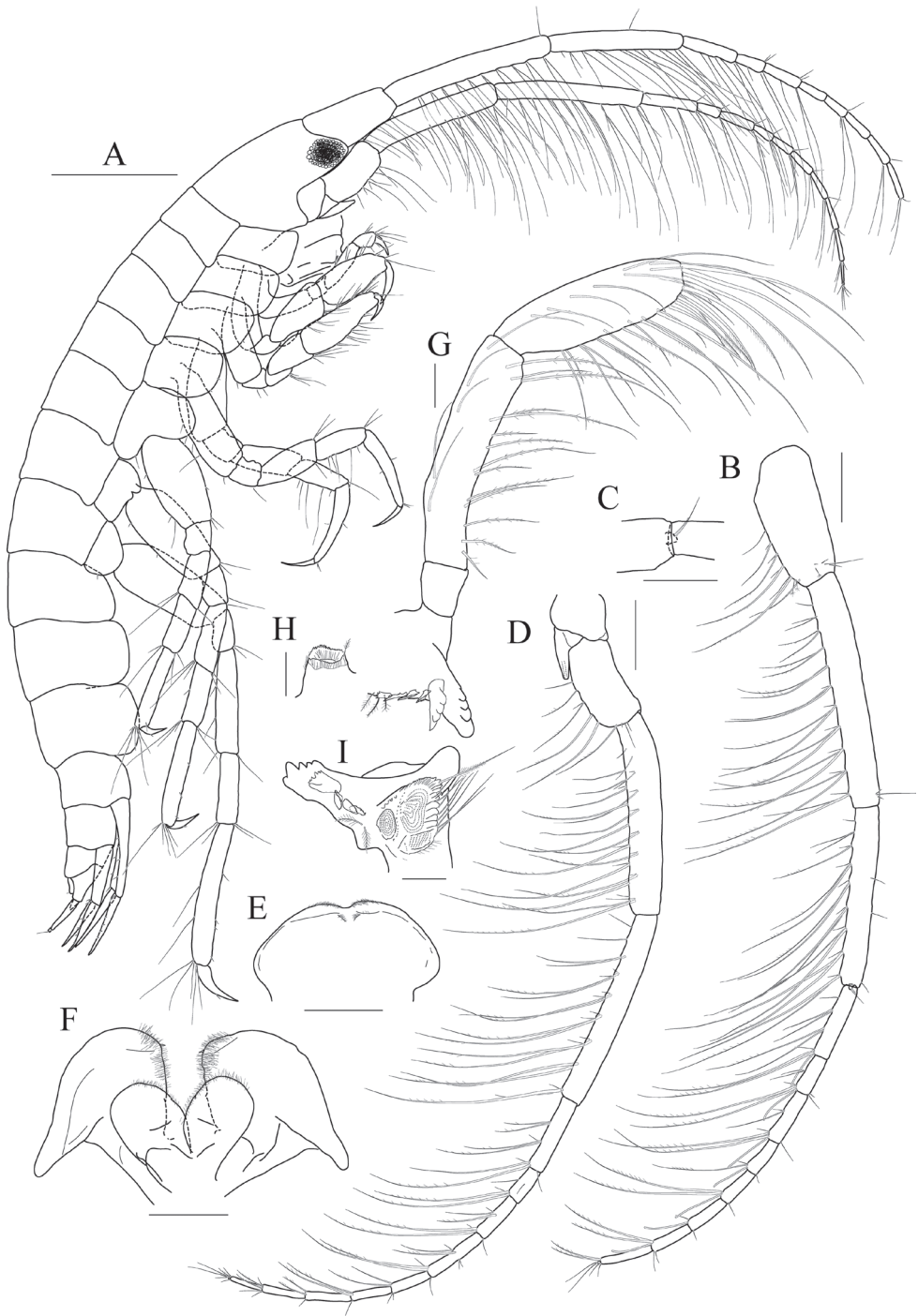


Figure 1. *Exiliphotis petila* sp. nov., holotype, NIBRIV0000806532, male, 3.7 mm, Daegwantal-do Island, South Korea. **A** habitus **B, C** antenna 1 **D** antenna 2 **E** upper lip **F** lower lip **G, H** left mandible **I** right mandible. Scale bars: 0.05 mm (**G–I**), 0.1 mm (**C, E, F**), 0.2 mm (**B, D**), 0.5 mm (**A**).

Maxilliped (Fig. 2C) inner lobe subrectangular, with three nodular setae apically and one medial nodular seta subdistally; outer lobe semiovoid, apex beyond half of 2nd palp article, lined with ten stout setae on medial to apical margins; palp composed of four articles, 3rd article a little expanded distally, half as long as 2nd article, 4th article 0.6× as long as 3rd article, with elongate seta apically (1.1× as long as 4th article).

Gnathopod 1 (Fig. 2D) coxa subtrapezoidal, 0.7× as wide as long, slightly produced anterioventrally; basis subtrapezoidal, anterior margin distal lobe weakly developed, with four elongate setae in the middle, posterior margin convex subproximally, with seven setae; carpus broad, 2.0× as long as wide, 0.8× as long as basis, with carpal lobe broad and blunt; propodus as long and as wide as carpus, anterior margin evenly rounded, with five oblique rows of elongate setae submarginally, posterior margin more convex than anterior margin, free from carpal lobe proximally, palmar margin convex, finely serrated on distal 3/4 margin, not defined distinctively, with one robust seta medially at 1/3 length distally; dactylus elongate, 0.8× as long as propodus, inner margin finely serrated, with four teeth.

Gnathopod 2 (Fig. 2E, F) subequal to gnathopod 1; coxa subtrapezoidal, 1.1× as wide as that of gnathopod 1, 0.7× as wide as long, rounded ventrally, not produced anterioventrally; coxal gill subovoid, 0.9× as long as coxa; basis similar to that of gnathopod 1, without setae on anterior margin; carpus 0.7× as long as basis and that of gnathopod 1, carpal lobe also shorter than that of gnathopod 1, blunt posteriorly; propodus as long as basis, 1.6× as long as carpus, anterior margin evenly rounded, posterior margin convex, not free from carpal lobe proximally, finely serrated on distal half margin, palmar margin oblique, strongly bisinuated, finely serrated, defined by one robust seta medially; dactylus 0.7× as long as propodus, exceeding palm, inner margin finely serrated, with three teeth.

Pereopod 3 (Fig. 2G) coxa as wide but 0.9× as long as that of gnathopod 2, rounded ventrally, weakly produced anterioventrally, coxal gill subovoid, 1.1× as long as that of gnathopod 2; basis 1.4× as long as coxa, 0.3× as wide as long, posterior margin convex, with elongate setae; merus 0.6× as long as basis, 0.5× as wide as long, slightly lobate anteriodistally; carpus subrectangular, 0.9× as long as merus, slightly convex anteriorly; propodus tapering distally, 0.8× as long as basis; dactylus 0.4× as long as propodus.

Pereopod 4 (Fig. 3A) similar to pereopod 3.

Pereopod 5 (Fig. 3B) slender; coxa bilobed, as long and 1.5× as wide as that of pereopod 4, anterior lobe expanded downward, 0.9× as wide as basis, rounded ventrally, posterior lobe expanded backwards, slightly smaller than anterior lobe; basis subovoid, 1.3× as wide as that of pereopod 4, half as wide as long, slightly wider proximally, posterior margin with one elongate seta and notched distally; merus and carpus not lobate, half as long as basis, with elongate setae at posteriodistal corners; propodus 1.5× as long as carpus, anterior margin with two robust setae and one pair of locking setae unequal in length; dactylus 0.4× as long as propodus, armed with one accessory cusp on outer margin.

Pereopod 6 (Fig. 3C) subequal to pereopod 5 except for coxa; coxa bilobed, anterior lobe small, posterior lobe as large as that of pereopod 4; basis subrectangular,

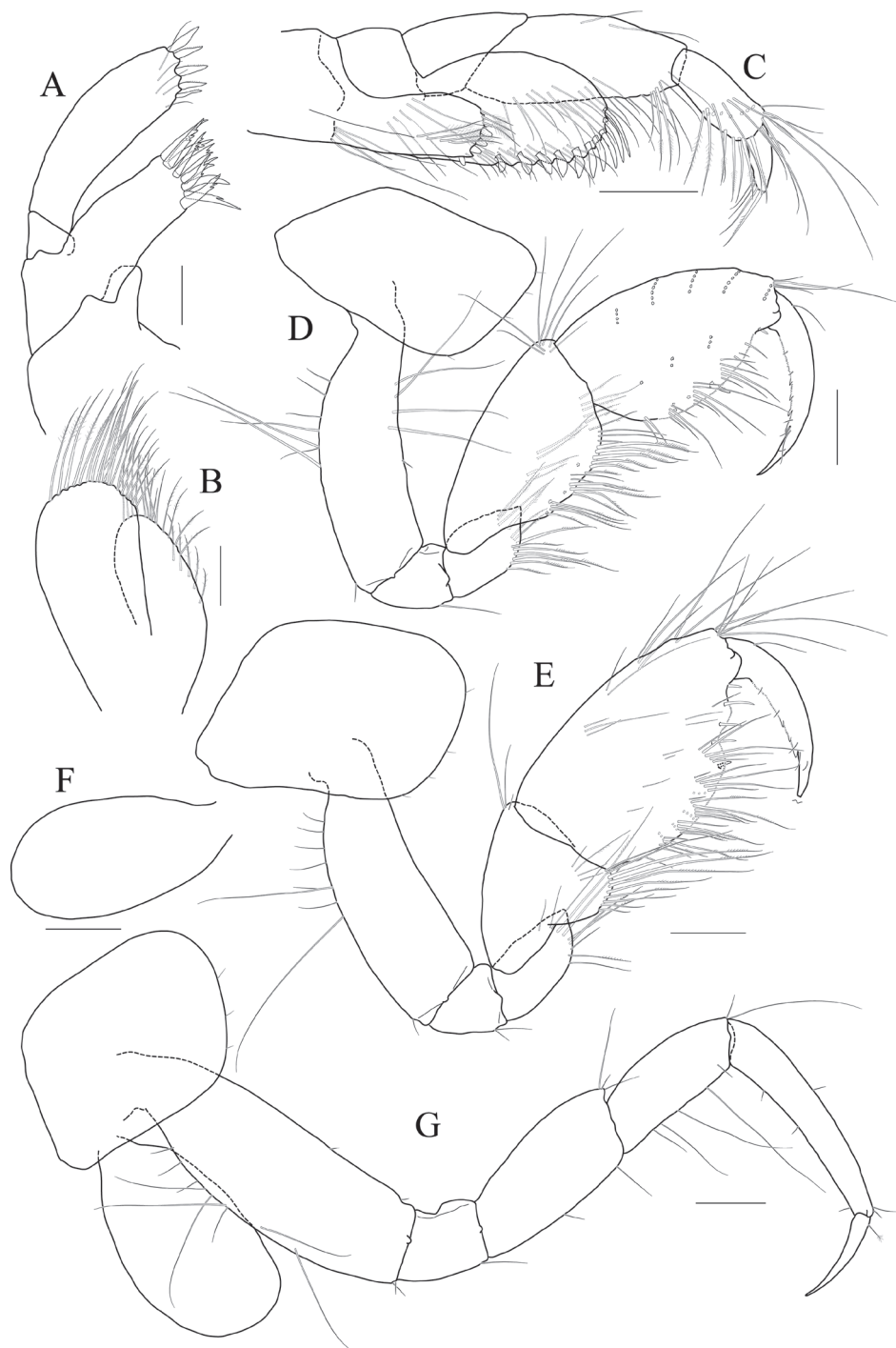


Figure 2 *Exiliphotis petila* sp. nov., holotype, NIBRIV0000806532, male, 3.7 mm, Daegwantal-do Island, South Korea. **A** maxilla 1 **B** maxilla 2 **C** maxilliped **D** gnathopod 1 **E, F** gnathopod 2 **G** pereopod 3. Scale bars: 0.05 mm (**A, B**), 0.1 mm (**C–G**).

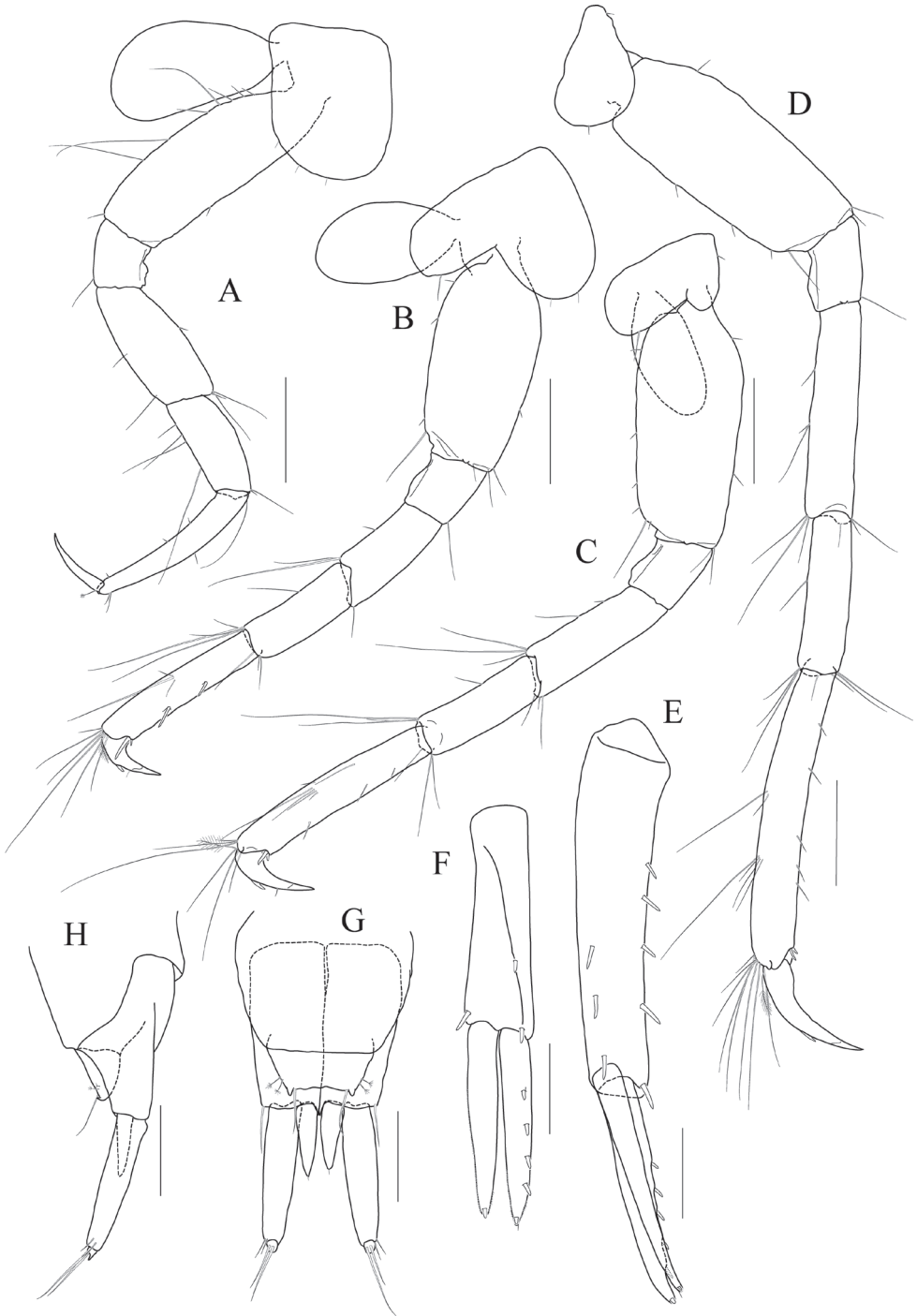


Figure 3 *Exiliphotis petila* sp. nov., holotype, NIBRIV0000806532, male. 3.7 mm, Daegwantal-do Island, South Korea. **A** pereopod 4 **B** pereopod 5 **C** pereopod 6 **D** pereopod 7 **E** uropod 1 **F** uropod 2 **G, H** uropod 3 and telson, dorsal (**G**) and lateral (**H**). Scale bars: 0.1 mm (**E-H**), 0.2 mm (**A-D**).

as long and wide as that of pereopod 5, slightly wider proximally; merus and carpus not lobate, each $0.6\times$ and $0.9\times$ as long as basis, with elongate setae at posteriodistal corners; propodus $1.6\times$ as long as carpus, anterior margin with simple setae and a pair of locking setae unequal in length; dactylus $0.4\times$ as long as propodus, armed with one accessory cusp on outer margin.

Pereopod 7 (Fig. 3D) $1.3\times$ as long as pereopod 6, slender; coxa unilobed, rounded ventrally, slightly dilated posterioventrally; basis subrectangular, as wide and $1.2\times$ as long as that of pereopod 6, $0.4\times$ as wide as long; merus slender, $0.8\times$ as long as basis slightly lobate posteriodistally; carpus not lobate, $0.7\times$ as long as merus; propodus $1.9\times$ as long as carpus, slightly curved, anterior margin with simple setae and a pair of locking setae unequal in length; dactylus $0.4\times$ as long as propodus, armed with one accessory cusp on outer margin.

Epimera 2–3 (Fig. 1A) subrectangular, rounded ventrally.

Uropod 1 (Fig. 3E) peduncle without distoventral spine, with five dorsolateral and three dorsomedial robust setae; outer ramus $0.6\times$ as long as peduncle, with five dorso-lateral robust setae, terminated by rounded apex bearing one robust seta; inner ramus as long as outer ramus, without marginal setae, terminated by rounded apex bearing one robust and one simple seta.

Uropod 2 (Fig. 3F) $0.7\times$ as long as uropod 1; peduncle without distoventral spine, $0.6\times$ as long as that of uropod 1, with one dorsomedial and two dorsolateral robust setae; outer ramus $0.9\times$ as long as peduncle, with four dorsolateral robust setae, terminated by rounded apex bearing one robust and one simple seta; inner ramus as long as outer ramus, without marginal setae, terminated by rounded apex bearing one robust seta.

Uropod 3 (Fig. 3G, H) $0.7\times$ as long as uropod 2; peduncle $0.7\times$ as long as that of uropod 2; inner ramus half as long as outer ramus, diminished distally, with minute apical seta; outer ramus as long as peduncle, biarticulated, 2nd article vestigial, with two elongate setae subapically.

Telson (Fig. 3G, H) trapezoidal in dorsal view, $2.1\times$ as wide as long, distal margin not acute, with one terminal spine, one simple seta, and two sensory setae on each side.

Remarks. See the remarks section under the genus.

Genus *Latigammaropsis* Myers, 1995

Korean name: Jjalb-eun-but-eun-ggo-ri-yeop-sae-u-sok

Latigammaropsis careocavata sp. nov.

<http://zoobank.org/69BD8FB5-D648-463A-958D-830CC7A423FF>

Figs 4–7

Korean name: Jjalb-eun-but-eun-ggo-ri-yeop-sae-u

Etymology. The composite epithet of the specific name, *careocavata*, is a combination of the Latin words *careo* and *cavatus*, meaning lacking excavation. This name refers to the shape of the palmar margin of gnathopod 2 in both sexes.

Material examined. Holotype: ♂ (7.5 mm), NIBRIV0000806529. Sogyeulbi-do Island, Gyeongsangnam-do, South Korea (34°34.571'N, 128°32.566'E), 7 May 2012, grab sampler (about 60 m depth), by Prof. HY Soh. Paratypes: 2 ♂♂ (4.5 and 4.8 mm), 3 ♀♀ (5.5–6.7 mm), NIBRIV0000848929. Same data as holotype.

Diagnosis. Gnathopod 2 stout in both sexes (similar in shape), but basis and propodus less setose anteriorly in females; propodus palmar margin oblique, slightly convex, serrated, without excavations, defined by a single stout spine and defining seta elongate, longer in males.

Description. Holotype male. Head (Fig. 4B) lateral cephalic lobe weakly produced anteriorly; eye lageniform, large; antennal sinus deep.

Antenna 1 (Fig. 4C, D) 0.6× as long as body; peduncle 1st article stout, 0.7× as long as head, with one robust seta posteriodistally; 2nd article 1.3× as long as 1st article; 3rd article 0.7× as long as 2nd article; accessory flagellum as long as peduncle 3rd article, composed of five articles (terminal article rudimentary); flagellum 0.9× as long as peduncle 1st–3rd articles combined, composed of twelve articles (terminal article rudimentary).

Antenna 2 (Fig. 4E, F) as long as antenna 1; peduncle 4th, 5th articles 0.9× as long as 2nd article of antenna 1; flagellum 1.4× as long as peduncle 5th article, composed of ten articles (terminal article rudimentary).

Upper lip (Fig. 4G) convex anteriorly, covered with minute setae.

Lower lip (Fig. 4H) inner lobe subovoid, outer lobe apex rounded, covered with minute setae; mandibular process well developed.

Mandibles (Fig. 4I, J) with 4-dentate incisor, 4-dentate lacinia mobilis, and eight raker setae on left mandible; with 5-dentate incisor and minutely dentate lacinia mobilis on right mandible, molar well developed, triturative; palp asymmetrical, composed of three articles, 3rd article distally rounded, 0.8× as long as 2nd article, with setae extending along most of posteriodistal margin.

Maxilla 1 (Fig. 4K, L) inner lobe small, subrectangular, produced laterodistally, with seven plumose setae; outer lobe nine dentate robust setae on apical margin; palp 2nd article slightly swollen laterally, apex with six dentate robust setae.

Maxilla 2 (Fig. 4M) inner lobe with an oblique row of plumose setae on surface; outer lobe slightly larger than inner lobe.

Maxilliped (Fig. 5A, B) inner lobe subrectangular, with three dentate robust setae apically and one medial robust seta subdistally; outer lobe semiovoid, apex beyond half of 2nd palp article, lined with eight robust setae on medial to apical margins; palp composed of four articles, 3rd article a little expanded distally, half as long as 2nd article, 4th article 0.4× as long as 3rd article, with elongate seta apically (1.3× as long as 4th article).

Gnathopod 1 (Fig. 5C) setose with elongate setae; coxa subrhomboid, 0.9× as wide as long, weakly produced anterioventrally, rounded ventrally; basis subtrapezoidal, swollen posteriodistally; carpus subtrapezoidal, 0.9× as long as basis, half as wide as long, with carpal lobe blunt; propodus subovoid, as long and wide as carpus, palm oblique, slightly convex, minutely serrated, not defined distinctively, with one robust seta medially; dactylus elongate, 0.7× as long as propodus, inner margin minutely serrated, with five teeth.

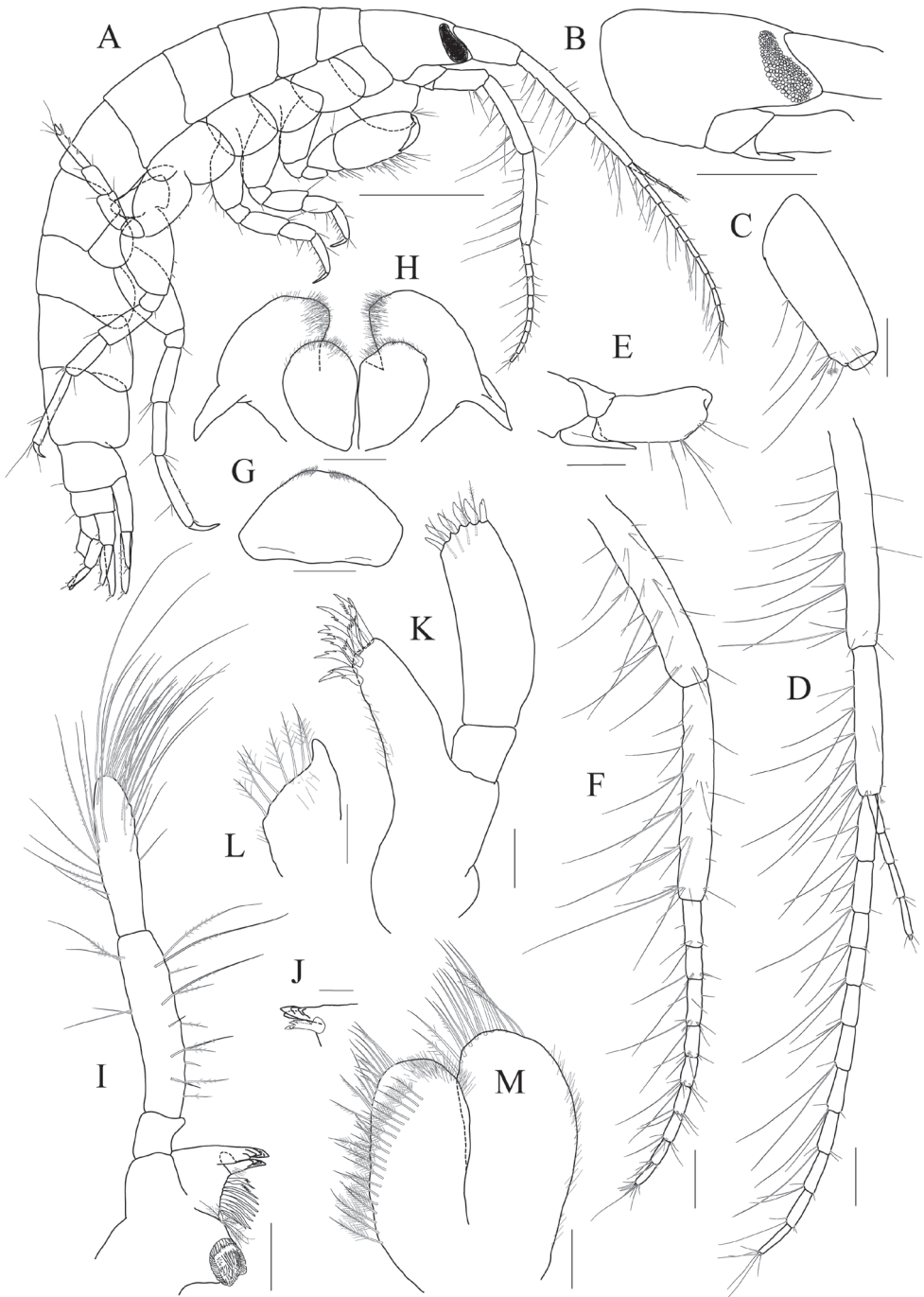


Figure 4 *Latigammaropsis careocavata* sp. nov., holotype, NIBRIV0000806529, male, 7.5 mm, Soguel-bi-do Island, South Korea. **A** habitus **B** head **C, D** antenna 1 **E, F** antenna 2 **G** upper lip **H** lower lip **I** left mandible **J** incisor and lacinia mobilis of right mandible **K, L** maxilla 1 **M** maxilla 2. Scale bars: 0.05 mm (**J–M**), 0.1 mm (**G–I**), 0.2 mm (**C–F**), 0.5 mm (**B**), 1.0 mm (**A**).

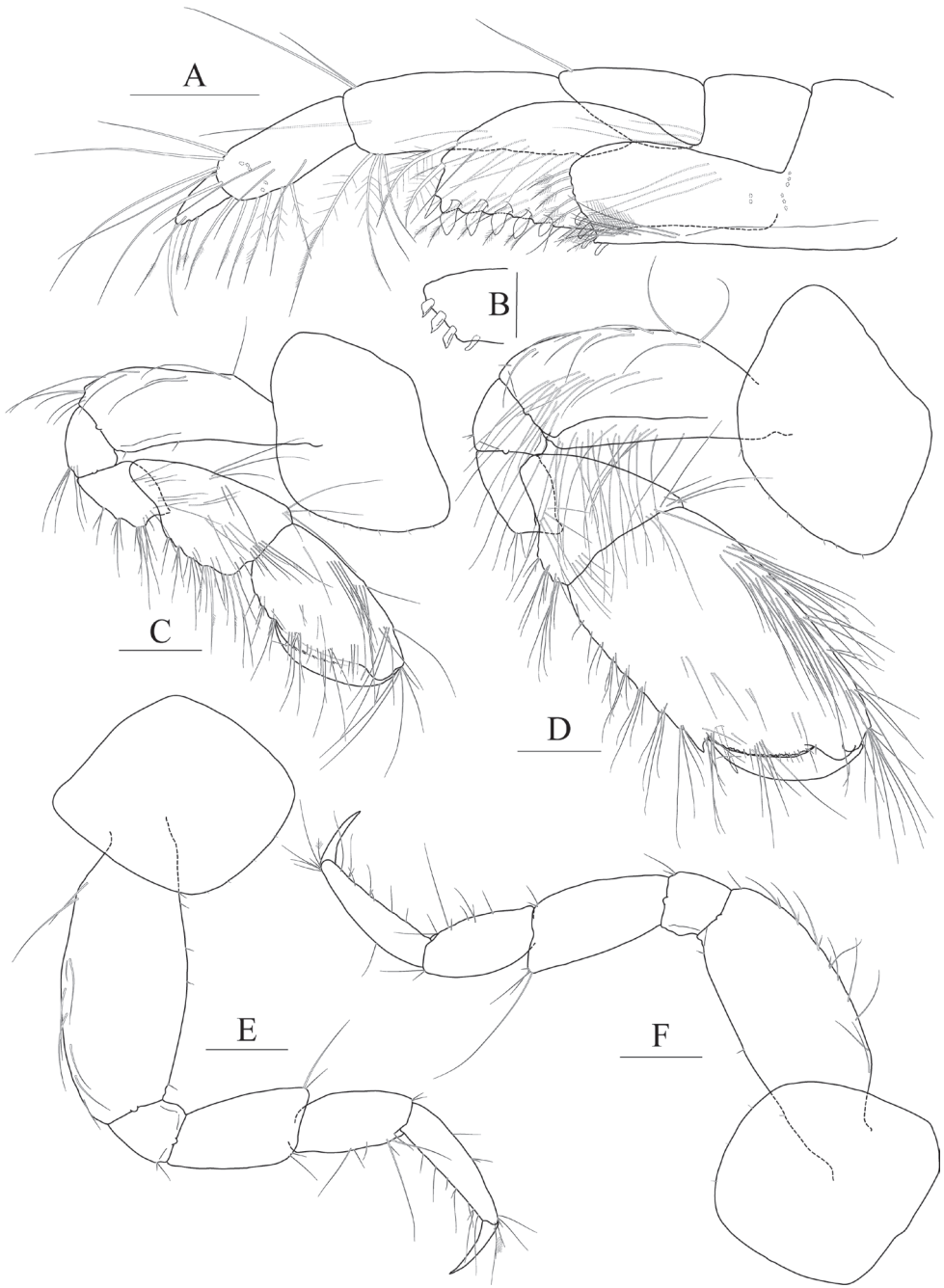


Figure 5 *Latigammaropsis careocavata* sp. nov., holotype, NIBRIV0000806529, male, 7.5 mm, Soguelbi-do Island, South Korea. **A, B** maxilliped **C** gnathopod 1 **D** gnathopod 2 **E** pereopod 3 **F** pereopod 4. Scale bars: 0.05 mm (**B**), 0.1 mm (**A**), 0.2 mm (**C–F**).

Gnathopod 2 (Fig. 5D) stout, 1.3× as long gnathopod 1, densely setose with elongate setae; coxa subrhomboid, as long as wide; basis subtrapezoidal, half as wide as long, anterior margin with lateral and medial borders forming weak lobes distally, posterior margin swollen; carpus 0.7× as long as basis, with carpal lobe not free from propodus posterior margin; propodus 1.3× as long as basis, 0.6× as wide as long, anterior and posterior margins subparallel, palmar margin oblique, half as long as posterior margin, slightly convex, weakly serrated, without excavation, defined by one stout spine, with one elongate robust seta medially; dactylus fitting palm.

Pereopod 3 (Fig. 5E) rarely setose than gnathopods; coxa subquadrate, 0.9× as long as that of gnathopod 2; basis expanded, 0.7× as wide as coxa, posterior margin more swollen in the middle, along with elongate setae; merus 0.4× as long as basis, expanded anteriodistally, half as wide as long; carpus as long as merus, not expanded; propodus half as long as basis, diminished distally; dactylus falcate, 1.2× as long as propodus.

Pereopod 4 (Fig. 5F) similar to pereopod 3, except for longer merus (half as long as basis).

Pereopod 5 (Fig. 6A) coxa bilobed, anterior lobe larger than posterior lobe, expanded and rounded ventrally; basis as wide as coxa anterior lobe, 0.8× as wide as long, anterior margin convex, posterior margin extremely expanded proximally, merus 0.6× as long as basis, slightly expanded anteriodistally; carpus subrectangular, 0.9× as long as merus, half as wide as long; propodus 1.3× as long as carpus, with three robust setae on posterior margin, with one pair of distal locking setae extremely unequal in length; dactylus 0.4× as long as propodus.

Pereopod 6 (Fig. 6B, C) 1.3× as long as pereopod 5; coxa 0.7× as wide as that of pereopod 5; bilobed, anterior lobe expanded downwards, posterior lobe as large as anterior lobe, expanded posteroventrally; basis subovoid, anterior margin evenly rounded, posterior margin expanded proximally, 0.6× as wide as long; merus slightly expanded distally, 0.4× as wide as long, 0.6× as long as basis; carpus rectangular, 0.9× as long as merus, 0.3× as wide as long; propodus 1.5× as long as carpus, with a pair of distal locking setae unequal in length, with a group of five setae (longest seta 0.7× as long as propodus) at anteriodistal corner; dactylus falcate, 0.4× as long as propodus.

Pereopod 7 (Fig. 6D) similar and 1.2× as long as pereopod 6; coxa unilobed, as wide as that of pereopod 6; slightly expanded posteroventrally; basis subovoid, as wide and 1.1× as long as that of pereopod 6, anterior margin evenly rounded, posterior margin expanded proximally; merus slightly expanded distally, 0.3× as wide as long, 0.6× as long as basis; carpus rectangular, as long as merus, 0.3× as wide as long; propodus 1.4× as long as carpus, with a pair of distal locking setae unequal in length at anteriodistal corner; dactylus falcate, 0.4× as long as propodus.

Epimera 1–3 each with a small notch bearing minute seta at posteroventral corner. Epimeron 1 rounded ventrally. Epimera 2 and 3 subrectangular (Fig. 6E).

Uropod 1 (Fig. 6F) peduncle with a well-developed distoventral spine, 0.7× as long as peduncle, with four dorsomedial and four dorsolateral robust setae on distal half margin; outer ramus 0.8× as long as peduncle, with three dorsolateral and two dorso-

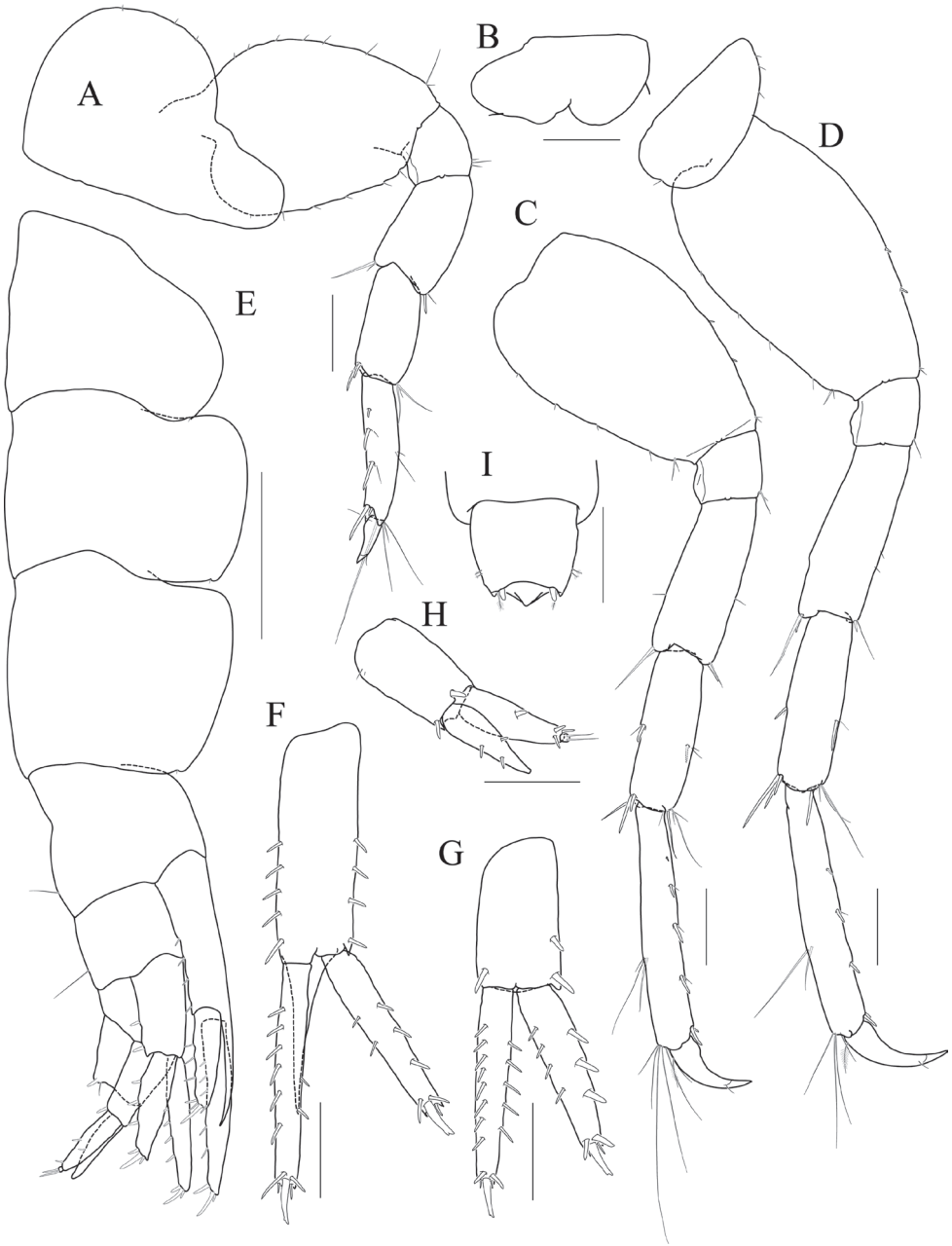


Figure 6 *Latigammaropsis careocavata* sp. nov., holotype, NIBRIV0000806529, male, 7.5 mm, Soguelbi-do Island, South Korea. **A** pereopod 5 **B, C** pereopod 6 **D** pereopod 7 **E** pleonites and urosomites, lateral **F** uropod 1 **G** uropod 2 **H** uropod 3 **I** telson. Scale bars: 0.2 mm (**A–D, F–I**), 0.5 mm (**E**).

medial robust setae, apex blunt bearing one group of robust setae; inner ramus 0.9× as long as peduncle, with two dorsolateral and six dorsomedial robust setae, apex blunt bearing one group of robust setae.

Uropod 2 (Fig. 6G) $0.7\times$ as long as uropod 1; peduncle $0.6\times$ as long as that of uropod 1, without distoventral spine, with one dorsomedial and two dorsolateral robust setae distally; outer ramus $1.1\times$ as long as peduncle, with three dorsolateral and four dorsomedial robust setae, apex blunt bearing one group of robust setae; inner ramus $1.3\times$ as long as peduncle, with five dorsolateral and eight dorsomedial robust setae, apex blunt bearing one group of robust setae.

Uropod 3 (Fig. 6H) $0.7\times$ as long as uropod 2; peduncle $0.8\times$ as long as that of uropod 2, with two robust setae distally; outer ramus as long as peduncle, biarticulated, 2nd article vestigial, with two elongate setae subdistally; inner ramus $0.9\times$ as long as peduncle, plump proximally but tapering distally.

Telson (Fig. 6I) subtrapezoidal in dorsal view, apex acute, with one robust seta on each side.

Paratype female. Gnathopod 1 (Fig. 7A) not sexually dimorphic between both sexes.

Gnathopod 2 (Fig. 7B) similar to that of holotype male in size, less setose anteriorly; basis posterior margin less swollen; palm defining robust seta smaller than that of holotype male.

Oostegites (Fig. 7C–F) those of gnathopod 2 and pereopod 3 elongate; that of pereopod 4 ovoid, widest; that of pereopod 5 small, half as long as that of pereopod 4, linear.

Remarks. The genus *Latigammaropsis* was established by Myers (2009) based on the ‘atlantica’ group of *Gammaropsis* sensu lato, and has been diagnosed by having a different shape of uropod 3: peduncle is shorter and broader; outer ramus is blunt-ended with a vestigial 2nd article bearing two fine setae; and inner ramus is subequal to or shorter than outer ramus, narrowing distally and with a single small robust seta inserted at its tip (Barnard 1965, 1970; Myers 1995, 2009). The Korean material examined in this study also shows these diagnostic characters and could be readily assigned to the genus *Latigammaropsis*. Moreover, this material was identified as a new species, with specimens notably characterized by the absence of excavations on the palmar margin of gnathopod 2 in both sexes. Usually, mature males of the genus *Latigammaropsis* have an excavated gnathopod 2 palmar margin and a smooth margin has been considered a feature of immature specimens (Barnard 1970). Unfortunately, the authors of this study only described one holotype male and one paratype female, so it is unknown if intraspecific variations are related to maturity in both sexes. However, we certainly confirmed their maturity based on the presence of lageniform eyes in both sexes as a sign of adulthood (Barnard 1965), and the ovigerous paratype female having a similar shaped gnathopod 2.

The shape of gnathopod 2 between both sexes is quite similar to each other, except for the more setose basis and propodus in males. A lack of strong sexual dimorphism in gnathopod 2 was described in *Latigammaropsis gemina* (Myers, 1995) and *Latigammaropsis christenseni* (Myers, 1995). However, *Latigammaropsis careocavata* sp. nov. differs from these species by the absence of an excavated palmar margin and the strongly setose basis and propodus of gnathopod 2 in males (Myers 1995).

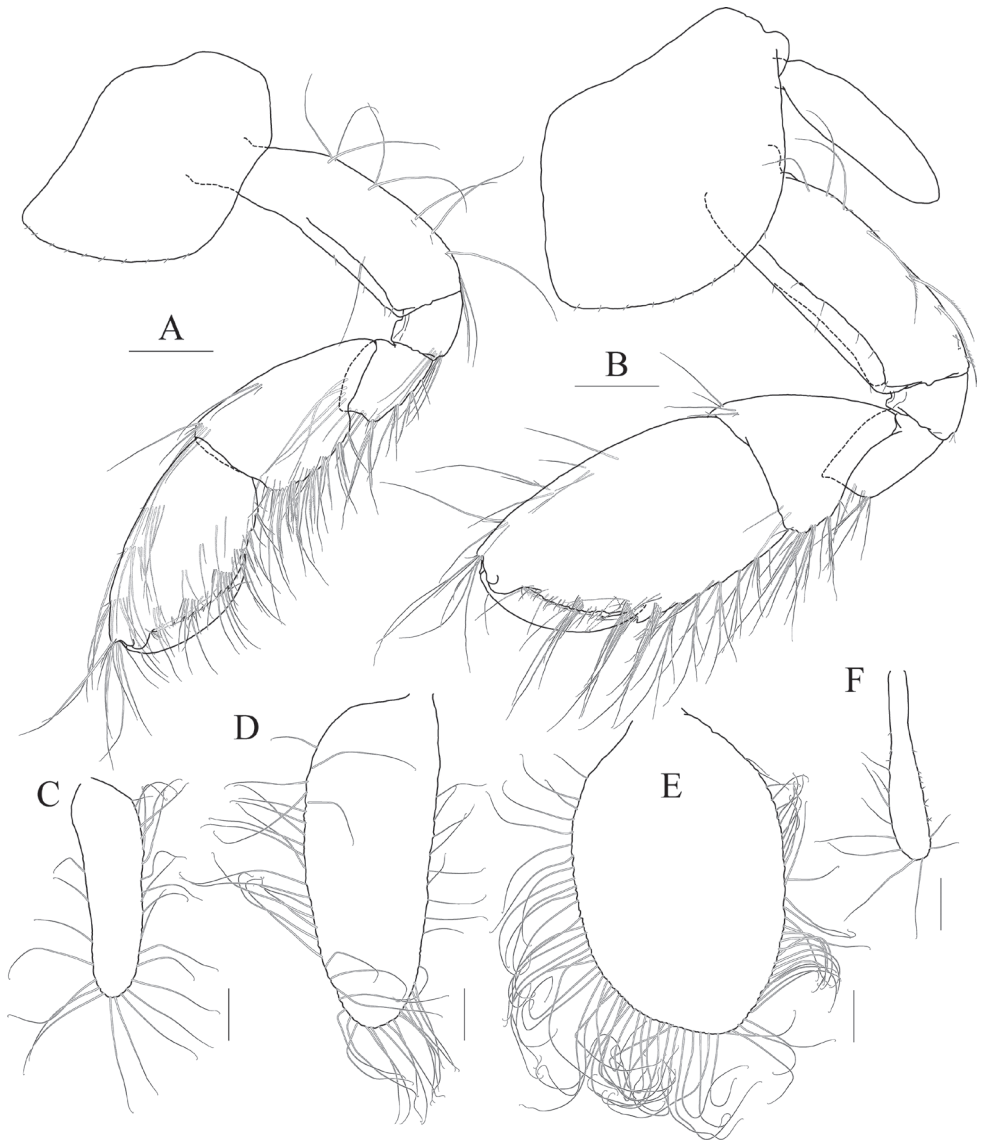


Figure 7 *Latigammaropsis careocavata* sp. nov., paratype, NIBRIV0000848929, female, 6.7 mm, So-gueulbi-do Island, South Korea. **A** gnathopod 1 **B** gnathopod 2 **C–F** oostegites of gnathopod 2–pereopod 5. Scale bars: 0.2 mm.

Until now, all known species of this genus have been recorded from tropical regions (Stebbing 1888; Schellenberg 1925, 1938; Barnard 1965, 1970; Ruffo 1969; Ledoyer 1978; Myers 1995, 2009, 2014; Myers and Nithyanandan 2016). This is the first record of the genus *Latigammaropsis* from Korean waters as well as from outside of the tropics.

Genus *Photis* Krøyer, 1842***Photis bronca* sp. nov.**

<http://zoobank.org/CE27564C-91FB-47A7-8500-9740799302A0>

Figs 8–11

Korean name: Dol-gi-son-i-hyeong-kko-ri-da-ri-yeop-sae-u

Photis longicaudata: Nagata 1965: 310, fig. 35; Hirayama 1984: 42, fig. 71; Kim et al. 2005: 3, figs 1, 2; Ren 1992: 259, fig. 28; 2000: 141, fig. 4; 2006: 398, fig. 171 [non *P. longicaudata* (Spence Bate & Westwood, 1862)].

Etymology. The epithet of the specific name, *bronca*, has its origin from the Latin word *bronus*. This name refers to the bearing of a quadrate tooth medially on the gnathopod 2 palmar margin in both sexes.

Material examined. Holotype: ♂ (5.8 mm), NIBRIV0000848472; Daryeo-do Island, Bukchon, Jeju-do, South Korea (34°33'27"N, 126°41'49"E); 30 Nov, 2012; grab sampler (about 20 m depth), by Prof. HY Soh. Paratypes: 2 ♂♂ (2.3 and 2.5 mm), 3 ♀♀ (ovigerous; 3.2–5.3 mm), NIBRIV0000848473; same data as holotype.

Additional materials: 3 ♂♂ 2 ♀♀, NIBRIV0000848930, Saekkiyeom, Ae-do Island, Mijo-myeon, Gyeongsangnam-do, South Korea (34°41'31"N, 128°02'00"E), 1 May 2009, Scuba diving (about 20 m depth), by TW Jung; 2 ♂♂, NIBRIV0000848931, Jeolmyeongyeo, Chuja-do Island, Jeju-do, South Korea (33°52'04"N, 126°18'43"E), 12 Jul, 2016, Scuba diving (about 16 m depth), by CH Yi; 3 ♂♂ 2 ♀♀, NIBRIV0000848932, Yena-ri, Goheung-gun, Jeollanam-do, South Korea (34°27'24"N, 127°31'16"E), 28 Mar 2017, washing macro-algae, by SH Kim.

Diagnosis. In both sexes, gnathopod 2 propodus palmar margin with subrectangular cavity bearing one rectangular tooth medially. Male gnathopod 2 basis lateral margin forming a well-developed sac-like lobe. Stridulated ridges only present on male gnathopod 2 basis and coxae 3 and 4 (absent in females).

Description. Holotype male. Head (Fig. 8A) as long as pereonites 1 and 2 combined; lateral cephalic lobe rounded; eye circular, moderate in size, located in the middle of lateral lobe; antennal sinus deep.

Antenna 1 (Fig. 8B) 0.4× as long as body; peduncle 1st article stout, 0.7× as long as head; 2nd article slender, 1.3× as long as 1st article; 3rd article 0.6× as long as 2nd article; accessory flagellum absent; flagellum 0.8× as long as peduncle 1st–3rd articles combined, composed of ten articles (terminal article rudimentary).

Antenna 2 (Fig. 8C) 1.1× as long as antenna 1; peduncle 3th article reaching end of lateral cephalic lobe; 4th article as long as 2nd article of antenna 1; 5th article as long as 4th article; flagellum 0.7× as long as peduncle 3rd–5th articles combined, composed of ten articles (terminal article rudimentary).

Upper lip (Fig. 8D) convex anteriorly, with notch in the middle, covered with minute setae.

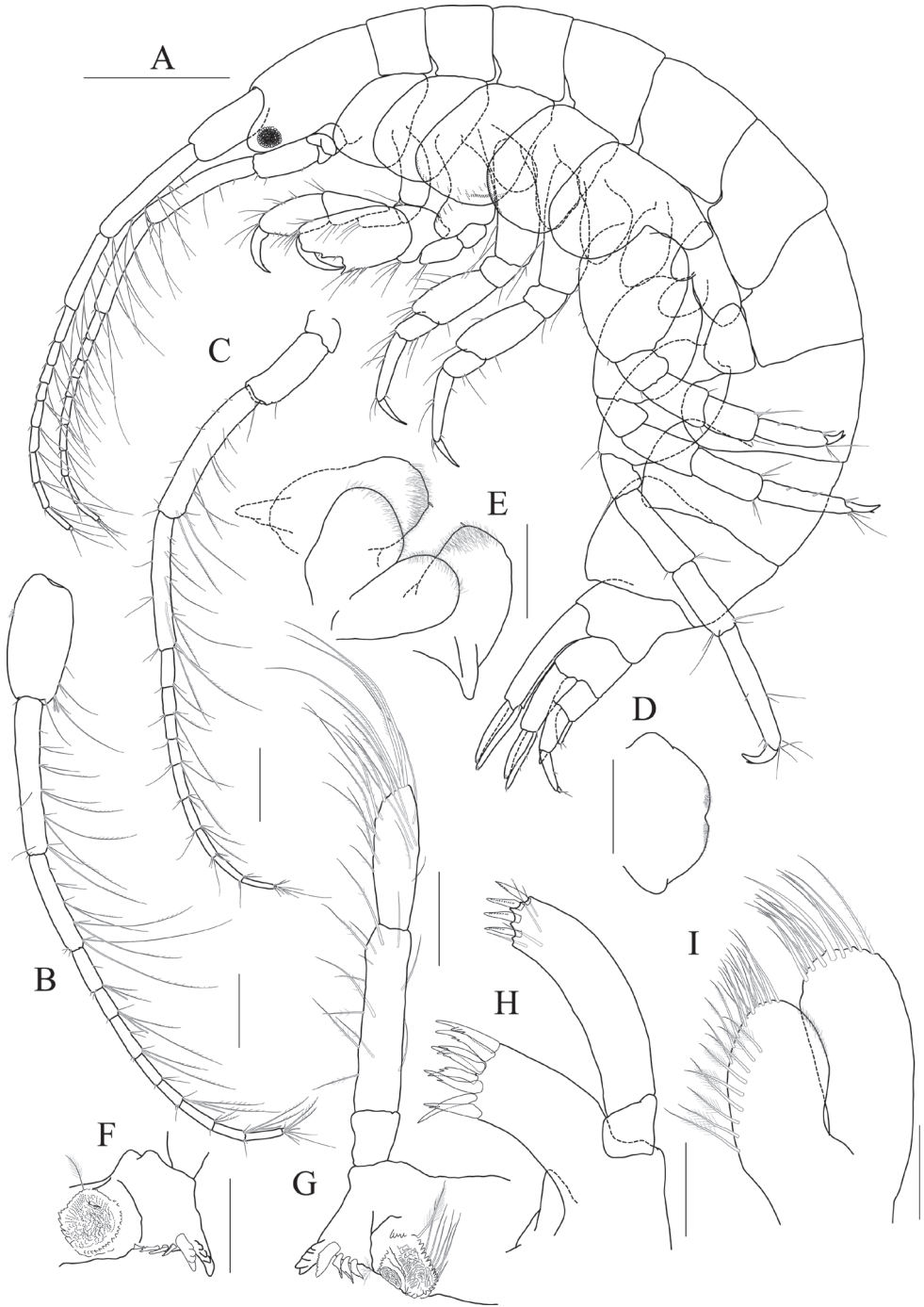


Figure 8 *Photis bronca* sp. nov., holotype, NIBRIV0000848472, male, 5.8 mm, Daryeo-do Island, South Korea. **A** habitus **B** antenna 1 **C** antenna 2 **D** upper lip **E** lower lip **F** left mandible **G** right mandible **H** maxilla 1 **I** maxilla 2. Scale bars: 0.1 mm (**D–I**), 0.2 mm (**B, C**), 0.5 mm (**A**).

Lower lip (Fig. 8E) inner lobe subovoid, outer lobe apex rounded, covered with minute setae, with one robust seta at mediobasal corner; mandibular process well developed.

Mandibles (Fig. 8F, G) with 4-dentate incisor, 4-dentate lacinia mobilis, and four raker setae on left mandible; with 5-dentate incisor, minutely dentate lacinia mobilis, and three raker setae on right mandible; molar well developed, triturative, with seven setae along the distal margin of right mandible; palp asymmetrical, composed of three articles, 3rd article distally rounded, 0.8× as long as 2nd article, with setae extending along most of posterodistal margin.

Maxilla 1 (Fig. 8H) inner lobe small, without minute setae; outer lobe with eight dentate robust setae on apical margin; palp biarticulated, distal article curved, with four dentate setae on apical margin.

Maxilla 2 (Fig. 8I) inner lobe with an oblique row of plumose setae on surface; outer lobe longer and slightly dilated distally than inner lobe.

Maxilliped (Fig. 9A) inner lobe subrectangular, a little expanded distally, with three nodular setae apically and one medial nodular seta subdistally; outer lobe exceeding half of palp 2nd article, lined with seven robust setae along apex to medial margin; palp composed of four articles, 3rd article slightly expanded distally, half as long as 2nd article, 4th article 0.8× as long as 3rd article, with elongate seta apically (as long as 4th article).

Gnathopod 1 (Fig. 9B) coxa subtrapezoidal, slightly extended distally, 0.7× as wide as long; basis as long as coxa, anterior margin lateral border forming weak lobe distally, with three elongate setae subproximally, posterior margin with three elongate setae at the middle; carpus subtrapezoidal, 0.7× as long as basis, half as wide as long, posterior lobe blunt; propodus as long and wide as carpus, rounded anteriorly, with minute serrations irregularly along palm and posterior margin, palm 0.6× as long as posterior margin, defined by one robust seta medially; dactylus 0.7× as long as propodus, exceeding palm, inner margin serrated, with two teeth.

Gnathopod 2 (Fig. 9C) stout, coxa subrectangular, 0.6× as wide as long, slightly extended and rounded anterioventrally; basis anterior margin lateral borders forming well-developed lobe distally (sac-like lobe reaching middle of merus) bearing oblique stridulated ridges on surface; ischium with small anterior lobe only; merus subrectangular, 0.4× as long as basis; carpus stout, anterior margin convex, carpal lobe well developed; propodus stout, as long as basis, 0.7× as wide as long, slightly widened distally, palmar margin defined by one large blunt spine, with small obtuse spine near dactylus base and robust seta near defining spine, concave subrectangularly, bearing quadrate tooth medially; dactylus half as long as propodus, with two teeth on inner margin.

Pereopod 3 (Fig. 9D, E) coxa widened distally, produced anterioventrally, 0.8× as wide as long, with stridulated ridges on medial surface and short stridulated ridges near the posterioventral corner on lateral surface submarginally; basis 0.4× as wide as long, with three plumose setae along distal half of anterior margin, posterior margin expanded, evenly rounded, with two elongate setae at the middle, with a pair of plumose and minute setae at distal corner; merus 0.7× as long as basis, anterior margin weakly expanded, with two plumose setae submarginally, distal corner somewhat produced,

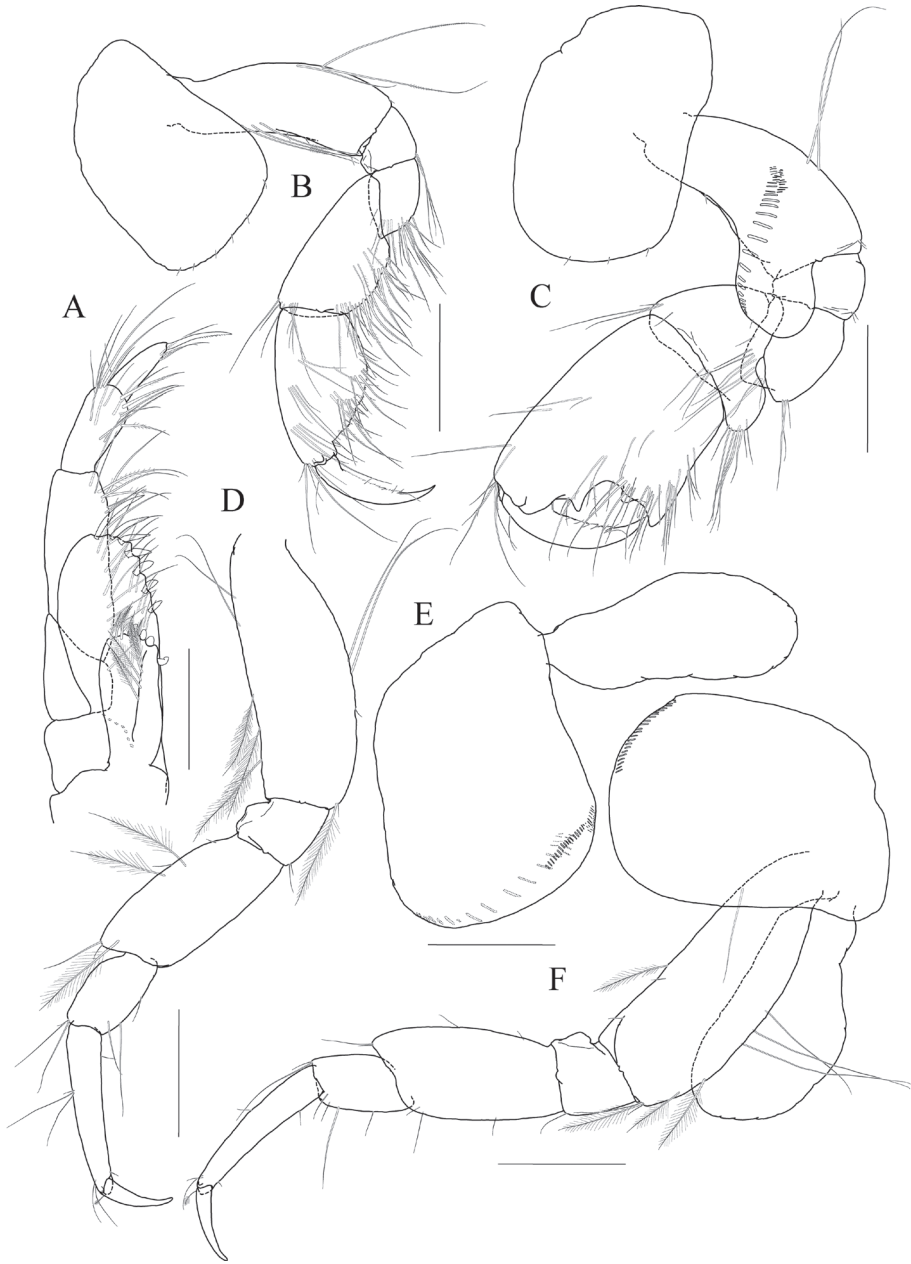


Figure 9 *Photis bronca* sp. nov., holotype, NIBRIV0000848472, male, 5.8 mm, Daryeo-do Island, South Korea. **A** maxilliped **B** gnathopod 1 **C** gnathopod 2 **D** pereopod 3 **E** coxa of pereopod 3 **F** pereopod 4. Scale bars: 0.1 mm (**A**), 0.2 mm (**B–F**).

with one plumose seta subapically; carpus subrectangular, half as long as and $0.7\times$ as wide as merus; propodus slender, diminished distally, $0.6\times$ as long as basis; dactylus $0.4\times$ as long as propodus.

Pereopod 4 (Fig. 9F) coxa slightly widened distally, as long as that of pereopod 3, with stridulated ridges along anterioventral corner more oblique than that of female; basis $0.4\times$ as wide as long, with one plumose seta at the middle of anterior margin, posterior margin expanded, evenly rounded, with three elongate setae at the middle, with three plumose setae distally; merus $0.7\times$ as long as basis, anterior margin weakly expanded, distal corner somewhat produced; carpus half as long as and $0.7\times$ as wide as merus, propodus slender, diminished distally, $0.6\times$ as long as basis; dactylus $0.4\times$ as long as propodus.

Pereopod 5 (Fig. 10A) coxa bilobed, large, anterior lobe subovoid, $0.7\times$ as wide, expanded ventrally, posterior lobe small, expanded backwards; basis subovoid, broad, more expanded proximally, $0.8\times$ as wide as long; merus subrectangular, half as long as basis, half as wide as long; carpus subrectangular, as long and wide as merus; propodus $1.1\times$ as long as carpus, with a pair of distal locking setae unequal in length (longer seta $0.8\times$ as long as dactylus), with a group of four setae (longest seta $0.6\times$ as long as propodus) at anteriodistal corner; dactylus $0.4\times$ as long as propodus, armed with one accessory cusp on outer margin.

Pereopod 6 (Fig. 10B, C) $1.2\times$ as long as pereopod 5; coxa bilobed, anterior lobe small, posterior lobe weakly dilated posteroventrally; basis subovoid, $0.8\times$ as wide as long, anterior margin convex, posterior margin slightly dilated proximally; merus half as long as basis, $0.4\times$ as wide as long; carpus as long and $0.9\times$ as wide as merus; propodus $1.3\times$ as long as carpus, with one pair of distal locking setae unequal in length (longer seta $0.6\times$ as long as dactylus), with one group of five setae (longest seta half as long as propodus) at anteriodistal corner; dactylus $0.4\times$ as long as propodus, armed with one accessory cusp on outer margin.

Pereopod 7 (Fig. 10D, E) $1.2\times$ as long as pereopod 6; coxa unilobed, dilated posteroventrally; basis subovoid, $0.8\times$ as wide as that of pereopod 6, $0.7\times$ as wide as long, anterior margin rather convex, posterior margin with one blunt extension proximally; merus subrectangular, a little extended posteriodistally, $0.6\times$ as long as basis; carpus rectangular, $0.9\times$ as long as merus, $0.4\times$ as long as wide; propodus $1.6\times$ as long as carpus, with one pair of distal locking setae subequal (smaller than those of pereopods 5 and 6); dactylus $0.4\times$ as long as propodus, armed with one accessory cusp on outer margin.

Epimeron 1 slightly extended anterioventrally. Epimera 2 and 3 with each posteroventral corner produced backwards, but not acute (Fig. 10F).

Uropod 1 (Fig. 10G) peduncle without distoventral spine, but bearing small acute extension, with six dorsolateral and three dorsomedial robust setae; inner ramus $0.6\times$ as long as peduncle, with one subapical seta only; outer ramus $0.9\times$ as long as inner ramus, with three dorsolateral setae and one subapical seta.

Uropod 2 (Fig. 10H) $0.7\times$ as long as uropod 1; peduncle $0.6\times$ as long as that of uropod 1, with small acute extension distoventrally; inner ramus $0.9\times$ as long as peduncle, with two dorsomedial setae and one subapical seta; outer ramus $0.8\times$ as long as inner ramus, with two dorsolateral setae and one subapical seta.

Uropod 3 (Fig. 10I) $0.7\times$ as long as uropod 2; peduncle $0.8\times$ as long as that of uropod 2; outer ramus biarticular, $0.6\times$ as long as peduncle, last article vestigial, with two elongate setae subapically; inner ramus scale-like, $0.3\times$ as long as outer ramus.

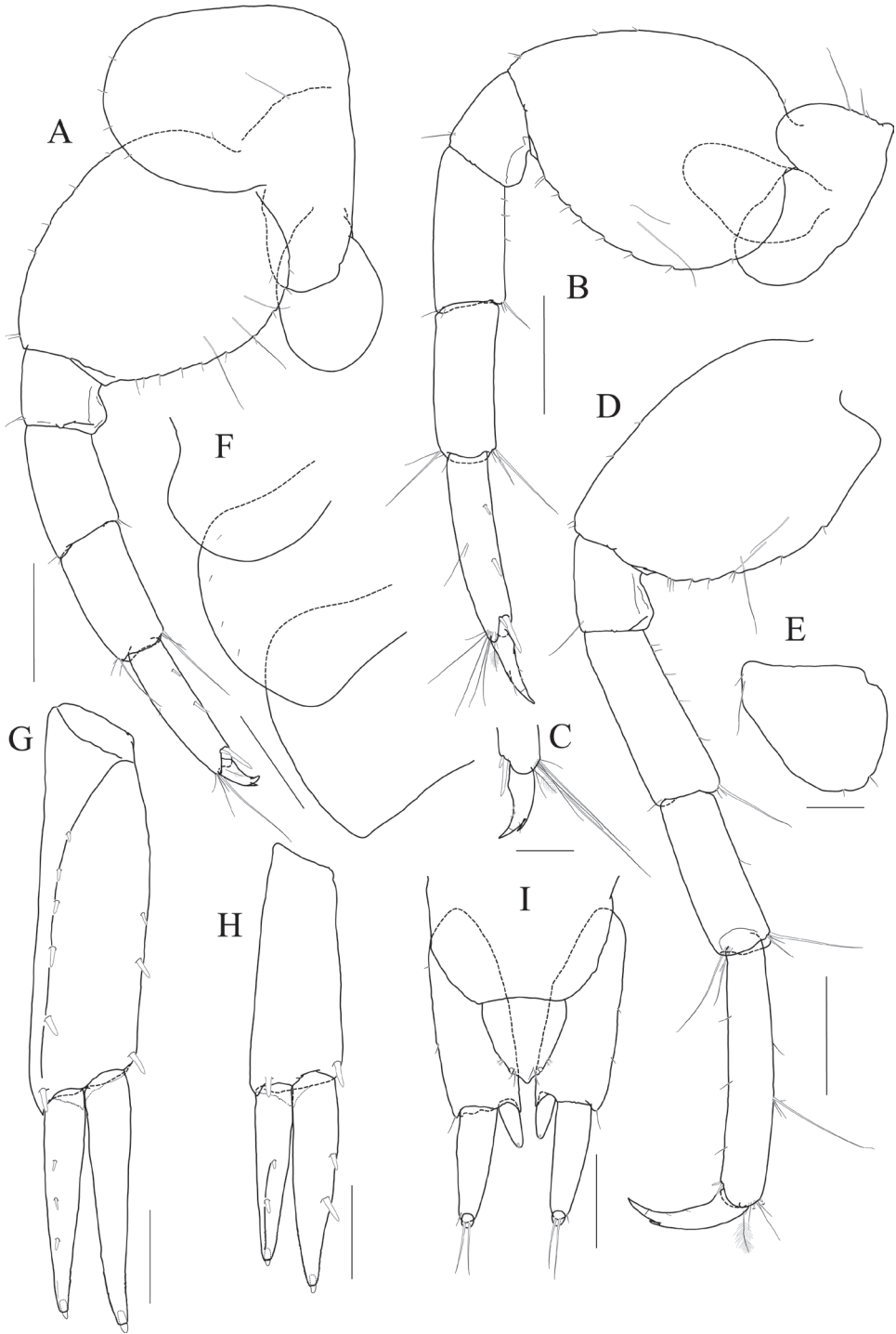


Figure 10 *Photis bronca* sp. nov., holotype, NIBRIV0000848472, male, 5.8 mm, Daryeo-do Island, South Korea. **A** pereopod 5 **B**, pereopod 6 **C** dactylus of pereopod 6 **D** coxa of pereopod 7 **E** pereopod 7 **F** uropod 1 **G** uropod 2 **H** uropod 3 and telson. Scale bars: 0.1 mm (**C**, **E**, **G**–**I**), 0.2 mm (**A**, **B**, **D**, **F**).

Telson (Fig. 10I) subtriangular in dorsal view, with a pair of simple setae, a pair of sensory setae, and one nodular robust seta on each side.

Paratype female. Gnathopod 1 (Fig. 11A) not sexually dimorphic.

Gnathopod 2 (Fig. 11B) stouter than female gnathopod 1, slightly smaller than that of male; coxa subrectangular, $1.5\times$ as long as wide, evenly rounded anterioventrally, oostegite $1.2\times$ as long as basis, $2.9\times$ as long as wide; basis anterior margin lateral borders forming lobe distally, but smaller than that of male (not exceeding ischium), without stridulated ridges on surface; ischium with small anterior lobe only; merus rectangular, $0.4\times$ as long as basis; carpus stout, anterior margin convex, carpal lobe well developed; propodus stout, $0.8\times$ as long as basis, $0.7\times$ as wide as long, not widened distally, palmar margin cavity subquadrate, bearing one quadrate tooth medially, proximal and defining spines weaker than those of male, with one robust defining seta medially; dactylus half as long as propodus, inner margin minutely serrated, with three teeth.

Pereopod 3 (Fig. 11C) not sexually dimorphic except for the absence of both medial and lateral stridulated ridges on coxa; oostegite $1.5\times$ as long as that of gnathopod 2.

Pereopod 4 (Fig. 11D) coxa without stridulated ridges at anterioventral corner, basis posterior margin more expanded distally, with twelve plumose setae along distal half.

Pereopod 5 oostegite (Fig. 11E) half as long as that of pereopod 4.

Remarks. *Photis bronca* sp. nov. has been misidentified as *Photis longicaudata* (Spence Bate & Westwood, 1862) in the Far East including Korea (Kim et al. 2005), Japan (Nagata 1965; Hirayama 1984), and China (Ren 1992, 2000, 2006). The authors re-examined the syntype series of *P. longicaudata* deposited at the Natural History Museum, London (NHMUK 1911.20899–20906; Figs 12, 13) and several specimens, which were collected from the North Sea, at the Museum für Naturkunde Berlin (ZMB 11656) to confirm the validity of *P. longicaudata* in Korean waters. As a result, the material formerly identified as *P. longicaudata* from Japan and China, as well as the Korean material, is herein described as a new species based on the following differences when compared with the newly designated *P. longicaudata* lectotype (NHMUK 1911.20899; Fig. 12): gnathopod 1 palmar margin has a robust defining seta medially in both sexes (absent in the *P. longicaudata* lectotype); gnathopod 2 palmar margin has a quadrate tooth medially in both sexes (obviously absent in the *P. longicaudata* lectotype); the sac-like lobe of male gnathopod 2 basis is much larger than that of *P. longicaudata* (slightly exceeding the ischium in the *P. longicaudata* lectotype); the anterior margin of male gnathopod 2 propodus is a little rounded (slightly shorter and more swollen in the *P. longicaudata* lectotype); the palmar margin of male gnathopod 2 propodus has more produced spines (slightly produced in the *P. longicaudata* lectotype); male pereopod 3 coxa has a different pattern of stridulated ridges; the male pereopod 4 coxa has stridulated ridges on the anterior half of the ventral margin (absent in the *P. longicaudata* lectotype); and female gnathopod 2 palmar margin is concave subrectangularly (more oblique and recessed in the *P. longicaudata* lectotype) (Bate and Westwood 1863; Sars 1895; Nagata 1965; Hirayama 1984; Ren 1992, 2000, 2006; Kim et al. 2005; see Figs 12, 13).

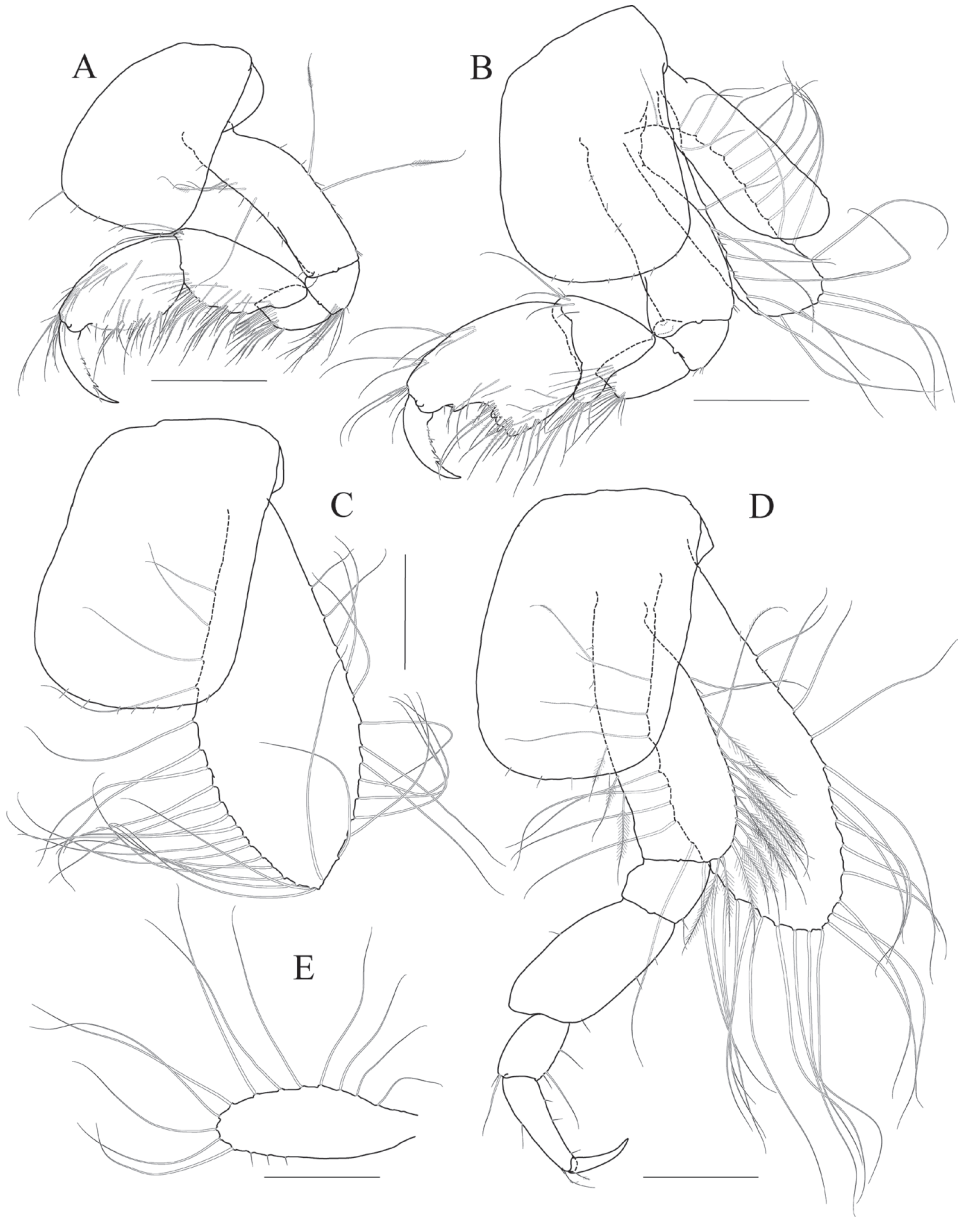


Figure 11 *Photis bronca* sp. nov., paratype, NIBRIV0000848473, female, 5.3 mm, Daryeo-do Island, South Korea. **A** gnathopod 1 **B** gnathopod 2 **C** coxa and oostegite of pereopod 3 **D** pereopod 4 **E** oostegite of pereopod 5. Scale bars: 0.2 mm.

It is well known that both *Photis aina* JL Barnard, 1970 and *Photis kapapa* JL Barnard, 1970 from the Hawaiian Islands have affinities with *P. longicaudata* in that gnathopod 2 has very well-developed (sac-like) anterior lobe of the basis (JL Barnard 1970). Among them, *Photis bronca* sp. nov. differs from *P. aina*, regarding the eyes being in the

middle of the cephalic lobe (occupying the end of the cephalic lobe in *P. aina*), lacking the defining seta on the palmar margin of male gnathopod 1 (with one robust seta medially in *P. aina*), lacking posteroventral notches of epimera 2 and 3, and a shorter inner ramus of uropod 2 (about half length in *P. aina*) (Barnard 1970; Myers 1985, 2009). *Photis bronca* sp. nov. can be distinguished from *P. kapapa* by the following differences: the eyes occupying at the middle of the cephalic lobe (at the end of the cephalic lobe in *P. kapapa*), lacking stridulated ridges in both posterior margins of the coxae of gnathopods 1 and 2, 0.7 times as wide as long male gnathopod 2 (0.8 times in *P. kapapa*), the female palmar margin of gnathopod 2 with a small obtuse spine near the dactylus base (without spine in *P. kapapa*), the presence of one accessory cusp on pereopod 5 dactylus (two accessory cusps in *P. kapapa*), subacutely produced posterior margin of epimeron 3 (rounded in *P. kapapa*), and uropod 3 outer ramus with the length of 0.6 times as long as the peduncle (0.9 times in *P. kapapa*) (Barnard 1970; Ren 2006).

Photis bronca sp. nov. resembles *Photis davei* Myers, 2009 in the shapes of elongate propodus of pereopods 3 and 4 as well as the outlines of gnathopods in both sexes, but the former differs from the latter in the presence of a well-developed sac-like lateral lobe on the basis of male gnathopod 2 (present but very weak in *P. davei*) and not-elongate rami of uropods 1 and 2 (Myers 2009).

Photis fischmanni Gurjanova, 1951 also has a similar gnathopod 2 shape in both sexes, but *P. bronca* sp. nov. is clearly different from this species by elongate antenna 1 and 2 (0.4 times as long as the body in *P. bronca* sp. nov., but less than 0.3 times in *P. fischmanni*), less expanded carpus and propodus of gnathopod 1, and less setose appendages than *P. fischmanni* (Gurjanova 1951, 1955; Conlan 1983).

This new species differs from *Photis paeowai* Myers, 1995 and *Photis pirloti* Myers, 1985 by bearing a well-developed sac-like lateral lobe on the basis of male gnathopod 2 (present but rather weak in *P. paeowai* and *P. pirloti*) and a quadrate medial tooth on the palmar margin of gnathopod 2 in both sexes (absent in *P. paeowai* and *P. pirloti*) (Myers 1985, 1995).

***Photis longicaudata* (Spence Bate & Westwood, 1862)**

Figs 12–13

Eiscladus longicaudatus Spence Bate & Westwood, 1862: 412.

Heiscladus longicaudatus Norman, 1869: 284.

Heiscladius longicaudatus Norman, 1874: 269.

Photis longicaudata: Sars 1894: 571, pl. 203, fig. 1; Stebbing 1906: 608; Chevreux and Fage 1925: 310; Schellenberg 1942: 201; Lincoln 1979: 518, figs 237a, 248a–g; Myers and McGrath 1981: 766.

Material examined. Lectotype: ♂, NHMUK 1911.20899. Shetlands, UK, 1861, by AM Norman. Paralectotypes: 7 specimens, NHMUK 1911.20900–20906. Same data as lectotype.

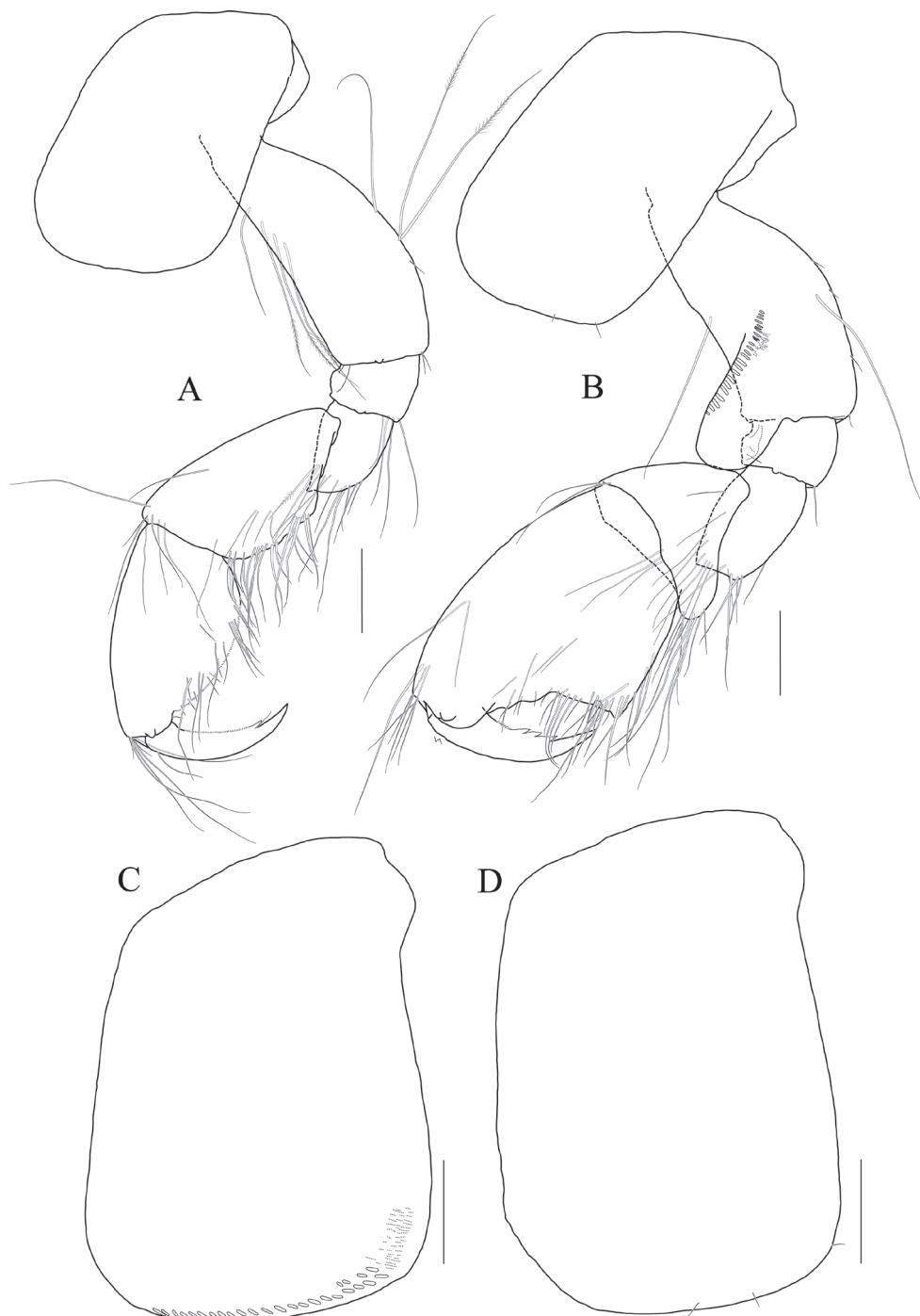


Figure 12 *Photis longicaudata* (Spence Bate & Westwood, 1862), lectotype, NHMUK 1911.20899, male. 3.2 mm, Shetland Islands, UK. **A** gnathopod 1 **B** gnathopod 2 **C** coxa of pereopod 3 **D** coxa of pereopod 4. Scale bars: 0.1 mm.



Figure 13 *Photis longicaudata* (Spence Bate & Westwood, 1862), paralectotype, NHMUK 1911.20890–20896, females. 5.3 mm (**A**, **B**) and 3.4 mm (**C**, **D**), Shetland Islands, UK **A** gnathopod 1 **B** gnathopod 2 **C** gnathopod 1 **D** gnathopod 2. Scale bars: 0.1 mm.

Additional material: 3 ♀♀, ZMB 11656. Nordsee, the North Sea, 1903, by Breidow.

Remarks. The materials identified as *Photis longicaudata* from the Far East including Korea, Japan, and China were re-examined in the present study, and turned to the new species, *Photis bronca* sp. nov. See the remarks of *Photis bronca* sp. nov.

***Photis longicarpus* sp. nov.**

<http://zoobank.org/EF85D444-15FD-435E-8813-95EE183B8E4D>

Figs 14–17

Korean name: Gin-pal-i-hyeong-kko-ri-da-ri-yeop-sae-u

Etymology. The composite epithet of the specific name, *longicarpus*, is a combination of the Latin words *longus* and *carpus*, meaning elongate carpus. This name refers to the elongate shape of the carpus of gnathopod 2 in males.

Material examined. Holotype: ♂ (4.9 mm), NIBRIV0000753910. Geomeunyeo, Jeju-do Island, South Korea (33°14'23"N, 126°34'59"E), 30 Dec 2012, grab sampler (about 24 m depth), by Prof. HY Soh. Paratypes: 5 ♂♂ (3.2–4.5 mm) and 1 ♀ (3.1 mm), NIBRIV0000848928. Same data as holotype.

Diagnosis. Gnathopod 1 elongate; coxa produced anterioventrally; basis 1.2× as long as coxa; merus half as long as basis; carpus elongate, 0.9× as long as basis; propodus half as long as carpus. Gnathopod 2 basis lateral borders forming developed lobe anteriodistally (not sac-like), with oblique stridulated ridges on the surface; carpus slightly elongate but shorter than that of gnathopod 1, 0.6× as long as basis; propodus stout, subovoid, 1.2× as long as carpus, palm defined by one acute spine. Female gnathopod 1 not elongate. Female gnathopod 2 as long as female gnathopod 1, but stouter; coxa anterioventral production weaker than that of male; basis with oblique stridulated ridges on lateral surface; merus 0.4× as long as basis; carpus 0.4× as long as basis; propodus without defining spine, but bearing defining robust seta medially. Pereopod 3 coxa with stridulated ridges on the surface along the ventral margin laterally in both sexes. Uropod 3 outer ramus biarticulated, 2nd article vestigial; inner ramus scale-like, 0.2× as long as outer ramus.

Description. Holotype male. Head (Fig. 14A) 0.8× as long as pereonite 1; lateral cephalic lobe subtriangular; eye small, circular; antennal sinus deep.

Antenna 1 (Fig. 14B) peduncle 1st article stout, 0.7× as long as head; 2nd article slender, 1.3× as long as 1st article; 3rd article 0.8× as long as 2nd article; accessory flagellum absent; flagellum 0.6× as long as peduncle 1st–3rd articles combined, composed of seven articles (terminal article rudimentary).

Antenna 2 (Fig. 14C) 1.2× as long as antenna 1; peduncle 3rd article exceeding end of cephalic lobe, 0.4× as long as 4th article; 4th article 1.1× as long as 2nd article of antenna 1; 5th article 0.9× as long as 4th article; flagellum 0.6× as long as peduncle 3rd–5th articles combined, composed of six articles (terminal article rudimentary).

Upper lip (Fig. 14D) convex anteriorly, entire, covered with minute setae.

Mandibles (Fig. 14E, F) with 5-dentate incisor, 4-dentate lacinia mobilis, and five raker setae on left mandible; with 6-dentate incisor, minutely dentate lacinia mobilis, and three raker setae on right mandible; molar well developed, triturative, with seven setae along the distal margin of right mandible; palp asymmetrical, composed of three articles, 3rd article distally rounded, 0.8× as long as 2nd article, with setae extending along most of posteriodistal margin.

Maxilla 1 (Fig. 14G, H) outer lobe with nine dentate robust setae on apical margin; palp biarticulated, distal article curved, a little swollen, with five setae on apical margin.

Maxilla 2 (Fig. 14I) inner lobe with an oblique row of plumose setae on surface; outer lobe longer and slightly dilated distally than inner lobe.

Maxilliped (Fig. 15A) inner lobe subrectangular, slightly expanded distally, with three nodular setae apically and one medial nodular seta subdistally; outer lobe exceeding half of palp 2nd article, lined with eight robust setae along apex to medial margin; palp composed of four articles, 3rd article slightly expanded distally, half as long as 2nd article, 4th article 0.6× as long as 3rd article, with elongate seta apically (1.1× as long as 4th article).

Gnathopod 1 (Fig. 15B, C) elongate; coxa subtriangular, half as wide as long, tapering and produced anterioventrally; ventral margin evenly rounded with six setae; basis subtrapezoidal, 1.2× as long as coxa, anterior margin lateral border lobate distally, with three plumose setae subproximally, posterior margin convex, more swollen at the middle, with six elongate setae; merus half as long as basis; carpus elongate, 0.9× as long as basis, 0.3× as wide as long, slightly widened distally, carpal lobe not developed; propodus half as long as carpus, rounded anteriorly, palm half as long as posterior margin, serrated irregularly, slightly concave, defined by one robust seta medially; dactylus half as long as propodus, with five teeth (proximal three minute) on inner margin.

Gnathopod 2 (Fig. 15D) stout, 0.7× as long as gnathopod 1; coxa subtrapezoidal, 1.4× as long as that of gnathopod 1, 0.4× as wide as long, produced anterioventrally; basis 0.7× as long as coxa, 0.4× as wide as long, anterior margin lateral borders forming developed lobe (but not sac-like) distally bearing oblique stridulated ridges on surface, posterior margin convex, with three elongate setae at the middle; merus 0.6× as long as basis; carpus slightly elongate but shorter than that of gnathopod 1, 0.6× as long as basis, with moderate carpal lobe posteriorly; propodus stout, subovoid, 1.2× as long as carpus, anterior margin evenly rounded, posterior margin 0.7× as long as anterior margin, palm oblique, half as long as posterior margin, defined by one acute spine; dactylus 0.4× as long as propodus, with two teeth on inner margin.

Pereopod 3 (Fig. 15E) coxa widened ventrally, somewhat curved, 0.9× as long as that of gnathopod 2, 0.7× as wide as long, with stridulated ridges on surface along ventral margin laterally; basis expanded posteriorly, 0.4× as wide as long, posterior margin convex, with four plumose setae in the middle; merus 0.7× as long and 0.6× as wide as basis, anterior margin weakly expanded, with twelve plumose setae submarginally, distal corner weakly produced; posterior margin not expanded, with four plumose setae; carpus half as long as merus; propodus diminished distally, half as long as basis; dactylus half as long as propodus.

Pereopod 4 (Fig. 16A) coxa not widened distally, slightly curved, half as wide as long, without stridulated ridges; other articles similar to those of pereopod 3 in shape, but plumose setae different in position.

Pereopod 5 (Fig. 16B) coxa 0.9× as long as that of pereopod 4, bilobed, anterior lobe subovoid, expanded ventrally, posterior lobe small, extended backwards; basis subovoid, broad, more expanded proximally, as long as wide, with four plumose setae on medial surface anterioproximally; merus subrectangular, a little lobate anteriodistally, 0.4× as long as basis, half as wide as long; carpus rectangular, as long and 0.9× as wide as merus; propodus 0.9× as long as carpus, with a pair of distal locking setae

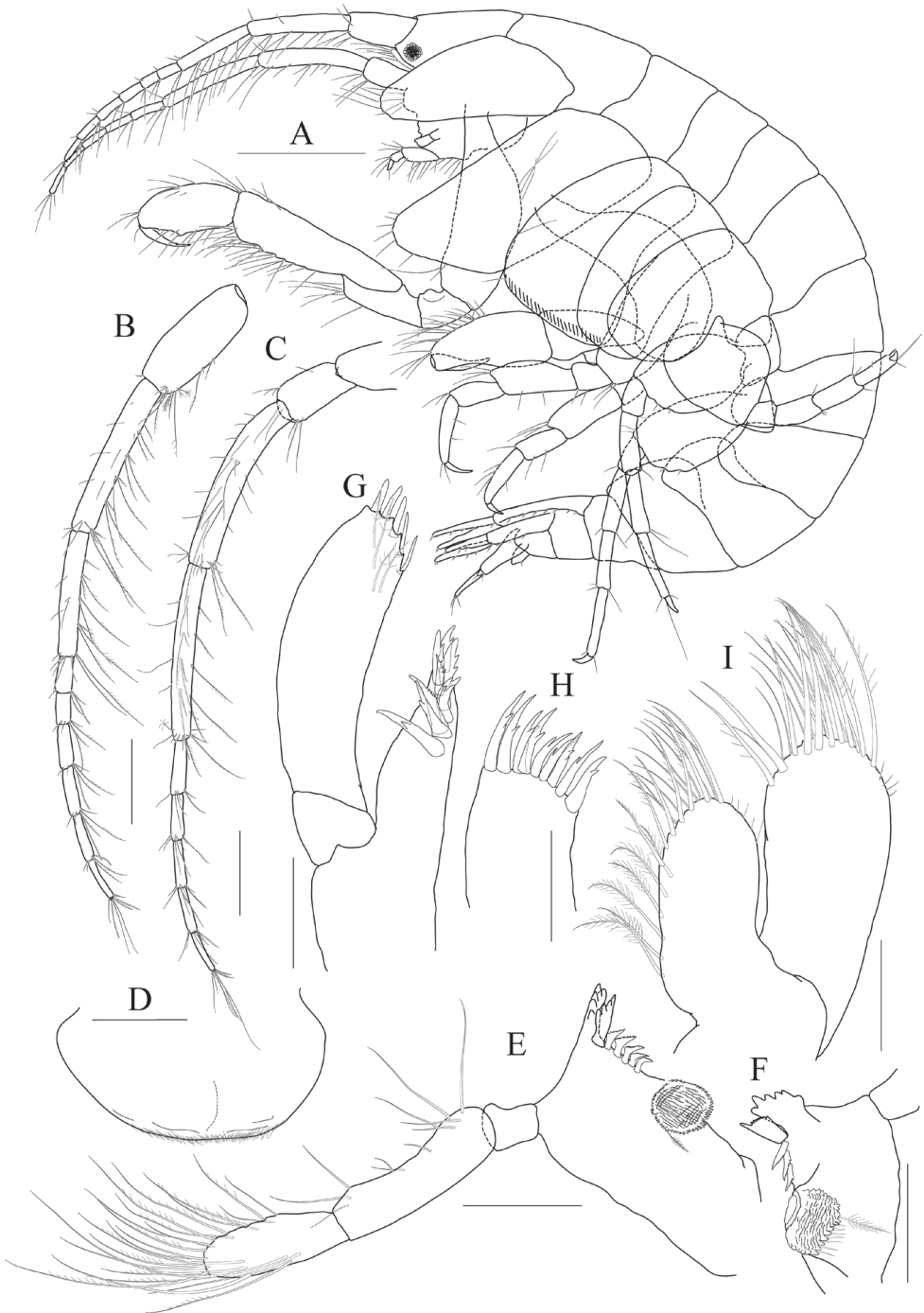


Figure 14 *Photis longicarpus* sp. nov., holotype, NIBRIV0000753910, male, 4.9 mm, Geomeunyeo, Jeju-do, South Korea. **A** habitus **B** antenna 1 **C** antenna 2 **D** upper lip **E** left mandible **F** right mandible **G, H** maxilla 1 **I** maxilla 2. Scale bars: 0.05 mm (**D, G–I**), 0.1 mm (**E, F**), 0.2 mm (**B, C**), 0.5 mm (**A**).

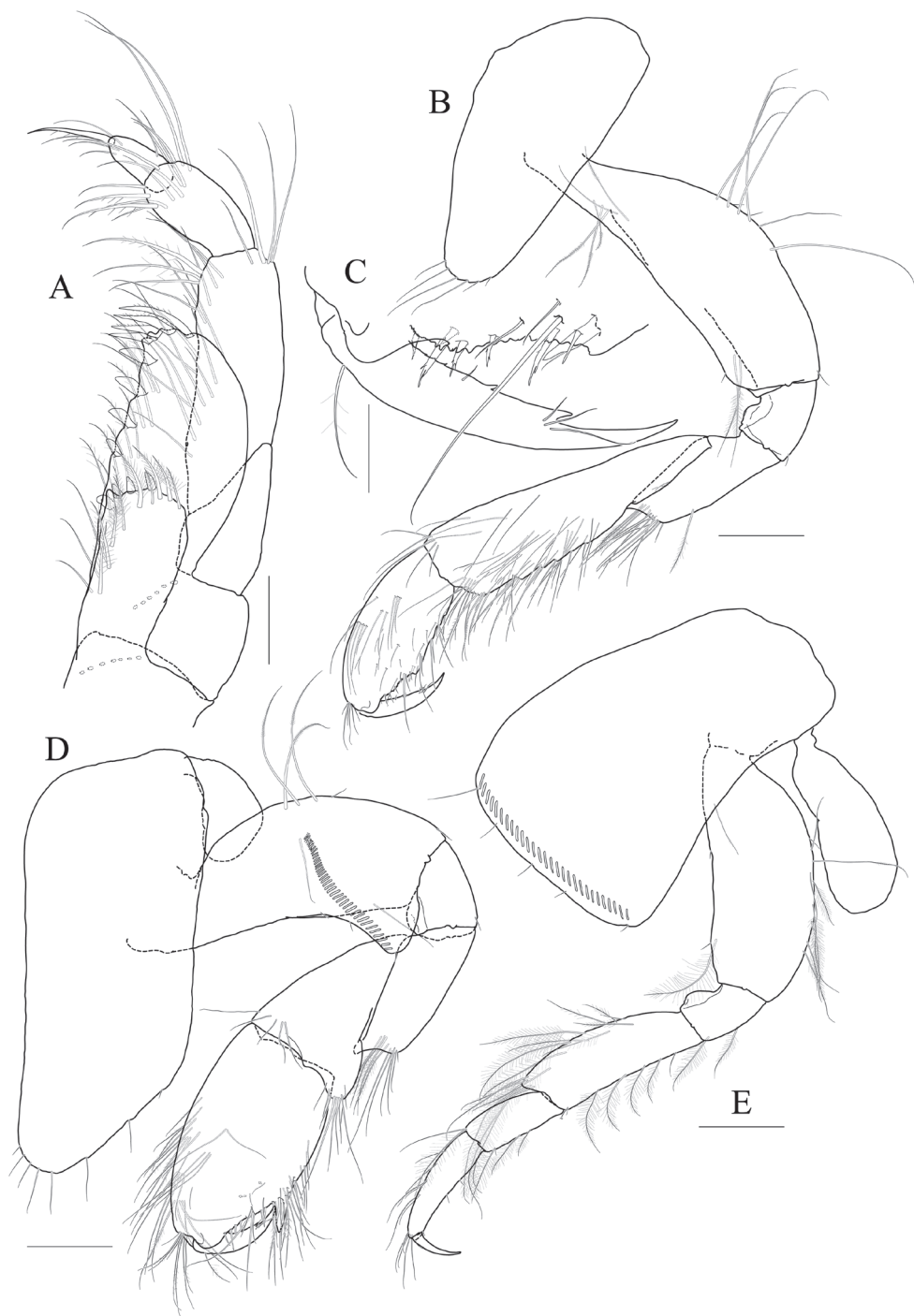


Figure 15 *Photis longicarpus* sp. nov., holotype, NIBRIV0000753910, male, 4.9 mm, Geomeunyeo, Jeju-do, South Korea. **A** maxilliped **B, C** gnathopod 1 **D** gnathopod 2 **E** pereopod 3. Scale bars: 0.05 mm (**A, C**), 0.2 mm (**B, D, E**).

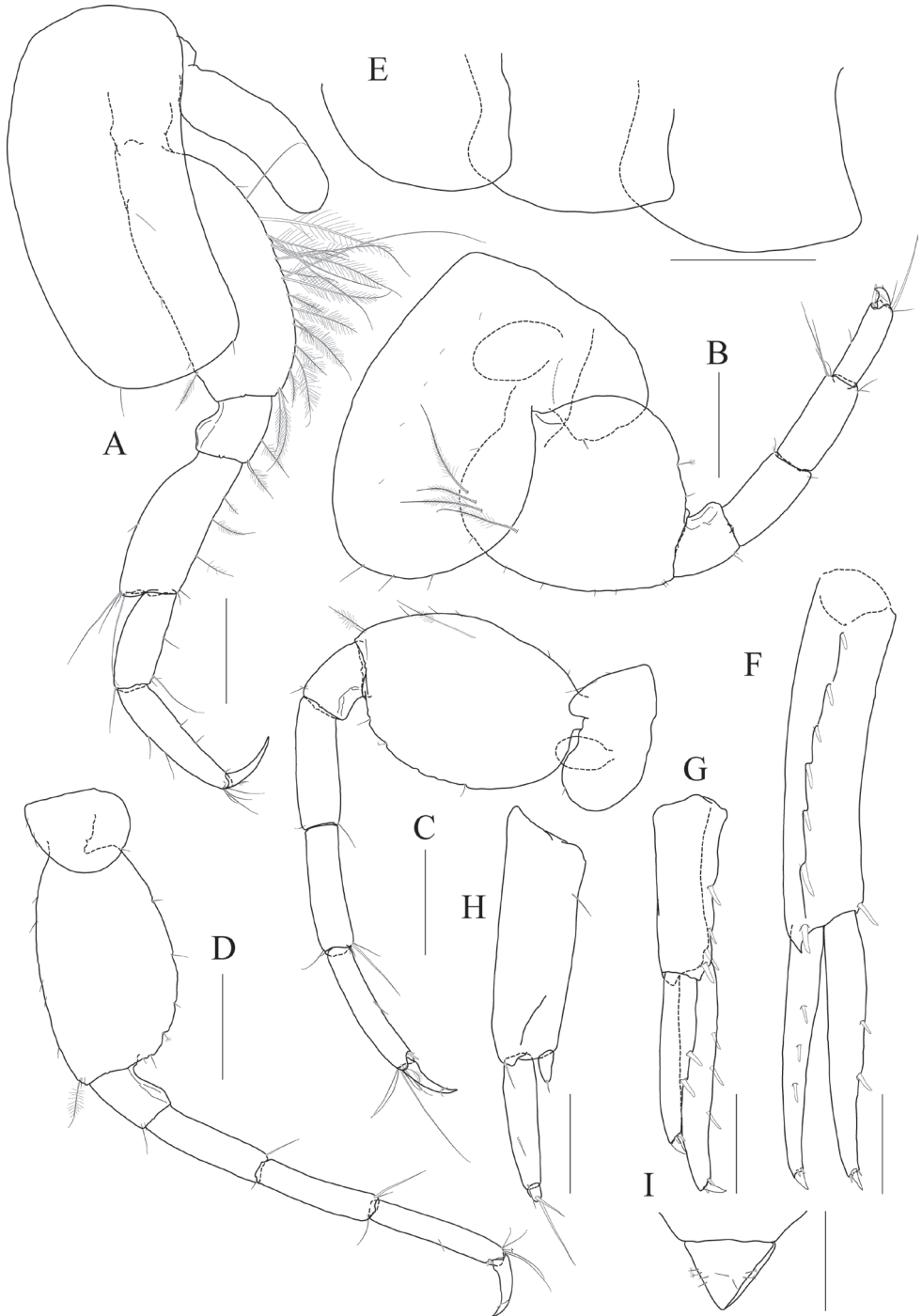


Figure 16 *Photis longicarpus* sp. nov., holotype, NIBRIV0000753910, male, 4.9 mm, Geomeunyeo, Jeju-do, South Korea. **A** pereopod 4 **B** pereopod 5 **C** pereopod 6 **D** pereopod 7 **E** pleonal epimera **F** uropod 1 **G** uropod 2 **H** uropod 3 **I** telson. Scale bars: 0.1 mm (**F–I**), 0.2 mm (**A–E**).

unequal in length (longer seta reaching end of dactylus), with a group of three setae (longest seta $0.9\times$ as long as propodus) at anteriodistal corner; dactylus short, armed with one accessory cusp on outer margin.

Pereopod 6 (Fig. 16C) as long as, but slender than pereopod 5; coxa bilobed, anterior lobe small, posterior lobe dilated posterioventrally; basis subovoid, $0.7\times$ as wide and as that of pereopod 5, anterior margin convex, slightly dilated distally, posterior margin convex, with four notches irregularly; merus rectangular, weakly widened distally, half as long as basis, $0.3\times$ as wide as long; carpus as long as merus; propodus as long as carpus, with a pair of distal locking setae unequal in length, with a group of five setae (longest seta $0.8\times$ as long as propodus) at anteriodistal corner; dactylus half as long as propodus, without accessory cusp on outer margin.

Pereopod 7 (Fig. 16D) as long as pereopod 6; coxa unilobed; basis subovoid, as long and $0.8\times$ as wide as that of pereopod 6, $0.6\times$ as wide as long, anterior margin rather convex, posterior margin weakly dilated distally; posterior margin proximal extension weak, with five notches irregularly; merus rectangular, linear, $0.2\times$ as wide as long, half as long as basis; carpus as long as merus; propodus $1.1\times$ as long as carpus, with a pair of distal locking setae unequal in length shorter than that of pereopods 5–6, with a group of more than five setae at posteriodistal corner; dactylus half as long as propodus, armed with one accessory cusp on outer margin.

Epimera 2 and 3 (Fig. 16E) each posterioventral corner produced backwards.

Uropod 1 (Fig. 16F) peduncle without distoventral spine, with seven robust setae on dorsolateral margin and one robust seta distally on dorsomedial margin; both rami $0.7\times$ as long as peduncle, with three and two robust setae on dorsal margin of outer and inner rami, each apex with one stout seta and two robust setae.

Uropod 2 (Fig. 16G) $0.6\times$ as long as uropod 1; peduncle half as long as that of uropod 1, with three robust setae on dorsolateral margin and one robust seta distally on dorsomedial margin; inner ramus $1.2\times$ as long as peduncle, with three robust setae on dorsal margin and with one stout seta and two robust setae at apex; outer ramus $0.8\times$ as long as inner ramus, with two robust setae on dorsal margin and with one stout seta and two robust setae at apex.

Uropod 3 (Fig. 16H) as long as uropod 2; peduncle $1.4\times$ as long as that of uropod 2; outer ramus biarticulated, $0.6\times$ as long as peduncle, 2nd article vestigial, with two elongate setae subapically; inner ramus scale-like, $0.2\times$ as long as outer ramus.

Telson (Fig. 16I) triangular in dorsal view, with a pair of simple setae and a pair of sensory setae on each side.

Paratype female. Gnathopod 1 (Fig. 17B, C) not elongate; coxa similar to that of male; basis subtrapezoidal, posterior margin flatter than that of male; carpus not elongate, $0.6\times$ as long and $1.1\times$ as wide as basis, carpal lobe blunt; propodus as long as carpus, posterior margin convex, palm serrated, slightly convex proximally and bearing weak cavity distally, defined by one robust seta medially; dactylus $0.6\times$ as long as propodus, inner margin serrated, with one tooth.

Gnathopod 2 (Fig. 17D, E) as long as but stouter than gnathopod 1; coxa subrectangular, $1.2\times$ as long as that of gnathopod 1, half as wide as long, anterioventral

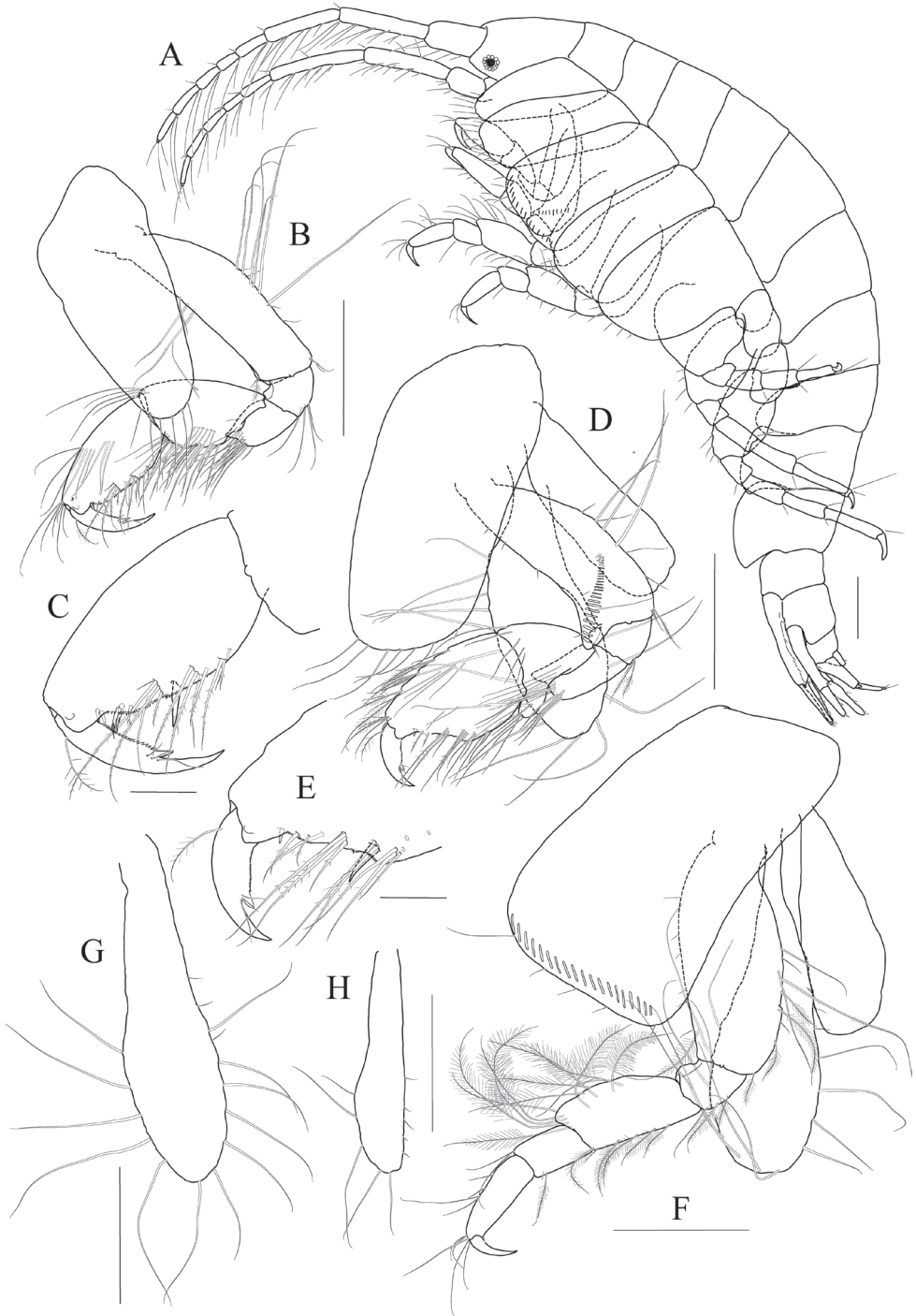


Figure 17 *Photis longicarpus* sp. nov., paratype, NIBRIV0000848928, female, 3.1mm, Geomeunyeo, Jeju-do, South Korea. **A** habitus **B, C** gnathopod 1 **D, E** gnathopod 2 **F** pereopod 3 **G, H** oostegites of pereopods 4 and 5. Scale bars: 0.05 mm (**C, E**), 0.2 mm (**A, B, D, F-H**).

production weaker than that of male, oostegite $1.3\times$ as long as basis, $0.4\times$ as wide as long; basis anterior margin lateral borders forming well-developed lobe distally bearing oblique stridulated ridges on surface; merus $0.4\times$ as long as basis; carpus $0.4\times$ as long as basis, with developed carpal lobe posteriorly; propodus stout, $0.6\times$ as long as basis, posterior margin $0.6\times$ as long as anterior margin, palm oblique, $0.9\times$ as long as posterior margin, without defining spine, but bearing defining robust seta medially; dactylus $0.4\times$ as long as propodus, inner margin serrated, with one tooth.

Pereopod 3 (Fig. 17F) coxa widened distally, $0.6\times$ as wide as long, slightly produced posteroventrally, with stridulated ridges on surface along ventral margin, oostegite as long and as wide as that of gnathopod 2; basis $0.4\times$ as wide as long, anterior margin slightly expanded proximally, posterior margin evenly rounded; merus half as wide as long, anterior margin expanded, with eleven plumose setae submarginally, distal corner weakly produced; posterior margin not expanded, with four plumose setae; carpus rectangular, half as long as merus; propodus diminished distally, $0.4\times$ as long as basis; dactylus half as long as propodus.

Oostegites on gnathopod 2 as long as that of pereopod 3. That of pereopod 5 $0.7\times$ as long as that of pereopod 4 (Fig. 17D, F–H).

Remarks. This species is closely related to *Photis japonica* Hirayama, 1984 in sharing a significantly elongate gnathopod 1 in mature males, but differs in having stridulated ridges on the lateral surface of gnathopod 1 basis and pereopod 3 coxa, which are arranged along the ventral margin in both sexes. Also, *Photis longicarpus* sp. nov. has a defining spine on gnathopod 2 palm in males only, but *P. japonica* has it in both sexes. Moreover, the uropod 3 outer ramus of *P. longicarpus* sp. nov. is biarticulated (distal article is vestigial), but that of *P. japonica* is uniarticulated (Hirayama 1984).

***Photis posterolobus* sp. nov.**

<http://zoobank.org/3C32E5BE-E031-4B56-A37E-0E9669F08972>

Figs 18–20

Korean name: Ju-meo-ni-i-hyeong-kko-ri-da-ri-yeop-sae-u

Etymology. The composite epithet of the specific name, *posterolobus*, is a combination of the Latin words *posterus* and *lobus*, referring to the presence of a posterior lobe produced distally on the ischium of male gnathopod 2.

Material examined. Holotype: ♂ (4.8 mm), NIBRIV0000753909. Geomeunyeo, Jeju-do Island, South Korea (33°14'23"N, 126°34'59"E), 24 Dec 2012, grab sampler (about 24 m depth), by Prof. HY Soh.

Diagnosis. Male gnathopod 1 palmar margin weakly sinuated. Male gnathopod 2 basis lateral border forming a well-developed sac-like lobe; ischium posterior margin with lateral lobe acutely produced distally; merus rectangular, stout, half as long as basis, with transparent lobe distally; carpus anterior margin irregular, carpal lobe well developed; propodus stout, as long as basis, posterior margin with one elongate process

half as long as anterior margin, palmar margin oblique, $0.7\times$ as long as anterior margin, with two spines (proximal larger than distal), without defining seta. Stridulated ridges only present on gnathopod 2 basis and coxae 3 and 4 in males (unclear in females).

Description. Holotype male. Head (Fig. 18A) as long as pereonites 1 and 2 combined; lateral cephalic lobe rounded; eye circular, moderate in size; located in the middle of lateral lobe; antennal sinus deep.

Antenna 1 (Fig. 18B) $0.4\times$ as long as body; peduncle 1st article stout, $0.7\times$ as long as head; 2nd article slender, $1.4\times$ as long as 1st article; 3rd article $0.7\times$ as long as 2nd article; accessory flagellum absent; flagellum $0.8\times$ as long as peduncle 1st–3rd articles combined, composed of ten articles (terminal article rudimentary).

Antenna 2 (Fig. 18C) peduncle 3th article exceeding end of lateral cephalic lobe; 4th and 5th articles as long as 2nd article; flagellum $0.6\times$ as long as peduncle 3rd–5th articles combined, composed of more than six articles.

Upper lip (Fig. 18D) convex anteriorly, with notch in the middle, covered with minute setae.

Mandibles (Fig. 18E, F) with 5-dentate incisor, 4-dentate lacinia mobilis, and four raker setae on left mandible; with 1/2 and 5-dentate incisor, minutely dentate lacinia mobilis, and three raker setae on right mandible; molar well developed, triturative, with seven setae along the distal margin of right mandible; palp asymmetrical, composed of three articles, 3rd article distally rounded, $0.7\times$ as long as 2nd article, with setae extending along most of posteriodistal margin.

Maxilliped (Fig. 19A) inner lobe subrectangular, weakly expanded distally, with three nodular setae apically and one medial nodular seta subdistally; outer lobe exceeding half of palp 2nd article, lined with nine robust setae along apex to medial margin; palp composed of four articles, 3rd article slightly expanded distally, $0.4\times$ as long as 2nd article, 4th article $0.8\times$ as long as 3rd article, with elongate seta apically ($1.2\times$ as long as 4th article).

Maxilla 1 (Fig. 19B) inner lobe small, covered with minute setae; outer lobe with ten dentate robust setae on apical margin; palp biarticulated, distal article curved, with five setae on apical margin.

Maxilla 2 (Fig. 19C) inner lobe with an oblique row of plumose setae on surface; outer lobe longer and slightly dilated distally than inner lobe.

Gnathopod 1 (Fig. 19D) coxa $0.7\times$ as wide as long, evenly rounded anterioventrally, slightly expanded anteriorly; basis as long as coxa, anterior margin lateral border forming weak lobe distally, with five elongate setae subproximally, posterior margin convex, with five elongate setae at the middle; carpus subtrapezoidal, $0.8\times$ as long as basis, half as wide as long, posterior lobe blunt; propodus as long and wide as carpus, rounded anteriorly, with minute serrations irregularly along palm and posterior margin, palm $0.8\times$ as long as posterior margin, weakly bisinuate, defined by one robust seta medially; dactylus $0.7\times$ as long as propodus, exceeding palm, inner margin serrated, with three teeth.

Gnathopod 2 (Fig. 19E, F) stout, coxa subrectangular, $0.8\times$ as wide as long, produced anterioventrally; basis anterior margin lateral border forming well-developed

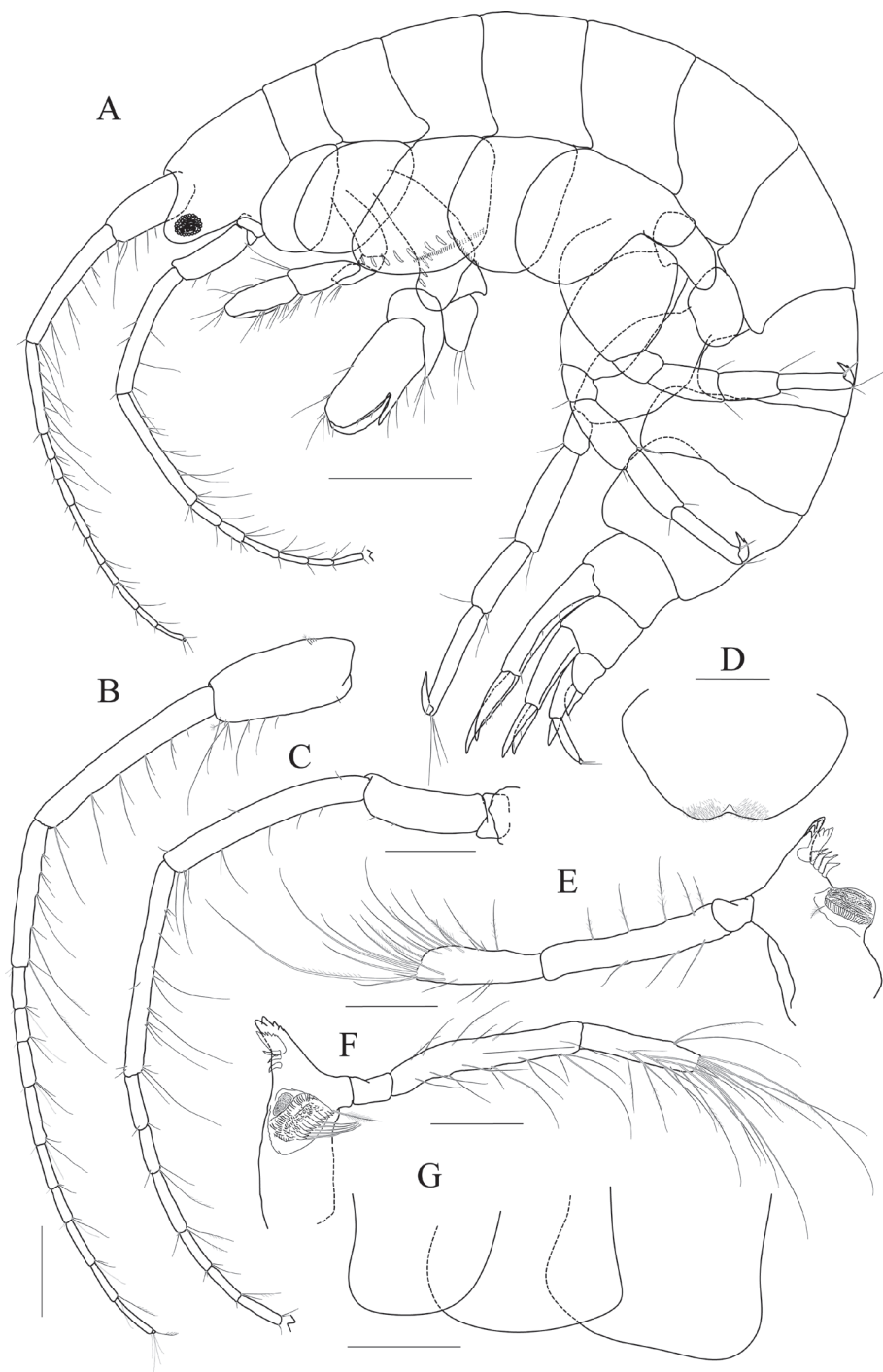


Figure 18 *Photis posterolobus* sp. nov., holotype, NIBRIV0000753909, male, 4.8 mm, Geomeunyeo, Jeju-do, South Korea. **A** habitus **B** antenna 1 **C** antenna 2 **D** upper lip **E** left mandible **F** right mandible **G** pleonal epimera. Scale bars: 0.05 mm (**D**), 0.1 mm (**E**, **F**), 0.2 mm (**B**, **C**, **G**), 0.5 mm (**A**).

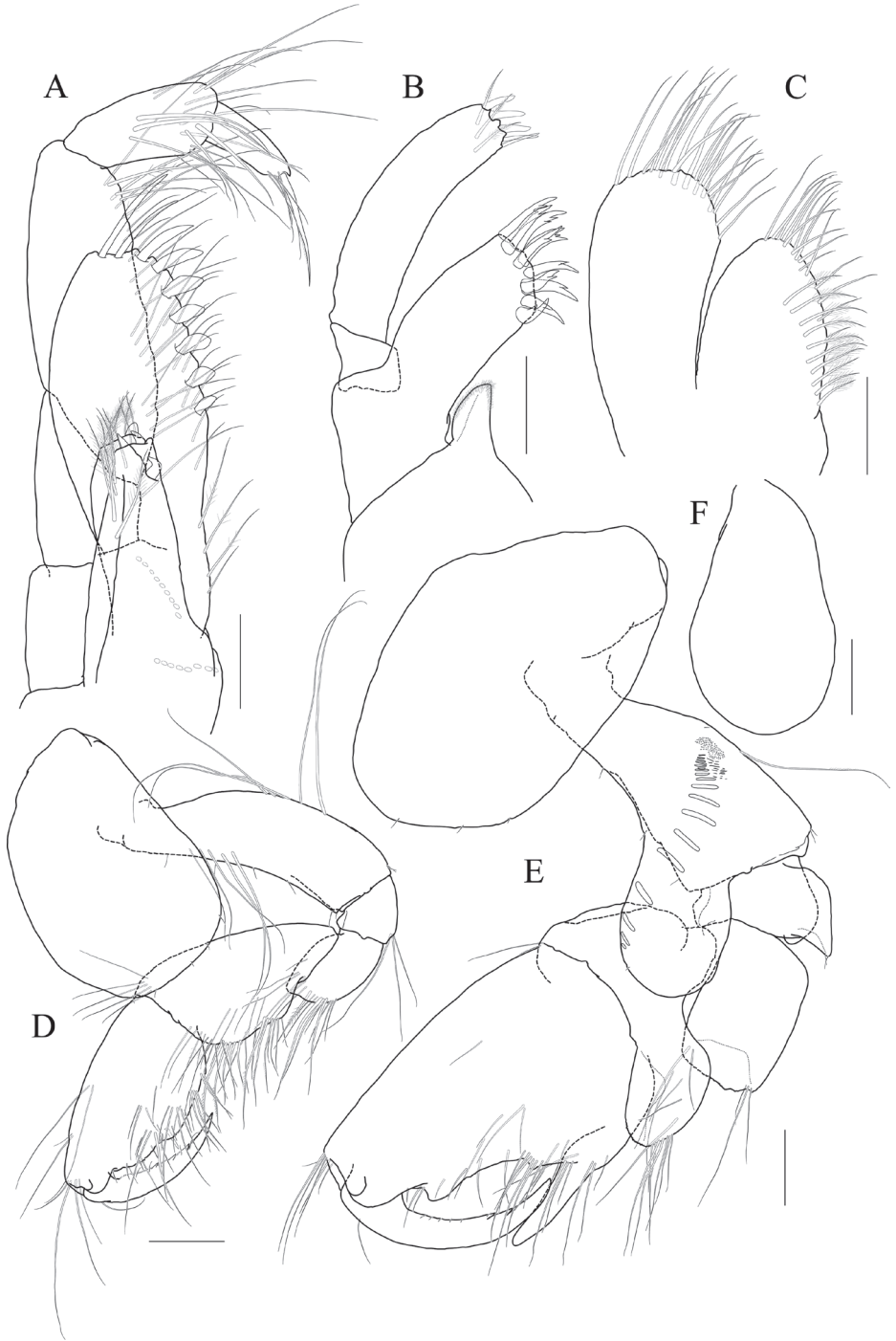


Figure 19 *Photis posterolobus* sp. nov., holotype, NIBRIV0000753909, male, 4.8 mm, Geomeunyeo, Jeju-do, South Korea. **A** maxilliped **B** maxilla 1 **C** maxilla 2 **D** gnathopod 1 **E** gnathopod 2 **F** gill of gnathopod 2. Scale bars: 0.05 mm (**A–C**), 0.1 mm (**D–F**).

lobe distally (sac-like lobe reaching middle of carpus) bearing oblique stridulated ridges on surface; ischium anterior lobe small, posterior margin lateral border forming lobe produced distally; merus rectangular, half as long as basis, with transparent lobe distally; carpus anterior margin irregular, carpal lobe well developed; propodus stout, as long as basis, posterior margin with one elongate process half as long as anterior margin, palmar margin oblique, $0.7\times$ as long as anterior margin, with two spines (proximal larger than distal), without defining seta; dactylus $0.7\times$ as long as propodus, with two teeth on inner margin.

Pereopod 3 (Fig. 20A, B) coxa produced anterioventrally, as long as wide, with stridulated ridges on medial surface and short stridulated ridges near the posteroventral corner on lateral surface submarginally; basis $0.3\times$ as wide as long, posterior margin expanded; merus $0.6\times$ as long as basis, anterior margin expanded distally, with two plumose setae submarginally, distal corner weakly produced; carpus half as long as merus, evenly rounded anteriorly; propodus slender, diminished distally, $0.6\times$ as long as basis; dactylus half as long as propodus.

Pereopod 4 coxa (Fig. 20C) not widened distally, as long as that of pereopod 3, with stridulated ridges along anterioventral corner oblique.

Pereopod 5 (Fig. 20D–F) coxa bilobed, large, anterior lobe subovoid, expanded ventrally, posterior lobe small, expanded backwards; basis subovoid, broad, more expanded proximally, $0.8\times$ as long as wide; merus subrectangular, slightly convex anteriorly, half as long as basis, $0.4\times$ as wide as long; carpus $0.8\times$ as long as merus; propodus $1.1\times$ as long as carpus, with a pair of distal locking setae unequal in length (longer seta $0.8\times$ as long as dactylus), with a group of four setae (longest seta half as long as propodus) at anteriodistal corner; dactylus half as long as propodus, armed with one accessory cusp on outer margin.

Pereopod 6 (Fig. 20G) $1.1\times$ as long as pereopod 5; coxa bilobed, anterior lobe small, posterior lobe dilated posteroventrally; basis subovoid, $0.8\times$ as wide as long, anterior margin convex, posterior margin slightly dilated proximally; merus $0.6\times$ as long as basis, $0.3\times$ as wide as long; carpus $0.8\times$ as long as merus; propodus $1.2\times$ as long as carpus, with a pair of distal locking setae unequal in length (longer seta $0.6\times$ as long as dactylus), with a group of five setae (longest seta $0.8\times$ as long as propodus) at anteriodistal corner; dactylus half as long as propodus, without accessory cusp on outer margin.

Pereopod 7 (Fig. 20H–I) $1.3\times$ as long as pereopod 6; coxa unilobed, produced posteriorly; basis subovoid, $0.8\times$ as wide as that of pereopod 6, $0.6\times$ as wide as long, anterior margin rather convex, posterior margin with one blunt extension proximally; merus rectangular, $0.7\times$ as long as basis; $0.2\times$ as wide as long; carpus $0.8\times$ as long as merus; propodus $1.5\times$ as long as carpus, with a pair of distal locking setae unequal in length (smaller than those of pereopods 5 and 6), with a group of more than seven setae at posteriodistal corner; dactylus $0.4\times$ as long as propodus, armed with one accessory cusp on outer margin.

Epimeron 1 slightly extended anterioventrally. Epimera 2 and 3 each posteroventral corner produced backwards, but not acute (Fig. 18G).

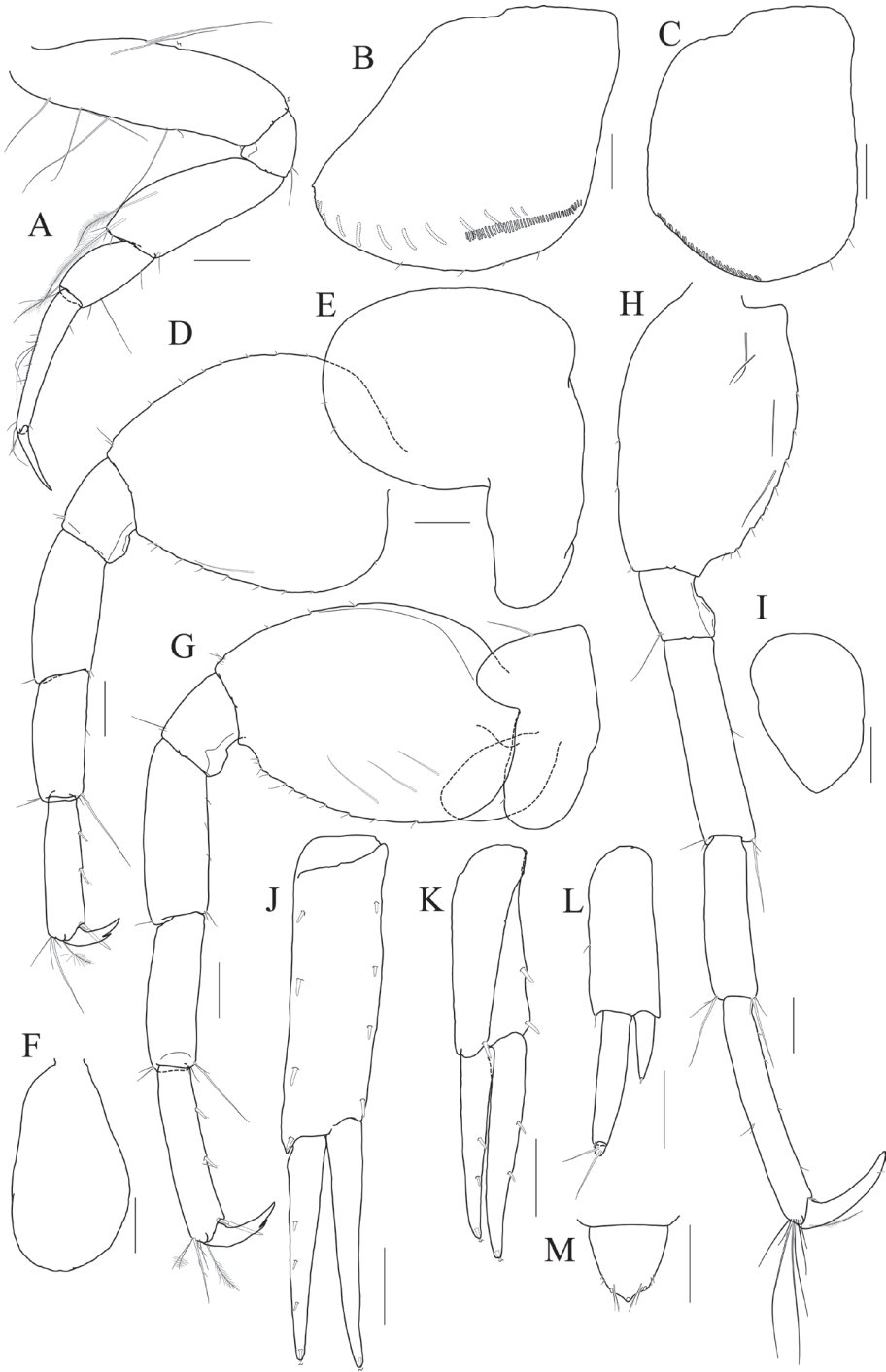


Figure 20 *Photis posterolobus* sp. nov., holotype, NIBRIV0000753909, male, 4.8 mm, Geomeunyeo, Jeju-do, South Korea. **A** coxa 3 **B** pereopod 3 **C** coxa 4 **D** coxa 5 **E** pereopod 5 **F** gill of pereopod 5 **G** pereopod 6 **H** coxa 7 **I** pereopod 7 **J** uropod 1 **K** uropod 2 **L** uropod 3 **M** telson. Scale bars: 0.1 mm.

Uropod 1 (Fig. 20J) peduncle without distoventral spine, with four robust setae on both dorsolateral and dorsomedial margins; inner ramus $0.8\times$ as long as peduncle, with one subapical seta only; outer ramus $0.9\times$ as long as inner ramus, with three dorsolateral setae and one subapical seta.

Uropod 2 (Fig. 20K) $0.8\times$ as long as uropod 1; peduncle $0.7\times$ as long as that of uropod 1; inner ramus $1.1\times$ as long as peduncle, with two dorsal robust setae and one subapical seta; outer ramus $0.9\times$ as long as inner ramus, with two dorsal robust setae and one subapical seta.

Uropod 3 (Fig. 20L) $0.8\times$ as long as uropod 2; peduncle $0.8\times$ as long as that of uropod 2; outer ramus biarticulated, $0.9\times$ as long as peduncle, last article vestigial, with two elongate setae subapically; inner ramus scale-like, $0.4\times$ as long as outer ramus.

Telson (Fig. 20M) subtriangular in dorsal view, with a pair of simple setae, a pair of sensory setae, and one nodular robust seta on each side.

Remarks. *Photis posterolobus* sp. nov. is closely related to nine *Photis* species [*P. bronca* sp. nov.; *P. fischmanni* Gurjanova, 1951; *P. guerrai* Tato & Moreira, 2017; *P. hawaiiensis* JL Barnard, 1955; *P. kapapa* JL Barnard, 1970; *P. lecroyae* Ortiz, Varela & Lalana, 2011; *P. longicaudata* (Spence Bate & Westwood, 1863); *P. sarae* Souza-Filho & Serejo, 2010; and *P. tenuicornis* GO Sars, 1882] in bearing a very well-developed sac-like lobe anteriodistally on the basis of male gnathopod 2. However, *Photis posterolobus* sp. nov. can be distinguished from above species by the presence of a posterior lobe produced distally in the ischium of male gnathopod 2 that is absent in the above species (Bate and Westwood 1863; Sars 1883; Gurjanova 1951, 1955; Barnard 1955, 1970; Ren 2006; Souza-Filho and Serejo 2010; Tato and Moreira 2017).

Genus *Podoceropsis* Boeck, 1861

Podoceropsis insinuomanus sp. nov.

<http://zoobank.org/9B529875-E9ED-428D-97B8-C39FDDABDD91>

Figs 21–23

Korean name: O-mok-son-jjalb-eun-bu-chae-jjik-yeop-sae-u

Etymology. The composite epithet of the specific name, *insinuomanus*, is a combination of the Latin words *insinuo* and *manus*, meaning sinuous hand. This name refers to the strongly sinuated shape of male gnathopod 2 palmar margin.

Material examined. Holotype: ♂ (4.2 mm), NIBRIV0000806531. Gageo-do Island, Jeollanam-do, South Korea (34°02'57"N, 125°08'14"E), 28 Oct 2015, light trap (6.6 m depth), by TW Jung.

Additional material: ♂, 3.3 mm, NIBRIV0000848933. Daryeo-do Island, Bukchon, Jeju-do, South Korea (34°34'56"N, 126°57'17"E), 30 Nov 2012, grab sampler (about 20 m depth), by Prof. HY Soh.

Diagnosis. Gnathopod 2 propodus stout, subovoid, $1.6\times$ as long as basis, palmar margin strongly bisinuate, wrinkly, with subrectangular protrusion near dactylus base and excavated posteriodistally, defined by one robust seta medially. Pereopod 5 basis subovoid, posteriodistal notch really weak.

Description. *Holotype male.* Head (Fig. 21B) $1.2\times$ as long as pereonites 1–2 combined; lateral cephalic lobe subtriangular, with small tip additionally on apex; eye circular, large, occupying most of lateral cephalic lobe; antennal sinus deep.

Antenna 1 (Fig. 21C, D) peduncle 1st article stout, half as long as head, with one robust seta at posteriodistal corner; 2nd article $1.6\times$ as long as 1st article; 3rd article $0.7\times$ as long as 2nd article; accessory flagellum uniarticulated, vestigial; flagellum $0.9\times$ as long as peduncle 1st–3rd articles combined, composed of ten articles (terminal article rudimentary).

Antenna 2 (Fig. 21E) as long as antenna 1; each peduncle's 4th and 5th articles as long as 2nd article of antenna 1; flagellum $0.9\times$ as long as peduncle 3rd–5th articles combined, composed of ten articles (terminal article rudimentary).

Upper lip (Fig. 21F) convex anteriorly, entire, covered with minute setae.

Lower lip (Fig. 21G) inner lobe subovoid, outer lobe apex rounded, covered with minute setae, with one robust seta at mediodistal corner; mandibular process well developed.

Mandibles (Fig. 21H–J) with 1/2 and 4-dentate incisor, 4-dentate lacinia mobilis, and five raker setae on left mandible; with 5-dentate incisor, minutely dentate lacinia mobilis, and five raker setae on right mandible; molar well developed, triturative; palp asymmetrical, composed of three articles, 3rd article distally rounded, $0.7\times$ as long as 2nd article, with setae extending along most of posteriodistal margin.

Maxilla 1 (Fig. 21K) inner lobe small, produced distally, with one plumose seta; outer lobe with ten dentate robust setae on apical margin; palp biarticulated, distal article curved, not swollen, with five setae on apical margin.

Maxilla 2 (Fig. 21L) inner lobe with an oblique row of plumose setae on surface; outer lobe slightly larger than inner lobe.

Maxilliped (Fig. 22A) inner lobe subrectangular, slightly expanded distally, with three nodular setae apically and one medial nodular seta subdistally; outer lobe exceeding half of palp 2nd article, lined with eight robust setae along apex to medial margin; palp composed of four articles, 3rd article slightly expanded distally, $0.4\times$ as long as 2nd article, 4th article $0.8\times$ as long as 3rd article, with elongate seta apically (as long as 4th article).

Gnathopod 1 (Fig. 22B) coxa subrhomboid, $0.8\times$ as wide as long; basis subtrapezoidal, $1.3\times$ as long as coxa, scarcely setose, anterior margin lateral border weakly lobate distally, posterior margin rather convex; carpus elongate, as long as basis, 0.3 as wide as long, slightly widened distally, carpal lobe not developed; propodus $0.7\times$ as long as carpus, rounded anteriorly, palm indistinct, posterior margin minutely serrated on distal half margin; dactylus elongate, $0.9\times$ as long as propodus, with three teeth on inner margin.

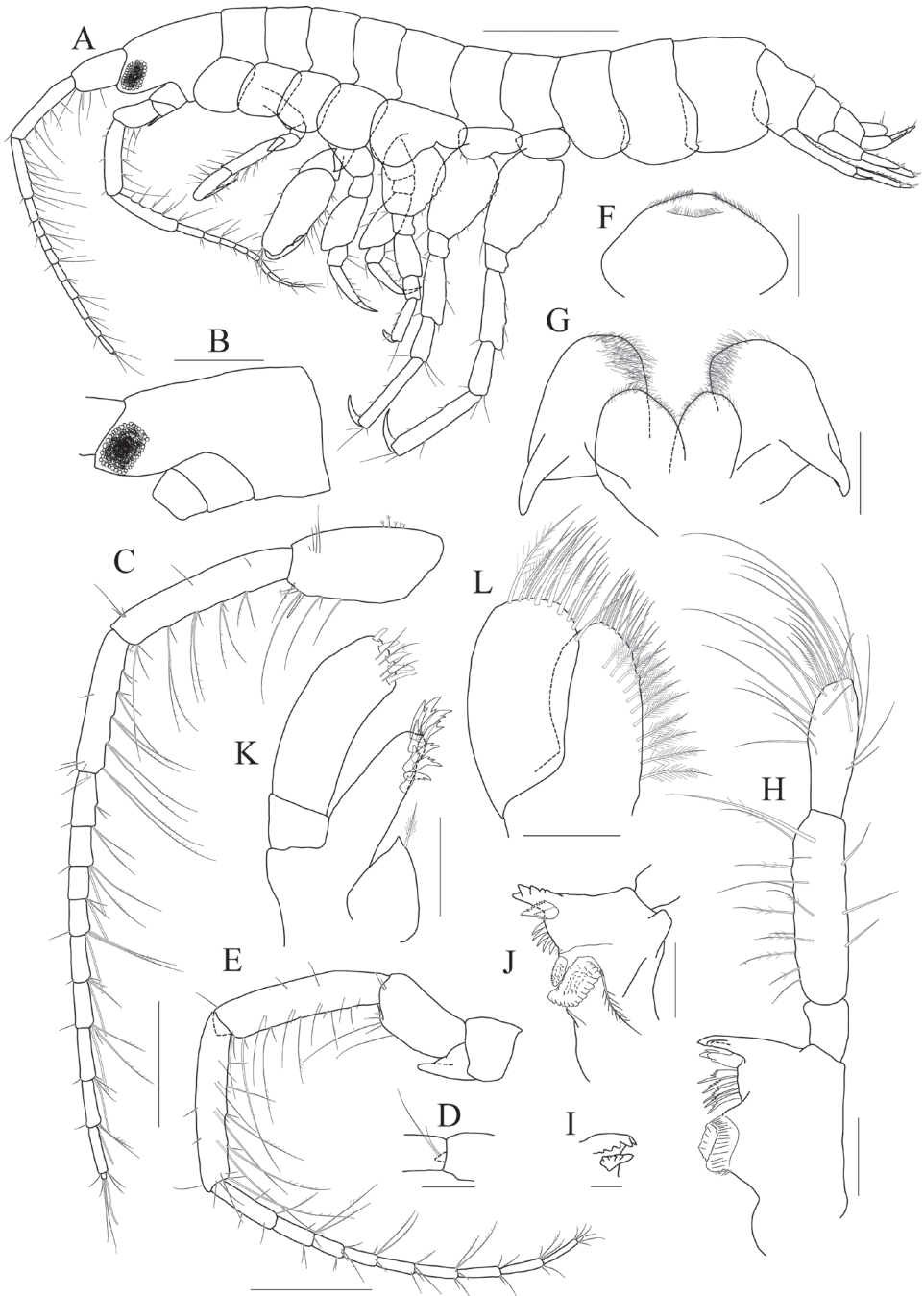


Figure 21 *Podoceroopsis insinuomanus* sp. nov., holotype, NIBRIV0000806531, male, 4.2 mm, Gageodo, South Korea. **A** habitus **B** head **C** antenna 1 **D** accessory flagellum **E** antenna 2 **F** upper lip **G** lower lip **H, I** left mandible **J** right mandible **K** maxilla 1 **L** maxilla 2. Scale bars: 0.02 mm (**I**), 0.05 mm (**F-H, J-L**), 0.2 mm (**C, E**), 0.5 mm (**A, B**).

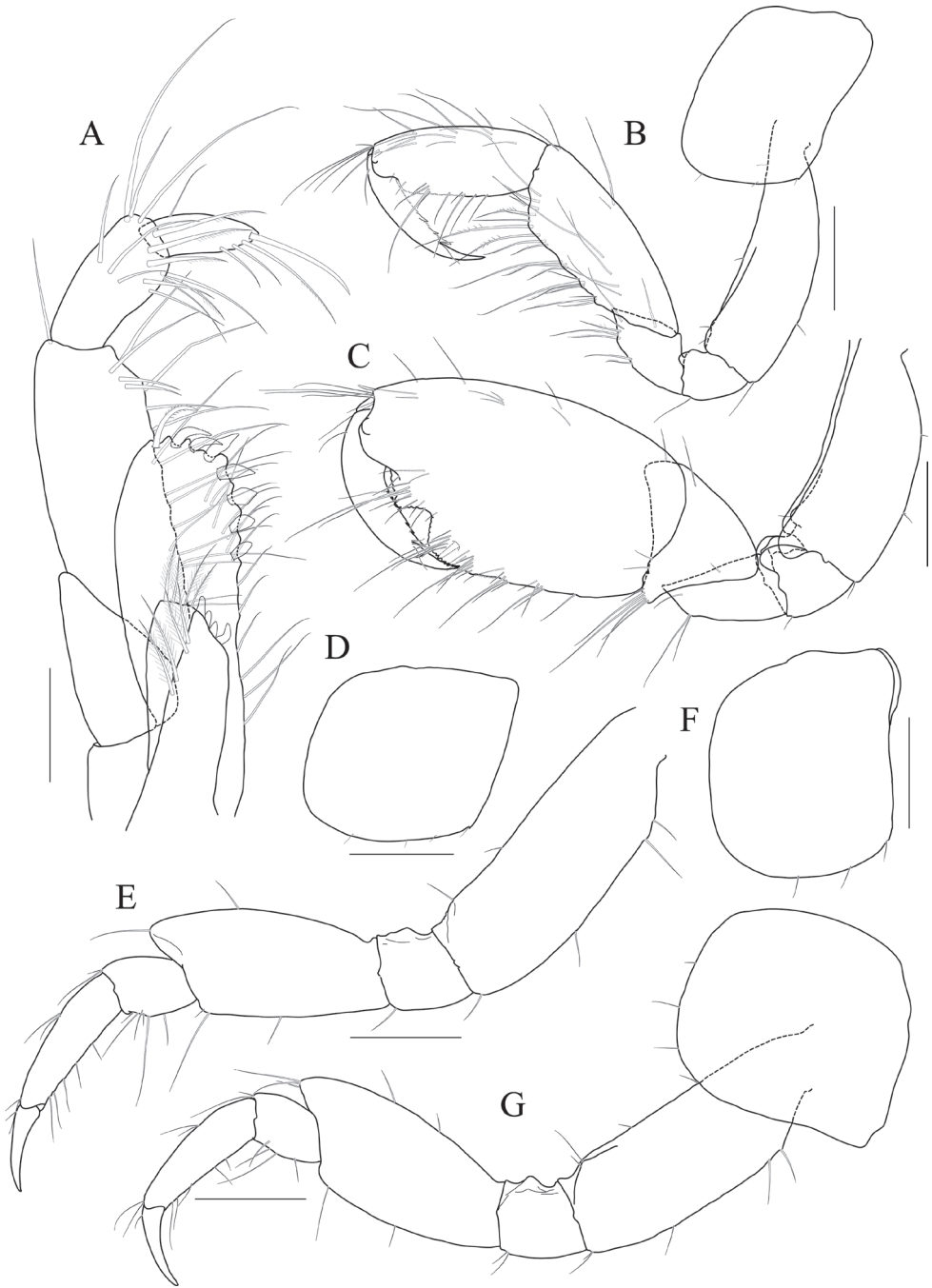


Figure 22 *Podoceroopsis insinuomanus* sp. nov., holotype, NIBRIV0000806531, male, 4.2 mm, Gageodo Island, South Korea. **A** maxilliped **B** gnathopod 1 **C** coxa 2 **D** gnathopod 2 **E** coxa 3 **F** pereopod 3 **G** pereopod 4. Scale bars: 0.05 mm (**A**), 0.1 mm (**B–G**).

Gnathopod 2 (Fig. 22C, D) stout, $1.1\times$ as long as gnathopod 1; coxa subrhomboid, as long as and $0.8\times$ as wide as that of gnathopod 1, rounded anterioventrally; basis scarcely setose, anterior margin both medial and lateral borders forming lobes distally but that of lateral more produced distally; ischium anterior margin with both lateral and medial lobes well developed; carpus with weak carpal lobe posteriorly; propodus stout, subovoid, $1.6\times$ as long as basis, $0.6\times$ as wide as long, anterior margin evenly rounded, posterior margin $0.6\times$ as long as anterior margin, palmar margin oblique, strongly bisinuate, wrinkly, with subrectangular protrusion near dactylus base and excavated posterodistally, defined by one robust seta medially; dactylus half as long as propodus, slightly exceeding palm, with five teeth on inner margin.

Pereopod 3 (Fig. 22E, F) coxa quadrate, $1.2\times$ as long as that of gnathopod 2, evenly rounded anterioventrally; basis subtrapezoidal, expanded posteriorly, $0.4\times$ as wide as long; merus $0.8\times$ as long as basis, as wide as basis, expanded anteriodistally, produced distal corner reaching half of carpus; carpus almost rectangular, short, $0.3\times$ as long as basis; propodus diminished distally, half as long as basis; dactylus $0.6\times$ as long as propodus.

Pereopod 4 (Fig. 22G) coxa $1.2\times$ as wide as that of pereopod 3; other articles almost similar to those of pereopod 3.

Pereopod 5 (Fig. 23A) coxa bilobed, anterior lobe rounded and expanded ventrally, $0.9\times$ as wide as basis, posterior lobe narrow, extended backwards, with one robust and one simple seta; basis subovoid, broader proximally, $0.7\times$ as wide as long, anterior margin rounded, posterior margin weakly crenulated, lined with simple setae only, with weak distal notch; merus slightly widened distally, half as long as basis, $0.6\times$ as wide as long, not twisted, posterior margin with one elongate robust seta at middle; carpus almost rectangular, slightly plump, $0.7\times$ as long as merus, $0.6\times$ as wide as long; propodus $1.6\times$ as long as carpus, somewhat widened distally, with two robust setae on anterior margin and one pair of unequal locking setae distally (longer seta exceeding dactylus); dactylus falcate. $0.4\times$ as long as propodus.

Pereopod 6 (Fig. 23B) $1.4\times$ as long as pereopod 5; coxa bilobed, anterior lobe smaller than that of pereopod 5, with two setae anteriorly, posterior lobe slightly larger than anterior lobe, weakly dilated posterioventrally, with two setae posteriorly; basis subovoid, broader proximally, as wide and $1.3\times$ as long as that of pereopod 5, anterior margin evenly rounded, with two robust setae, posterior margin weakly crenulated, lined with simple setae only, with weak distal notch; merus $0.6\times$ as long as basis, $0.4\times$ as wide as long, posterior margin expanded distally, with elongate robust setae (longest seta $0.3\times$ as long as merus); carpus subrectangular, slightly widened distally, $0.7\times$ as long as merus, $0.4\times$ as wide as long; propodus linear, $1.7\times$ as long as carpus, a little widened distally, with a pair of unequal locking setae; dactylus stout, falcate, half as long as propodus.

Pereopod 7 (Fig. 23C, D) $1.2\times$ as long as pereopod 6; coxa unilobed, dilated posterioventrally; basis subovoid, as wide and $1.1\times$ as long as that of pereopod 6, anterior margin evenly rounded, with one robust seta, posterior margin weakly crenulated, lined with simple setae only, proximal cusp developed proximally, with weak distal notch, medial surface with two plumose setae, merus expanded posteriodistally, $1.2\times$

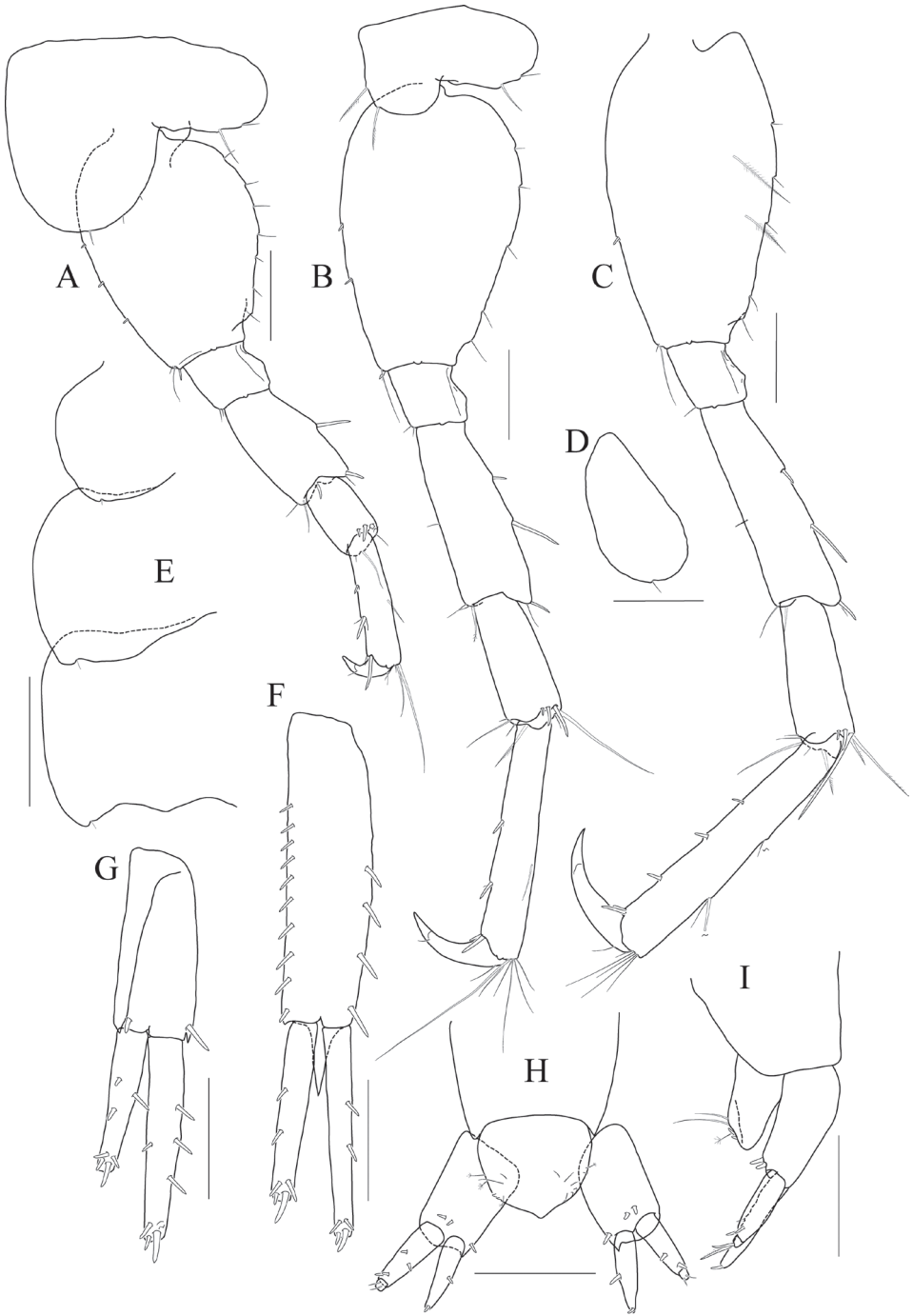


Figure 23 *Podoceroopsis insinuomanus* sp. nov., holotype, NIBRIV0000806531, male, 4.2 mm, Gageo-do Island, South Korea. **A** pereopod 5 **B** pereopod 6 **C** coxa 7 **D** pereopod 7 **E** pleonal epimera **F** uropod 1 **G** uropod 2 **H, I** uropod 3 and telson, dorsal (**H**) and lateral (**I**). Scale bars: 0.1 mm (**A–D, F–I**), 0.2 mm (**E**).

as long and $0.9\times$ as wide as that of pereopod 6, posterior margin with elongate robust setae (longest seta $0.3\times$ as long as merus); carpus subrectangular, slightly widened distally, $0.7\times$ as long as merus, with a group of robust setae at posteriodistal corner (longest seta $0.6\times$ as long as carpus); propodus as long as basis, slightly widened distally, distal locking setae unequal in length; dactylus stout, $0.4\times$ as long as propodus.

Epimeron 1 rounded, with a notch bearing minute seta on posteroventral corner. Epimera 2 and 3 each posteroventral corner produced backwards, with a notch bearing minute seta (Fig. 23E).

Uropod 1 (Fig. 23F) peduncle with distoventral spine $0.2\times$ as long as peduncle, with four dorsomedial and ten dorsolateral robust setae; inner ramus $0.7\times$ as long as peduncle, with two dorsomedial robust setae and one group of four robust setae on apex; outer ramus $0.8\times$ as long as inner ramus, with two dorsolateral robust setae and one group of four robust setae on apex.

Uropod 2 (Fig. 23G) $0.8\times$ as long as uropod 1; peduncle $0.6\times$ as long as that of uropod 1, both dorsal margins with distal robust seta only; inner ramus $1.1\times$ as long as peduncle, with three dorsomedial robust setae and one dorsolateral robust seta, with one group of four robust setae on apex; outer ramus $0.7\times$ as long as inner ramus, with one dorsomedial robust seta and two dorsolateral robust setae, with one group of four robust setae on apex.

Uropod 3 (Fig. 23H, I) $0.4\times$ as long as uropod 1; peduncle $0.6\times$ as long as that of uropod 2; inner ramus $0.7\times$ as long as peduncle, tapering distally, terminated by one robust seta; outer ramus as long as inner ramus, biarticulated, 2nd article vestigial, with two elongate setae subapically.

Telson (Fig. 23H, I) subtrapezoidal in dorsal view, produced in apex, margins rounded, with a pair of robust setae on each side.

Remarks. *Podoceroopsis insinuomanus* sp. nov. is closely related to *Podoceroopsis barnardi* Kudryashov & Tzvetkova, 1975, reported from the southern and western Sakhalin, eastern Russia (Kudryashov and Tzvetkova 1975) and Vancouver, Canada (Conlan 1983), in the similar shape of the palmar margin of male gnathopod 2. However, this new species differs from *P. barnardi* in the shape of the posterior margin of male pereopod 5 basis, which has a very weak distal extension (well-developed in *P. barnardi*), biarticulated uropod 3 with the terminal article being vestigial (uniarticulated in *P. barnardi*) (Kudryashov and Tzvetkova 1975; Conlan 1983).

***Podoceroopsis pseudoclavapes* sp. nov.**

<http://zoobank.org/C3203587-E4C4-4E52-9EE2-744B2C4818A3>

Figs 24–27

Korean name: Jak-eun-bal-ga-rak-jjalb-eun-bu-chae-jjik-yeop-sae-u

Etymology. The composite epithet of the specific name, *pseudoclavapes*, is a combination of the Greek word *pseudos*, and the specific name of *Podoceroopsis clavapes* Jung, Choi, Kim & Yoon, 2017. This name refers to the similarity of this new species to *P. clavapes*.

Material examined. Holotype: ♂ (3.2 mm), NIBRIV0000806530. Bigin-do Island, Gyeongsangnam-do, South Korea (34°42'52"N, 128°27'04"E), 18 Oct 2014, Scuba diving (about 20 m depth), by TW Jung. Paratypes: 1 ♂ (2.0 mm) and 3 ♀♀ (ovigerous; 2.1–2.7 mm), NIBRIV0000807157. Same data as holotype.

Diagnosis. Gnathopod 1 carpus elongate, 0.9× as long as basis; dactylus as long as propodus. Gnathopod 2 propodus extremely stout, elongate ovoid, 1.2× as long as basis, half as wide as long, posterior margin with short undulate border distally, palm defined by rounded protrusion, with excavation successively posteriodistally and subquadrate protrusion bearing minutely serrated margin near dactyl base; dactylus stout, 0.4× as long as propodus, falcate, but apex quite obtuse. Pereopods 3 and 4 merus expanded, half as wide as long. Pereopod 5 basis posterior margin sinuated distally. Pereopod 5 basis posterior margin with additional lobe, but not produced distally. Uropod 3 rami subequal in length, 0.8× as long as peduncle.

Description. Holotype male. Head (Fig. 24A) lateral cephalic lobe subtriangular; eye subcircular, large, occupying most of lateral cephalic lobe; antennal sinus deep.

Antenna 1 (Fig. 24B–D) peduncle 1st article stout, with one robust seta at posterio-distal corner; 2nd article 1.3× as long as 1st article; 3rd article 0.7× as long as 2nd article; accessory flagellum uniarticulated, vestigial; flagellum as long as peduncle 1st–3rd articles combined, composed of ten articles (terminal article rudimentary).

Antenna 2 (Fig. 24E) 1.1× as long as antenna 1; peduncle 4th, 5th articles 0.9× as long as 2nd article of antenna; flagellum as long as peduncle 3rd–5th articles combined, composed of twelve articles (terminal article rudimentary).

Upper lip (Fig. 24F) convex anteriorly, with notch in the middle, covered with minute setae.

Lower lip (Fig. 24G) inner lobe subovoid, outer lobe apex rounded, covered with minute setae; mandibular process well developed.

Mandibles (Fig. 24H, I) with 4-dentate incisor, 4-dentate lacinia mobilis, and four raker setae on left mandible; with 5-dentate incisor, 5-dentate lacinia mobilis, and five raker setae on right mandible; molar well developed, triturative; palp asymmetrical, composed of three articles, 3rd article distally rounded, 0.8× as long as 2nd article, with setae extending along most of posteriodistal margin.

Maxilla 1 (Fig. 24J) inner lobe small, produced distally, without setae; outer lobe with ten dentate robust setae on apical margin; palp biarticulated, distal article curved, a little swollen, with five setae on apical margin.

Maxilliped (Fig. 24K, L) inner lobe subrectangular, expanded distally, with three nodular setae apically and one medial nodular seta subdistally; outer lobe reaching half of palp 2nd article, lined with eight robust setae along apex to medial margin; palp composed of four articles, 3rd article slightly expanded distally, 0.4× as long as 2nd article, 4th article 0.8× as long as 3rd article, with elongate seta apically (1.1× as long as 4th article).

Gnathopod 1 (Fig. 25A) coxa rhomboid, produced anterioventrally, as long as wide, without setae on ventral margin; basis subtrapezoidal, 1.8× as long as coxa, scarcely setose, anterior margin lateral border lobate distally, posterior margin rather convex; carpus elongate, 0.9× as long as basis, 0.3× as wide as long, weakly widened distally,

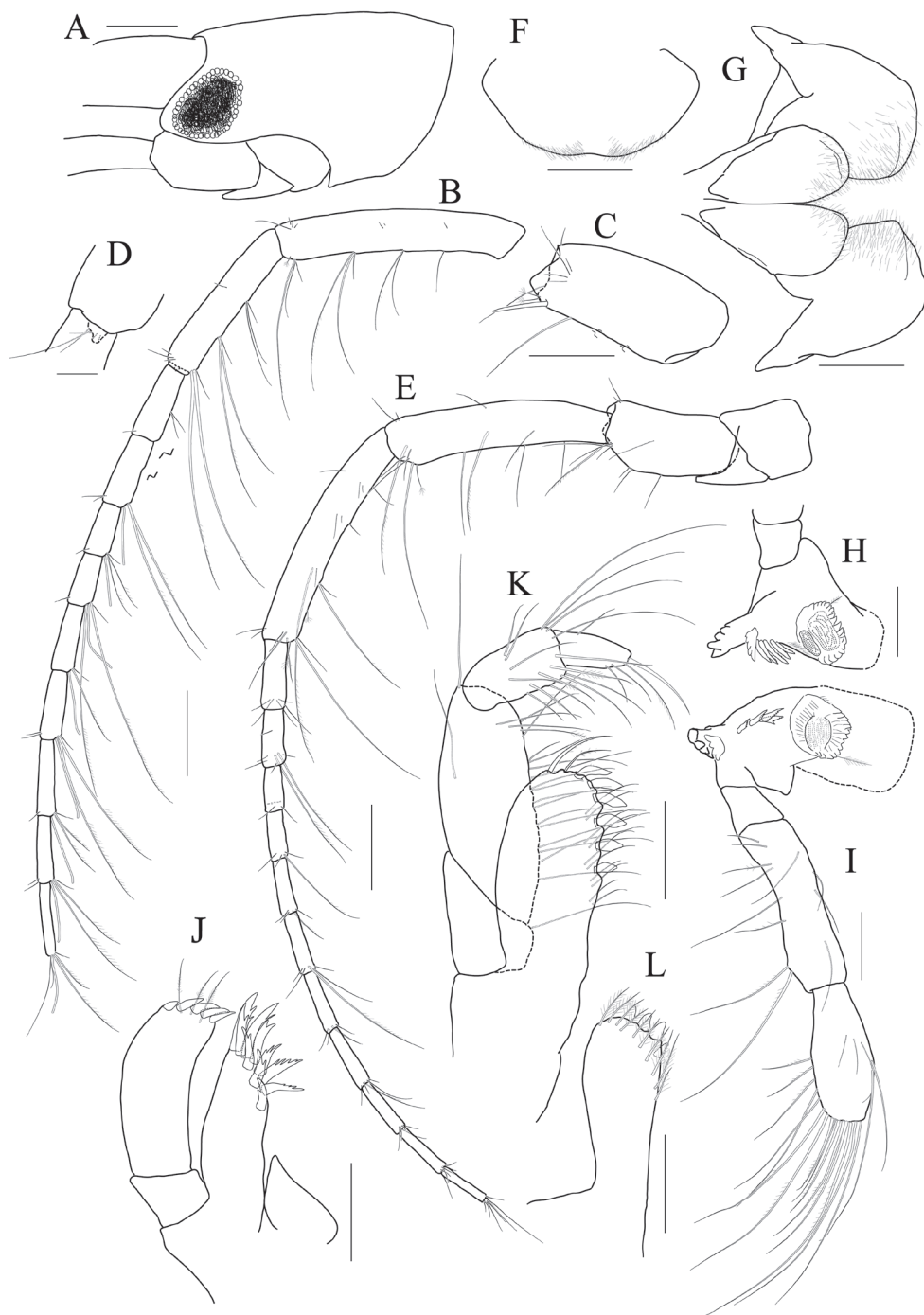


Figure 24 *Podoceroopsis pseudoclavapes* sp. nov., holotype, NIBRIV0000806530, male, 3.2 mm, Bigin-do Island, South Korea. **A** head **B–D** antenna 1 **E** antenna 2 **F** upper lip **G** lower lip **H** right mandible **I** left mandible **J** maxilla 1 **K, L** maxilliped. Scale bars: 0.02 mm (**D**), 0.05 mm (**F–L**), 0.1 mm (**A–C, E**).

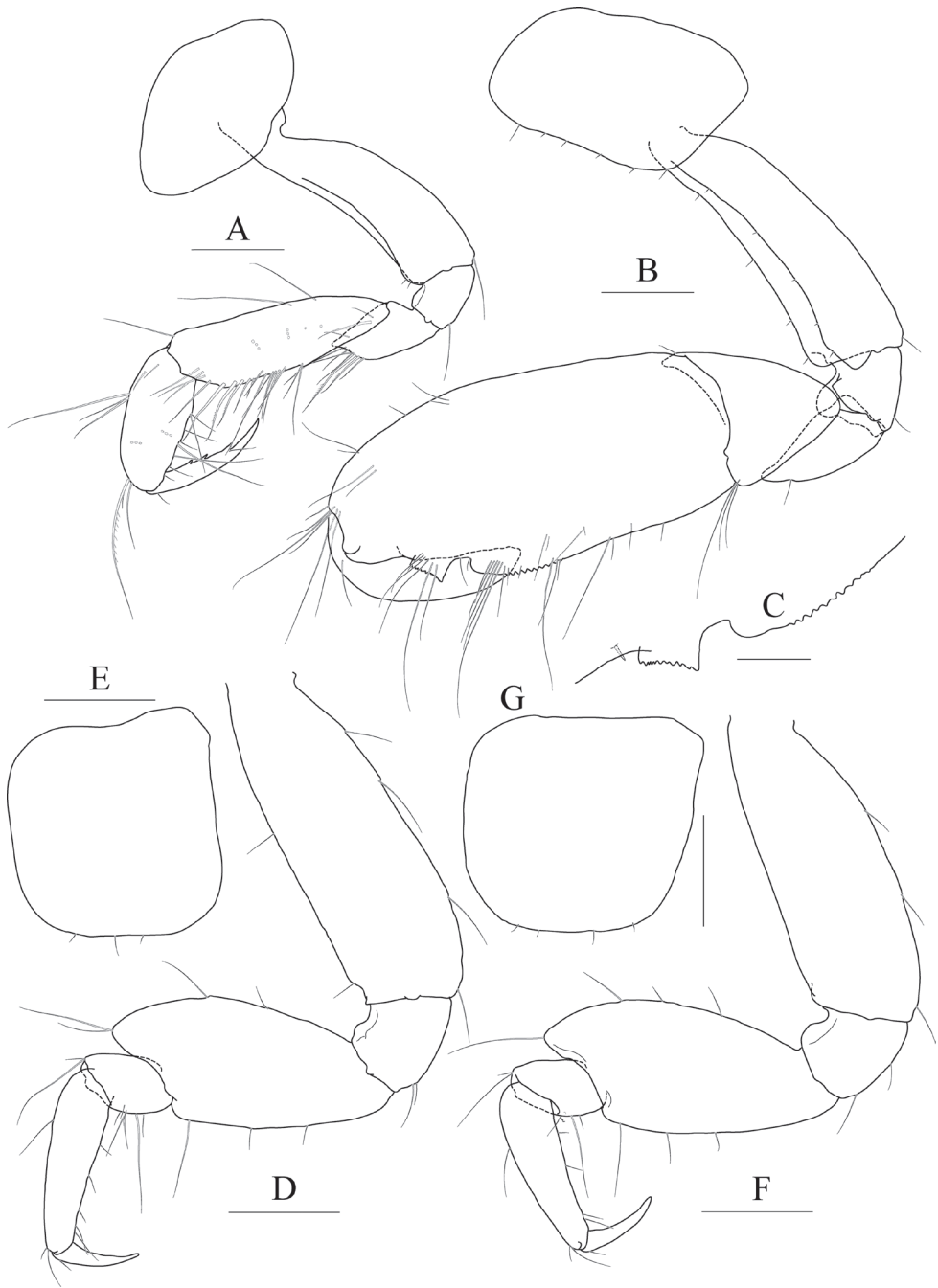


Figure 25 *Podoceroopsis pseudoclavapes* sp. nov., holotype, NIBRIV0000806530, male, 3.2 mm, Bigin-do Island, South Korea. **A** gnathopod 1 **B** gnathopod 2 **C** palmer margin of gnathopod 2 **D** coxa 3 **E** pereopod 3 **F** coxa 4 **G** pereopod 4. Scale bars: 0.01 mm (**C**) 0.1 mm (**A, B, D-G**).

carpal lobe not developed; propodus $0.6\times$ as long as carpus, rounded anteriorly, palm indistinct; dactylus elongate, as long as propodus, with three teeth on inner margin.

Gnathopod 2 (Fig. 25B, C) extremely stout, coxa subrhomboid, $1.4\times$ as wide as long, convex anterioventrally, ventral margin slightly sinuous, with six setae; basis subtrapezoidal, $2.2\times$ as long as coxa, anterior margin both lateral and medial borders forming lobes distally, but that of lateral obliquely truncated and more produced distally; ischium anterior margin with both lateral and medial lobes, medial lobe more developed; carpal lobe weakly developed; propodus extremely stout, elongate ovoid, $1.2\times$ as long as basis, half as wide as long, anterior margin convex, slightly widened in proximal $2/3$ margin, remaining distal $1/3$ margin and dactylus forming smooth ellipse together, posterior margin with short undulate border distally, palm defined by rounded protrusion, with excavation successively posteriodistally and subquadrate protrusion bearing minutely serrated margin near dactylus base; dactylus stout, $0.4\times$ as long as propodus, falcate, but apex quite obtuse.

Pereopod 3 (Fig. 25D, E) coxa subquadrate, with rounded corners; basis subtrapezoidal, somewhat expanded posteriorly, $0.4\times$ as wide as long; merus as wide as basis, anterior margin extremely expanded, produced distal corner exceeding half of carpus; carpus short, $0.2\times$ as long as basis; propodus diminished distally, half as long as basis; dactylus half as long as propodus.

Pereopod 4 (Fig. 25F, G) coxa $1.2\times$ wider proximally than that of pereopod 3; other articles subequal to those of pereopod 3.

Pereopod 5 (Fig. 26A, B) coxa bilobed, anterior lobe rounded and expanded ventrally, $0.9\times$ as wide as basis, posterior lobe narrow, extended backwards, with one robust and one simple seta; basis subovoid, $0.6\times$ as wide as long, anterior margin more swollen proximally, posterior margin crenulated, lined with simple setae only, sinuated (notched) distally; merus widened distally, twisted, half as long as basis; carpus subrectangular, $0.7\times$ as wide as long; propodus slightly plump, $1.3\times$ as long as carpus, a pair of distal locking setae unequal in length (longer seta exceeding dactylus); dactylus falcate.

Pereopod 6 (Fig. 26C) $1.5\times$ as long as pereopod 5; coxa bilobed, anterior lobe expanded ventrally, smaller than that of pereopod 5, with two simple setae anteriorly, posterior lobe slightly larger than anterior lobe, weakly dilated posterioventrally; basis subovoid, half as wide as long, with simple setae only, anterior margin convex, posterior margin scarcely crenulated, slightly expanded but flatter than anterior margin, bearing small notch distally; merus $0.6\times$ as long as basis, $0.4\times$ as wide as long, posterior margin expanded distally, with elongate robust setae (longest seta $0.3\times$ as long as merus); carpus subrectangular, slightly widened distally, $0.7\times$ as long as merus, half as wide as long; propodus linear, $2.0\times$ as long as carpus, with a pair of unequal locking setae; dactylus stout, falcate, $0.3\times$ as long as propodus.

Epimera 1–3 (Fig. 26D) each with a notch bearing minute seta on posterioventral corner, convex ventrally.

Uropod 1 (Fig. 26F) peduncle with distoventral spine $0.2\times$ as long as peduncle, with four dorsomedial and nine dorsolateral robust setae; inner ramus $0.7\times$ as long as peduncle, with two dorsomedial robust setae and one group of four robust setae on

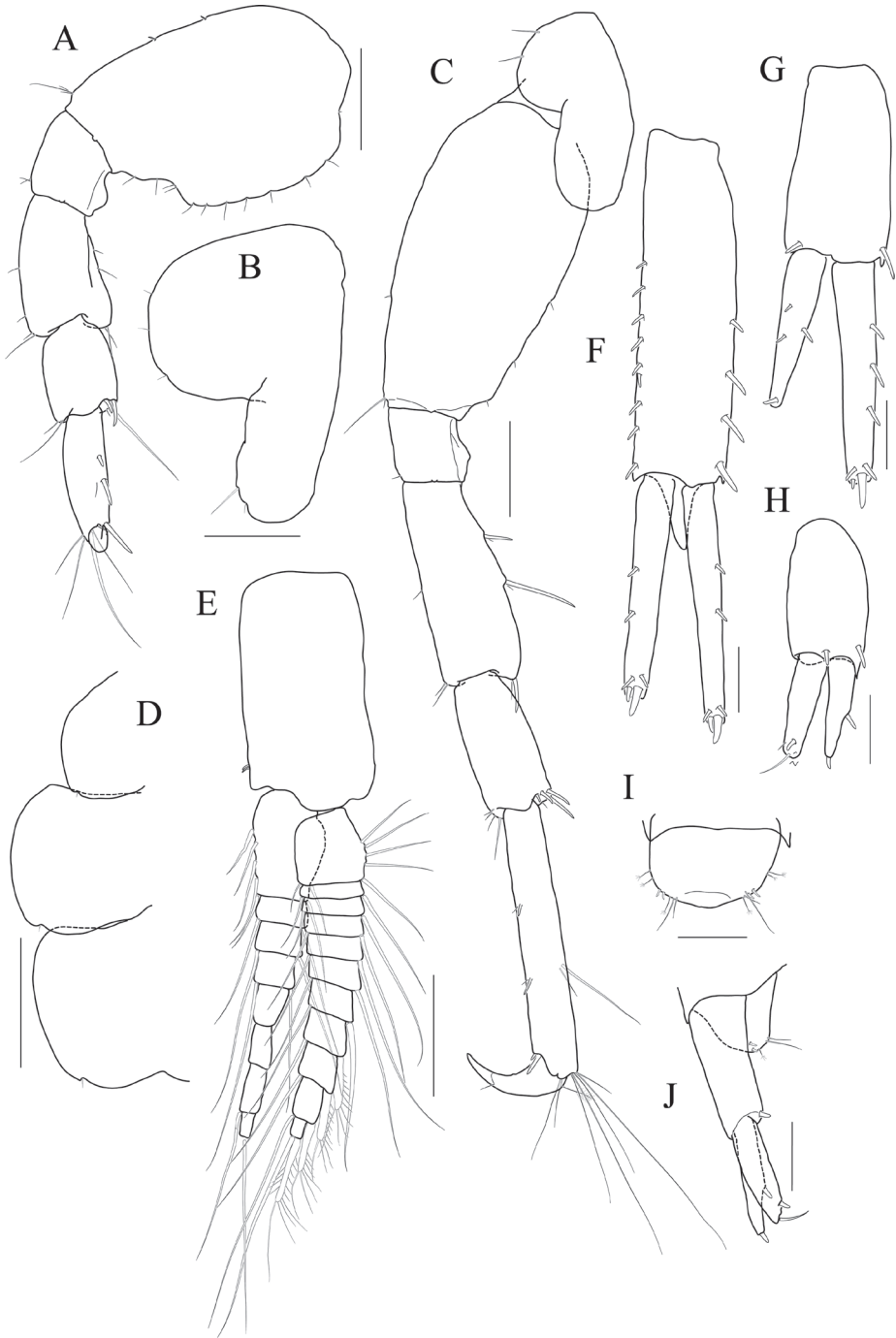


Figure 26 *Podoceroopsis pseudoclavipes* sp. nov., holotype, NIBRIV0000806530, male, 3.2 mm, Bigin-do Island, South Korea. **A** coxa 5 **B** pereopod 5 **C** pereopod 6 **D** pleonal epimera **E** pleopod 2 **F** uropod 1 **G** uropod 2 **H** uropod 3 **I** telson **J** uropod 3 and telson, lateral. Scale bars: 0.05 mm (**F–J**), 0.1 mm (**A–C, E**), 0.2 mm (**D**).

apex; outer ramus 0.9× as long as inner ramus, with two dorsolateral robust setae and one group of four robust setae on apex.

Uropod 2 (Fig. 26G) 0.7× as long as uropod 1; peduncle 0.6× as long as that of uropod 1, both dorsal margins with distal robust seta only; inner ramus 1.2× as long as peduncle, with 3 dorsomedial robust setae and one group of four robust setae on apex; outer ramus 0.7× as long as inner ramus, diminished distally, terminated by subacute-end bearing one robust seta.

Uropod 3 (Fig. 26H) 0.4× as long as uropod 1; peduncle 0.8× as long as that of uropod 2; inner ramus 0.8× as long as peduncle, diminished distally, with one robust seta on dorsomedial margin, terminated by one robust seta; outer ramus as long as inner ramus.

Telson (Fig. 26I, J) subtrapezoidal in dorsal view, slightly produced in apex, margins rounded, with a pair of robust setae on each side.

Paratype female. Maxilla 2 (Fig. 27B) inner lobe with an oblique row of plumose setae on surface; outer lobe slightly longer than inner lobe.

Gnathopod 1 (Fig. 27C) not sexually dimorphic between both sexes.

Gnathopod 2 (Fig. 27D) as long as but stouter than female gnathopod 1, coxa subrhomboid, slightly produced anterioventrally, as long as wide, evenly rounded ventrally, oostegite broad, 1.3× as long as basis; basis anterior margin lateral borders forming lobe distally, but less produced distally than that of male; ischium with small anterior lobe only; merus rectangular, 0.4× as long as basis; carpus stout, anterior margin convex, carpal lobe weak; propodus stout, slightly elongate, 0.8× as long as basis, half as wide as long, palmar obliquely excavated, margin irregularly wrinkly, bearing one blunt spine medially; dactylus half as long as propodus, inner margin minutely serrated, with one tooth.

Pereopod 5 (Fig. 27E) basis posterior margin not sinuated and without excavation distally.

Remarks. *Podoceropsis clavapes* Jung, Choi, Kim & Yoon, 2017, which is the only known *Podoceropsis* species from Korean waters, is characterized by its peculiarly shaped gnathopod 2 in mature males: the propodus is markedly stout and enlarged (1.4 times as long as basis), the palmar margin has one proximal cavity and two distal protrusions, and the dactylus is stout and 0.8 times as long as the propodus (Jung et al. 2017). *Podoceropsis pseudoclavapes* sp. nov. has a similar shape of gnathopod 2 propodus in males to that of *P. clavapes*, but notably differs by gnathopod 1 propodus, which is half as long as the carpus (0.8 times as long as carpus in *P. clavapes*), the palmar margin of gnathopod 2, which has one rectangular protrusion and one distal cavity (one proximal cavity and two distal protrusions in *P. clavapes*), gnathopod 2 dactylus, which is 0.4 times as long as the propodus (0.8 times as long as propodus in *P. clavapes*), the merus of pereopods 3 and 4, which are half as wide as long (0.4 times as wide as long in *P. clavapes*), the posterior margin of pereopod 5 basis, which has an additional lobe, but it is not produced distally (also with lobes but differently produced distally in *P. clavapes*), and both rami of uropod 3, which are subequal in length and 0.9 times as long as the peduncle (inner ramus is 0.9 times as long as outer ramus and 0.7 times as long as peduncle in *P. clavapes*) (Jung et al. 2017).

Podoceropsis angustimana Conlan, 1983 also has a markedly stout and enlarged propodus and a similar excavation of the palmar margin of male gnathopod 2, but

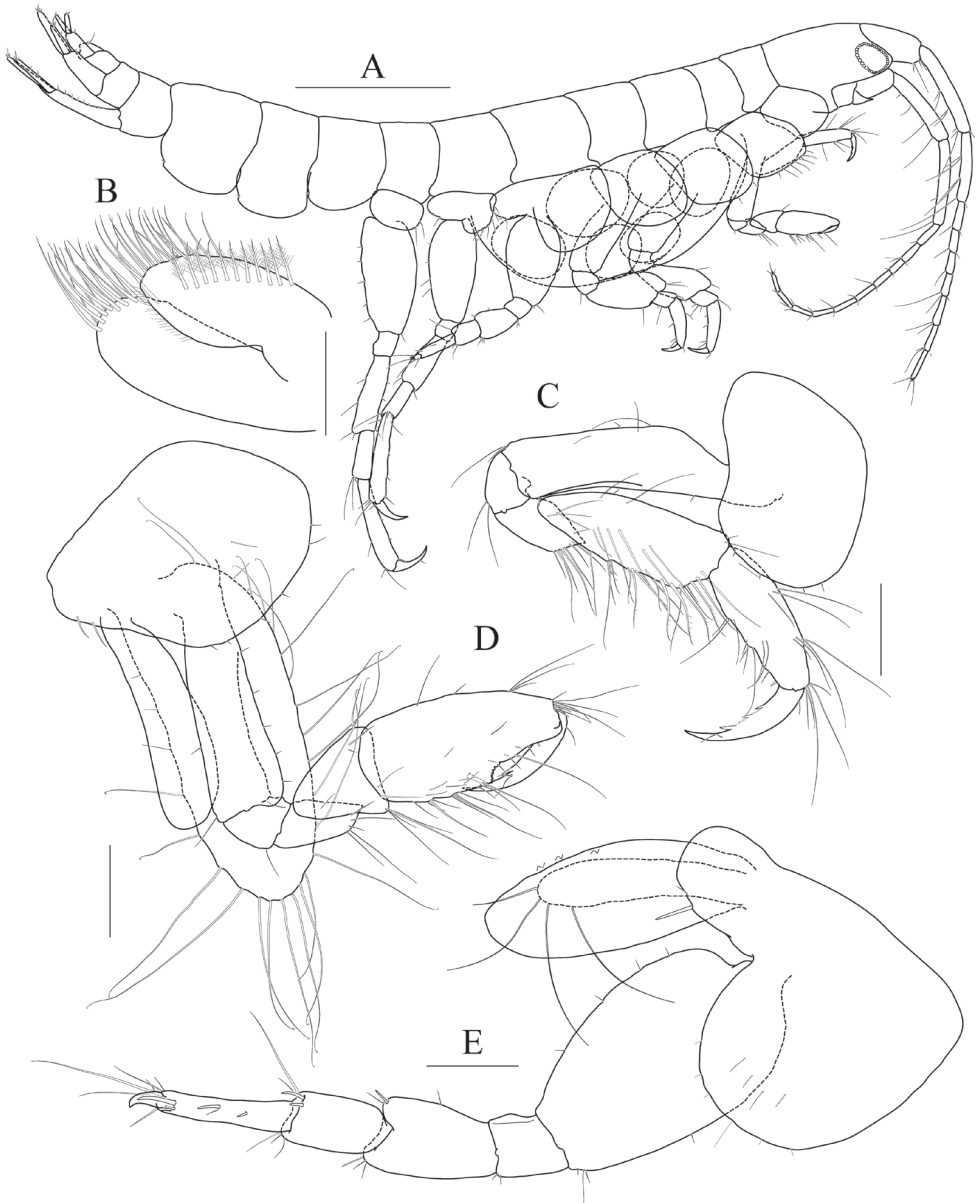


Figure 27 *Podoceroopsis pseudoclavapes* sp. nov., paratype, NIBRIV0000807157, female, 2.5 mm, Bigindo Island, South Korea. **A** habitus **B** maxilla 2 **C** gnathopod 1 **D** gnathopod 2 **E** pereopod 5. Scale bars: 0.05 mm (**B**), 0.5 mm (**A**, **C**–**E**).

P. pseudoclavapes sp. nov. can be distinguished by the following differences: the propodus is half as long as the carpus (exceeding half the length in *P. angustimana*); pereopods 3 and 4 are widened; the posterior margin of pereopod 5 basis is lobed but not distally produced (posterior margin is slightly oblique and distally produced in *P. angustimana*); and uropod 3 rami are shorter than the peduncle (1.3 times as long as peduncle in *P. angustimana*) (Conlan 1983).

Key to known photid amphipods from Korean waters

- 1 Uropod 3 with inner ramus notably shorter than outer ramus2
- Uropod 3 both rami subequal in length6
- 2 Pereopods 5–7 elongate, slender; basis not expanded... *Exiliphotis petila* sp. nov.
- Pereopods 5–7 not elongate; basis moderately expanded3
- 3 Females with stridulated ridges on gnathopod 2 basis and pereopod 3 coxa
.....*Photis stridulus* Jung, Choi, Kim & Yoon, 2017
- Females without stridulated ridges4
- 4 Male gnathopod 1 notably longer than gnathopod 2; carpus very elongate, 0.9×
as long as basis*Photis longicarpus* sp. nov.
- Male gnathopod 1 shorter than gnathopod 2; carpus not elongate5
- 5 Gnathopod 2 ischium posterior margin without lateral lobe; propodus palmar
margin with one quadrate tooth medially, distal spine very weak
.....*Photis bronca* sp. nov.
- Gnathopod 2 ischium posterior margin forming lateral lobe produced distally;
propodus palmar margin without quadrate teeth, with strong distal spine.....
.....*Photis posterolobus* sp. nov.
- 6 Antenna 1 accessory flagellum uniarticulated, rudimentary7
- Antenna 1 accessory flagellum multiarticulated9
- 7 Male gnathopod 2 propodus moderately stout, palm distinct. Uropod 2 outer
ramus distally blunt with 4 robust setae *Podoceropsis insinuomanus* sp. nov.
- Male gnathopod 2 propodus strongly elongate, palm indistinct. Uropod 2 outer
ramus narrowing distally, with one robust seta8
- 8 Male gnathopod 2 dactylus massive, 0.8× as long as propodus
.....*Podoceropsis clavapes* Jung, Choi, Kim & Yoon, 2017
- Male gnathopod 2 dactylus 0.4× as long as propodus
.....*Podoceropsis pseudoclavapes* sp. nov.
- 9 Uropod 3 inner ramus narrowing distally, with one single small robust seta in-
serted at its tip; outer ramus distally blunt with a small second article
.....*Latigammaropsis careocavata* sp. nov.
- Uropod 3 both rami narrowing distally; outer ramus consisting of only one arti-
cle10
- 10 Male gnathopod 2 propodus very elongate, 1.9× as long as carpus. Male pereopod
7 basis moderately expanded *Gammaropsis longipropodi* Hirayama, 1984
- Male gnathopod 2 propodus not elongate, 0.8× as long as carpus. Male pereopod
7 basis posterior margin notably expanded, with one strong notch posteriorly
.....*Gammaropsis utinomii* (Nagata, 1961)

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Two new species of *Araneus* Clerck, 1757 (Araneae, Araneidae) and first description of *A. wulongensis* male from China

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Abstract

Two new species of *Araneus* Clerck, 1757 are described: *A. conexus* **sp. nov.** (♂♀) and *A. digitatus* **sp. nov.** (♂♀) from Yunnan and Hubei provinces. The male of *A. wulongensis* Song & Zhu, 1992 is described here for the first time. All species treated in this study belong to *A. strurmi* species group. Detailed description and illustrations of somatic features, and copulatory organs as well as distribution maps are provided.

Keywords

Araneinae, Chongqing, Gaoligong Mountain, Hubei, orb-weaver, taxonomy, Wuling Mountain, Yunnan

Introduction

Araneus Clerck, 1757, the largest genus of the family, currently comprises 712 named species (112 of the them are listed as nomina dubia) distributed all over the world (WSC 2019). Until now, 114 species are known from China (Li and Lin 2016; Zhou et al. 2017) and 20 of them have been reported from the Gaoligong and Wuling mountains, central and southwestern China (Yin et al. 1990, 1997, 2009; Zhu et al. 1994; Song and Zhu 1992; Song and Li 1997). Araneidae is relatively well-studied family in China due to revisions made by Yin et al. (1990, 1997).

While examining specimens collected from the Gaoligong and Wuling mountains, two new species were recognized and are described here. The male of *A. wulongensis*

Song & Zhu, 1992, a species known previously by only the holotype female, is described here for the first time, and the female is redescribed based on material collected from the type locality.

Material and methods

Specimens were collected by hand picking, beating shrubs and stored in 75% ethanol. Epigynes were cleared in trypsin enzyme solution before examination and photography. Left male palps were used for description and illustration. Specimens were examined and measured with a Leica M205C stereomicroscope. Photos were taken with a digital camera Canon PowerShot G12 mounted on an Olympus BX53 and a Leica MC170 HD mounted on a Leica M205C. Compound focus images were generated using Helicon Focus v. 3.10. Map was created by ArcMap v. 10.2, and then modified by using Adobe Photoshop CS2 Extended (Fig. 12). Leg measurements are given in the following order: total length (femur, patella + tibia, metatarsus, tarsus). All measurements are given in millimeters (mm). All the type specimens treated in this study are deposited at the College of Life Sciences, Hunan Normal University, Changsha, China. The terminology used in text and figure legends follows Guo et al. (2011).

Abbreviations used in the text and figures are as follows: **ALE** = anterior lateral eyes; **AME** = anterior median eyes; **AME–AME** = distance between AME; **AME–ALE** = distance between AME and ALE; **MO** = median ocular quadrangle; **MOA** = MO anterior width; **MOL** = length of MO; **MOP** = MO posterior width; **PLE** = posterior lateral eyes; **PME** = posterior median eyes; **PME–PME** = distance between PME; **PME–PLE** = distance between PME and PLE; **d** = dorsal; **v** = ventral; **p** = prolateral; **r** = retrolateral.

Taxonomy

Family Araneidae Clerck, 1757

Genus *Araneus* Clerck, 1757

The genus *Araneus* is polyphyletic. All species treated in this study belong to the *A. sturmi* group; *A. sturmi* is the type species of *Atea* C.L. Koch, 1837, a genus currently considered as a junior synonym of *Araneus* (Levi 1991).

Araneus conexus sp. nov.

<http://zoobank.org/08B788A4-1CEF-4673-9BCE-56E4CA49A456>

Figs 1–5, 12

Type material. Holotype, ♂, **CHINA, Yunnan Province:** Tengchong County, Jietou Township, Datang Village: Longtang River, papaya orchard, 25.75720N, 98.69459E,

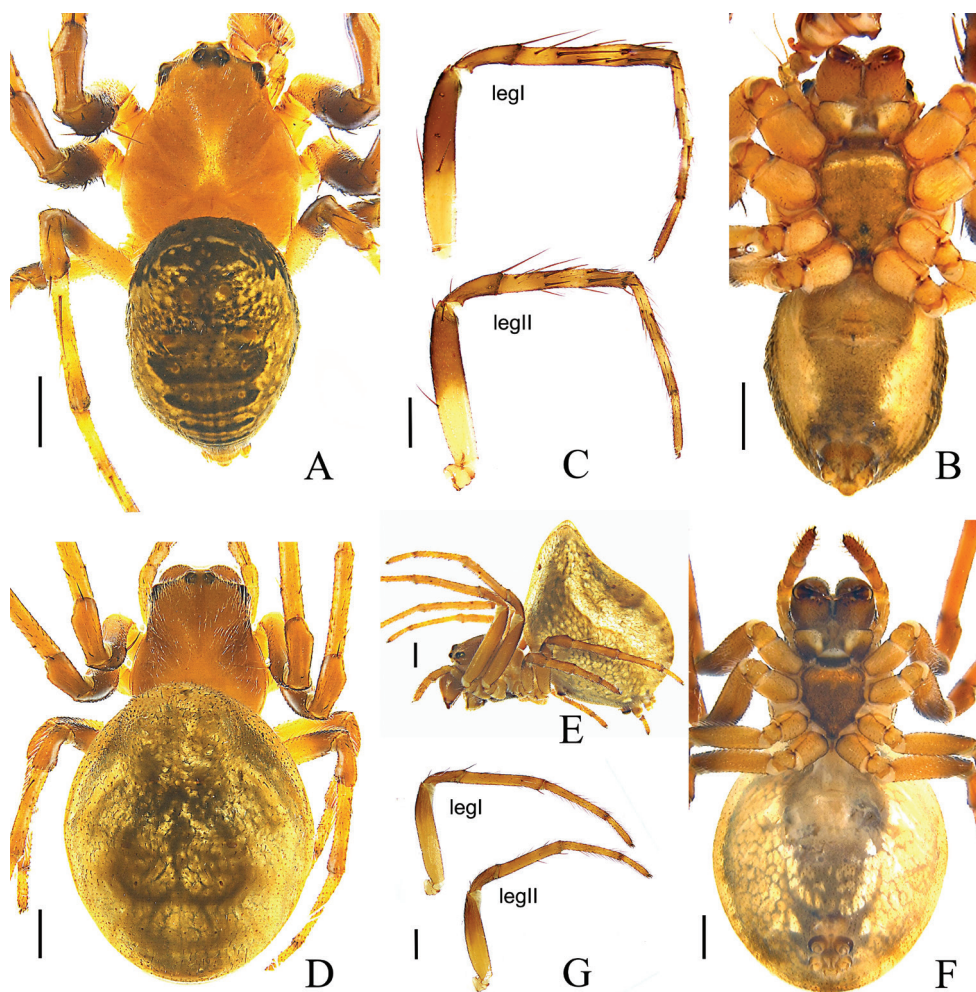


Figure 1. *Araneus conexus* sp. nov., male (holotype, **A–C**); female (paratype collected together with the holotype, **D–G**). **A, D** habitus, dorsal view **B, F** habitus, ventral view **E** habitus, lateral view **C, G** leg I and II, prolateral view. Scale bars: 0.5 mm.

2078 m, 16.05.2006, X. J. Peng, X.P. Wang and P. Hu leg. (Peng060516). Paratypes: 1♂ 2♀, same data as holotype (Peng060516); 4♂ 3♀, Dahe Ridge, 25.42018N, 98.40946E, 1878 m, 19.05.2006, X.J. Peng, X.P. Wang and P. Hu leg. (Peng060519); 1♂ 2♀, Longling County, Longjiang Township, Xiaoheishan Nature Reserve, 24.82886N, 98.75917E, 2010 m, 26.05.2005, H.M. Yan leg. (GKJ026); 2♀, Longyang District, Bawan Village, Nankang Valley, 24.82587N, 98.76832E, 2148 m, 26.05.2005, K.J. Guo leg. (GKJ027).

Etymology. The specific name from Latin adjective *conexus* (joined together), referring to the abdominal humps joined together in female.

Diagnosis. The new species resembles *A. stella* (Karsch, 1879) (Tanikawa 2009: figs 218, 219; Kim and Lee 2012: fig. 18), but can be distinguished by: 1) median

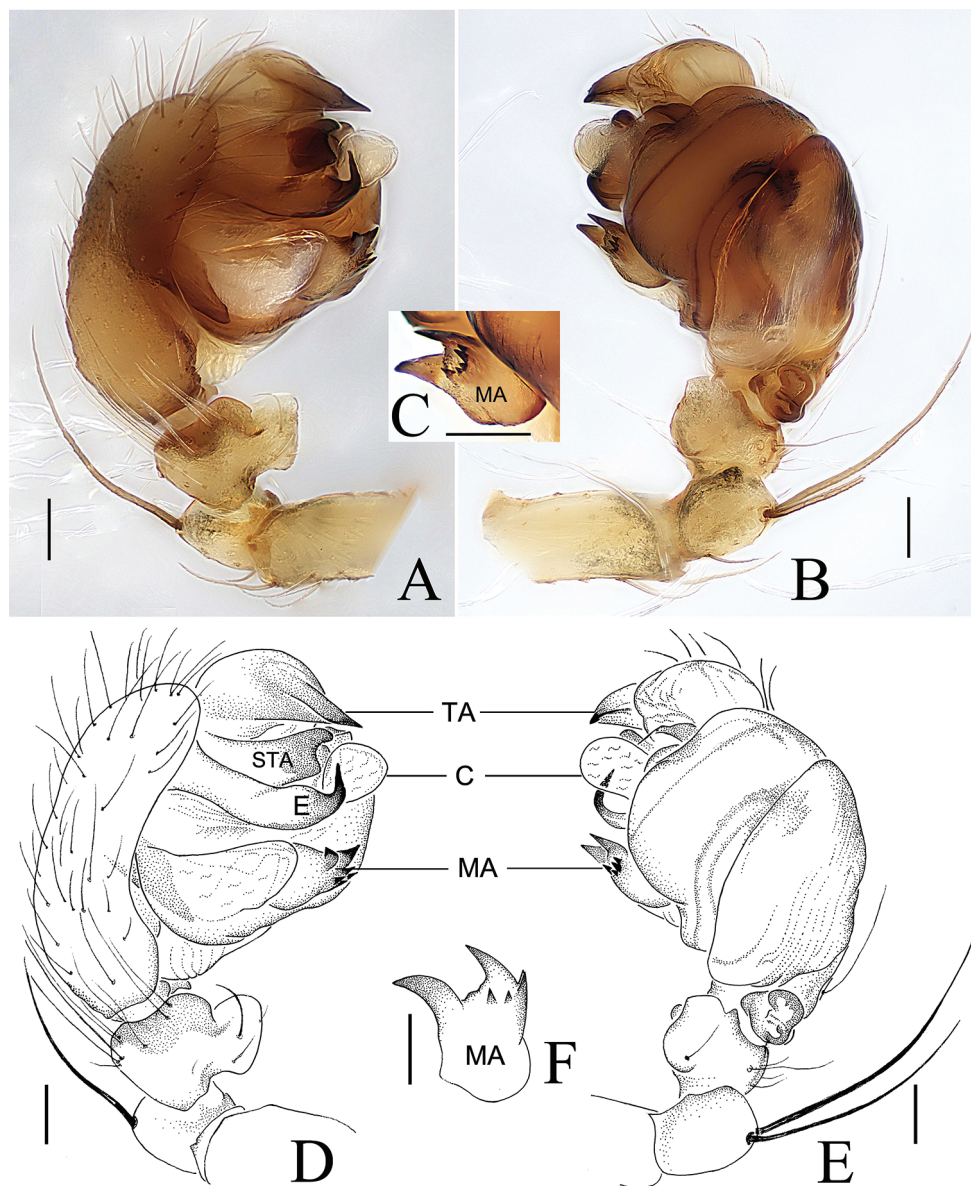


Figure 2. *Araneus conexus* sp. nov., male holotype palp **A, D** prolateral view **B, E** ventral view **C, F** median apophysis. Abbreviations: C = conductor; E = embolus; MA = median apophysis; STA = subterminal apophysis; TA = terminal apophysis. Scale bars: 0.1 mm.

apophysis with a spur and 4–6 teeth in *A. conexus* sp. nov. vs with 2 large teeth in *A. stella*; 2) subterminal apophysis longer than wide, with blunt tip in *A. conexus* sp. nov. vs almost as long as wide, with pointed tip in *A. stella*; 3) terminal apophysis almost parallel to the embolus and subterminal apophysis in prolateral view in *A. conexus* sp. nov. vs almost perpendicular, tip overlapping the conductor in *A. stella*; 4) distal part

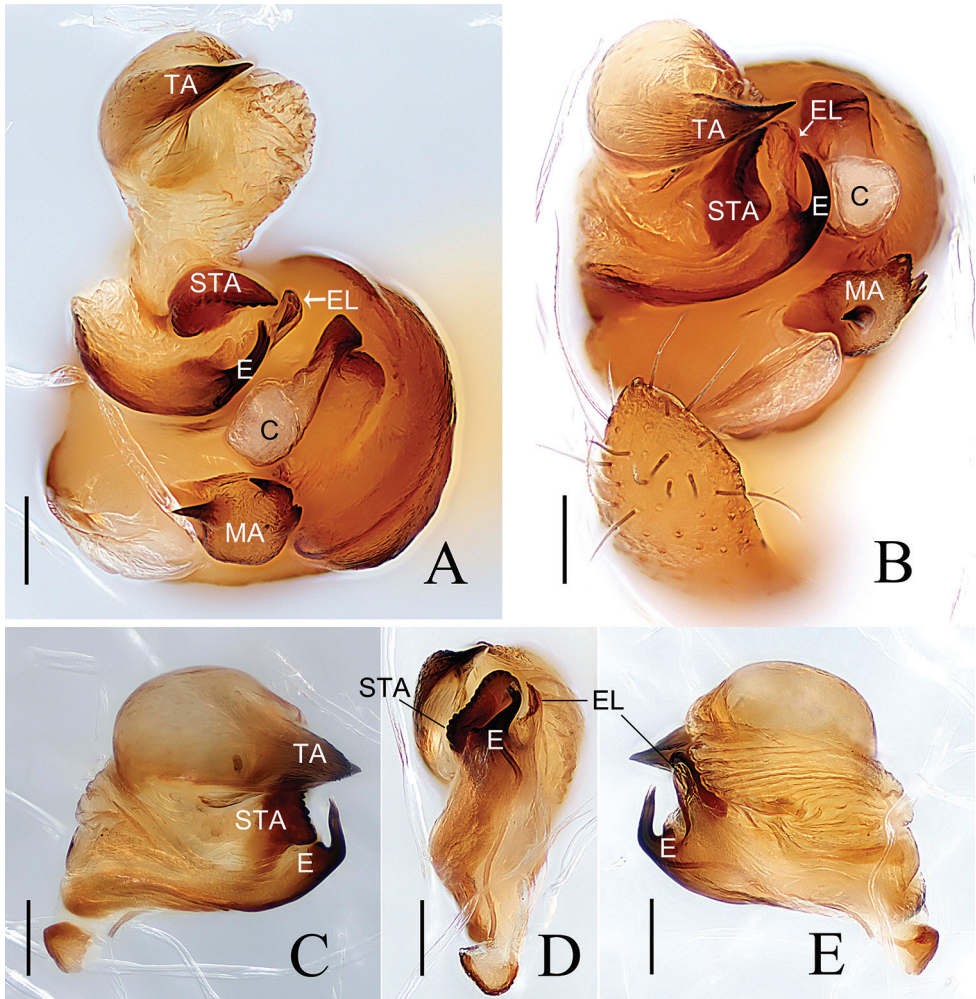


Figure 3. *Araneus conexus* sp. nov., male (paratype palp expanded **A, B**; endaparatus **C-E**) **A-C** prolateral view **D** lateral view **E** ventral view. Abbreviations: C= conductor; E= embolus; EL= embolic lamella; MA= median apophysis; STA= subterminal apophysis; TA= terminal apophysis. Scale bars: 0.1 mm.

of embolus hook-shaped in *A. conexus* sp. nov. vs straight in *A. stella*; 5) scape almost as long as epigyne in *A. conexus* sp. nov. vs about 2 times longer than epigyne in *A. stella*; 6) abdomen with a pair of humps at the anterior part, almost merged with each other in *A. conexus* sp. nov. vs humps not merged and located at the lateral sides in *A. stella*. The female of new species resembles *A. bicavus* Zhu & Wang, 1994 (Yin et al. 1997: fig. 77), but can be distinguished by: 1) the abdomen with a pair of large humps at the anterior part, almost merged with each other in *A. conexus* sp. nov. vs small humps not merged and located at the lateral sides in *A. bicavus*; 2) the epigyne with a depression positioned vertically on each side of the scape in *A. conexus* sp. nov. vs with a circular depression in *A. bicavus*. The female also resembles *A. boesenbergi* (Fox, 1938) (Yin et

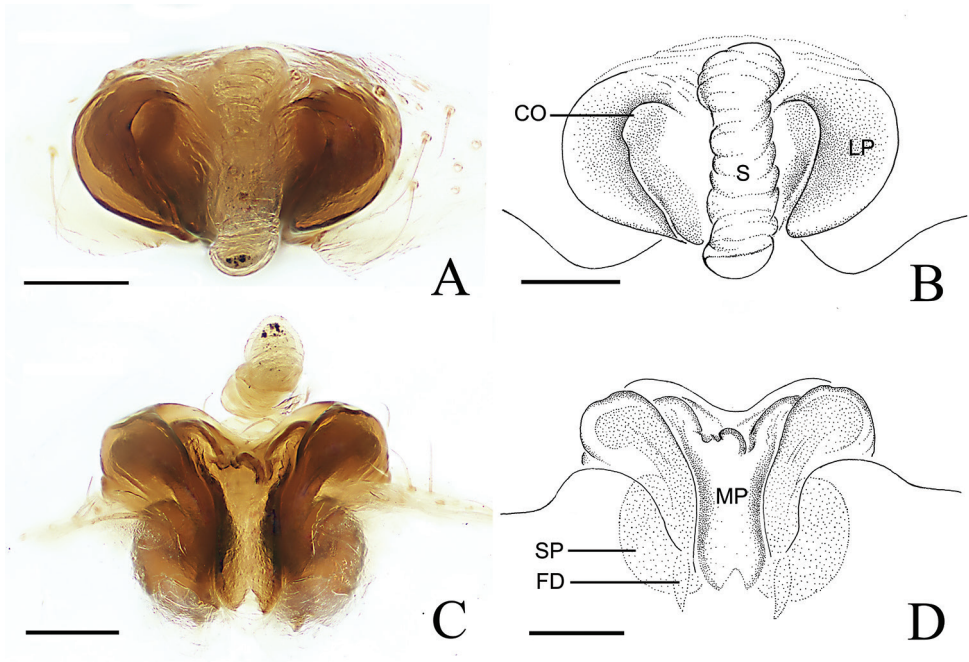


Figure 4. *Araneus conexus* sp. nov., female (epigyne, **A–D**) **A, B** ventral view **C, D** posterior view. Abbreviations: CO = copulatory opening; FD = fertilization duct; LP = lateral plate; MP = median plate; S = scape; SP = spermatheca. Scale bars: 0.1 mm.

al. 1997: fig. 79), but can be distinguished by: furrow of epigynal plate semicircular in *A. conexus* sp. nov. vs almost circular in *A. boesenbergi*.

Description. Male (holotype) (Fig. 1A–C): total length 3.04. Carapace 1.62 long, 1.30 wide, yellow; fovea, cervical, and radial grooves distinct. Eye sizes and interdistances: AME 0.08; ALE 0.09; PME 0.10; PLE 0.08; AME–AME 0.06; AME–ALE 0.23; PME–PME 0.14; PME–PLE 0.24; MOL 0.24; MOA 0.23; MOP 0.27. Sternum yellowish brown, with transverse light band anteriorly. Chelicerae yellow. Endites yellow, distal end pale. Labium brown, distal part pale yellow. Legs yellow, with dark-brown annuli. Tibia I slightly curved, with several strong spines: 3d, 1v, 7p, 1r; tibia II spines: 3d, 3v, 6p, 1r. Leg lengths: I, 6.54 (1.86, 2.25, 1.51, 0.92); II, 5.21 (1.56, 1.77, 1.28, 0.60); III, 3.04 (1.03, 1.02, 0.60, 0.39); IV, 4.22 (1.33, 1.44, 0.98, 0.47). Abdomen 2.63 long, 1.30 wide, oval, dorsum grayish yellow, anterior part dark and slightly bulged in the middle, posterior part with 4 dark transverse bands, 4 pairs of sigillae; ventral side with a longitudinal brown band, lateral sides grayish yellow. Spinnerets yellowish brown.

Palp (Figs 2, 3). Patella with 2 macrosetae. Tibia wider than long, ventral side bulging in prolateral view. Tegulum slightly grooved ventrally. Median apophysis with a prolateral spur, with 1 large and 3–5 small retrolateral teeth. Conductor membranous, gear lever-shaped, with swollen tip (Fig. 3A, B). Subterminal apophysis sclerotized, longer

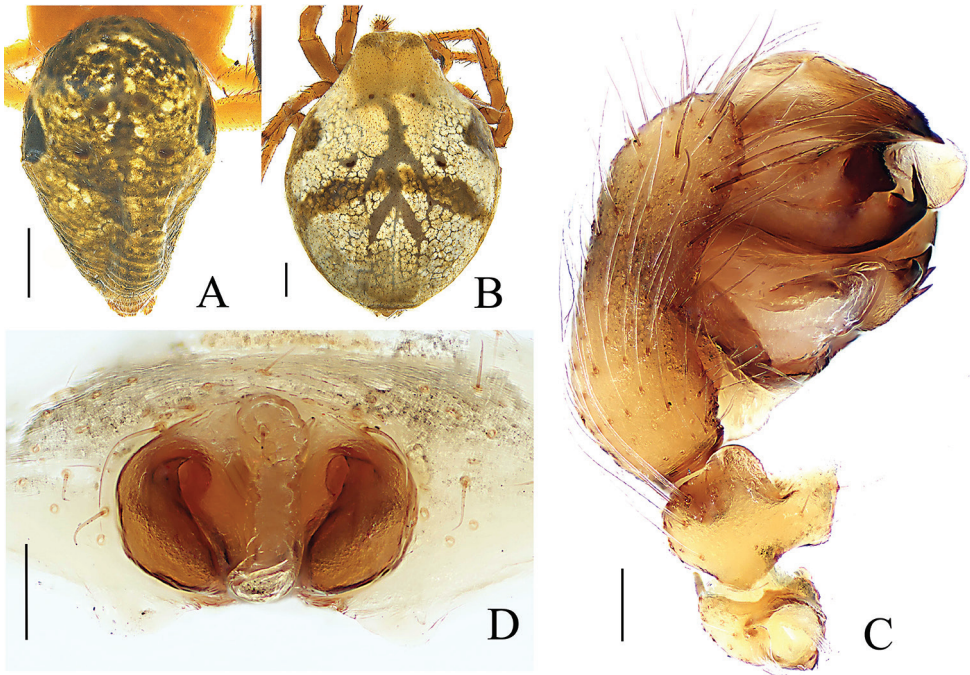


Figure 5. *Araneus conexus* sp. nov., male (paratype, **A, C** GKJ026); female (paratype, **B, D** GKJ026) **A, B** habitus, dorsal view **C** palp, prolateral view **D** epigyne, ventral view. Scale bars: 0.5 mm (**A, B**); 0.1 mm (**C, D**).

than wide, terminal margin with several teeth. Terminal apophysis sword-shaped, with pointed tip. Embolus longer than wide, tip hooked, directed anti-clockwise; embolic lamella membranous, finger-shaped in ventral view, distally grooved (Fig. 3).

Female (allotype) (Fig. 1C–F): total length 4.42. Carapace 1.79 long, 1.65 wide, yellowish brown; cervical and radial grooves distinct. Eye sizes and interdistances: AME, 0.07; ALE, 0.08; PME, 0.10; PLE, 0.07; AME–AME, 0.12; AME–ALE, 0.35; PME–PME, 0.12; PME–PLE, 0.29; MOL, 0.26; MOA, 0.26; MOP, 0.30. Sternum dark brown with transverse light band anteriorly. Chelicerae dark brown. Endites brown, distal end pale. Labium brown, distal third part pale yellow. Legs yellow, annuli indistinct. Tibia I straight with few spines: 2d, 2p, 1r; tibia II: 2d, 2r. Leg lengths: I, 5.45 (1.68, 1.99, 1.20, 0.58); II, 4.70 (1.50, 1.65, 1.02, 0.53); III, 2.89 (0.92, 0.98, 0.59, 0.40); IV, 4.26 (1.33, 1.45, 1.00, 0.48). Abdomen 3.70 long, 2.67 wide, with 2 anterior humps, almost merged with each other, paler and all other morphological pattern similar to the male.

Epigyne (Fig. 4). Epigyne wider than long; scape almost straight, tip slightly curved ventrally; lateral plates longer than wide, expanded laterally in ventral view; median plate longer than wide, tongue-shaped, grooved posteriorly; basal lamellae absent. Copulatory openings facing ventrally, in the slit between median and lateral plates. Copulatory ducts inconspicuous. Spermathecae oval.

Variation (paratype male and female from GKJ026) (Fig. 5): abdomen with a pair of large dark lateral spots, and pair of herringbones spots in the middle area of dorsum. The structure of copulatory organs as in holotype and paratypes of Peng060516.

Distribution. Known only from the type locality.

***Araneus digitatus* sp. nov.**

<http://zoobank.org/C3AABB33-9290-4683-AECA-27C692F92A36>

Figs 6–8, 12

Type material. Holotype, ♂, **CHINA, Hubei Province:** Badong County, Yanduhe Town, Songziyuan Village, Wagang Creek, 31.35067N, 110.42625E, 1340 m, 28.04.2016, W. Liu, C. Zeng and T. Tian leg (20160428). Paratypes: 1♀, same data as holotype (20160428); 1♂, same locality, Tiansheng Valley, 31.35279N, 110.39937E, 1836 m, 27.04.2016, W. Liu et al. leg. (20160427).

Etymology. The specific name is derived from the Latin adjective *digitatus* (finger-shaped), referring to the finger-shaped terminal apophysis.

Diagnosis. The new species resembles *A. ryukyuanus* Tanikawa, 2001 (Tanikawa 2001: figs 5–8, 19–21), but can be distinguished by: 1) embolus with pointed and straight tip in *A. digitatus* sp. nov. vs with blunt and bended tip in *A. ryukyuanus*; 2) tip of scape about 2/3 of epigyne width in ventral view in *A. digitatus* sp. nov. vs only 1/3 of the width of epigyne in *A. ryukyuanus*; 3) epigynal lateral plates expanded laterally in *A. digitatus* sp. nov. vs tube-shaped in *A. ryukyuanus*; 4) abdomen with dark brown folium in both sexes in *A. digitatus* sp. nov. vs female abdomen mid-dorsally with broad, yellowish band and black in male in *A. ryukyuanus*. The new species also resembles *A. zhaoi* Zhang & Zhang, 2002 (Zhang and Zhang 2002: fig. 1), but can be distinguished by: 1) embolus hook-shaped, distal part slender in *A. digitatus* sp. nov. vs sickle-shaped, distal part not slender in *A. zhaoi*; 2) tegular rim almost straight in ventral view in *A. digitatus* sp. nov. vs waved in *A. zhaoi*; 3) copulatory openings distinct in ventral view in *A. digitatus* sp. nov. vs indistinct in *A. zhaoi*.

Description. Male (holotype) (Fig. 6A, B, E): total length 4.92. Carapace 2.28 long, 1.91 wide, light yellowish with broad, brown lateral margins. Fovea, cervical, and radial grooves distinct. Eye sizes and interdistances: AME, 0.08; ALE, 0.08; PME, 0.10; PLE, 0.10; AME–AME, 0.15; AME–ALE, 0.23; PME–PME, 0.07; PME–PLE, 0.26; MOL, 0.31; MOA 0.30; MOP, 0.32. Sternum dark brown. Chelicerae pale yellow. Endites brown with distal end yellow. Labium dark brown, distal part pale yellow. Legs I and II with yellow coxae and trochanters, other segments yellowish brown. Legs III and IV yellow, with brown annuli. Tibia I and II with several strong spines, tibia I: 3d, 7p, 1r; tibia II: 3d, 3v, 6p, 1r. Leg lengths: I, 8.54 (2.48, 3.17, 2.03, 0.86); II, 7.87 (2.39, 2.82, 1.87, 0.79); III, 4.37 (1.45, 1.57, 0.86, 0.49); IV, 6.35 (2.09, 2.25, 1.46, 0.55). Abdomen 2.89 long, 1.97 wide, oval, grayish, dark-brown folium covers almost whole dorsum, 4 pairs of sigillae, posterior 2 pairs indistinct. Ventral median band dark brown, lateral sides grayish. Spinnerets dark brown.

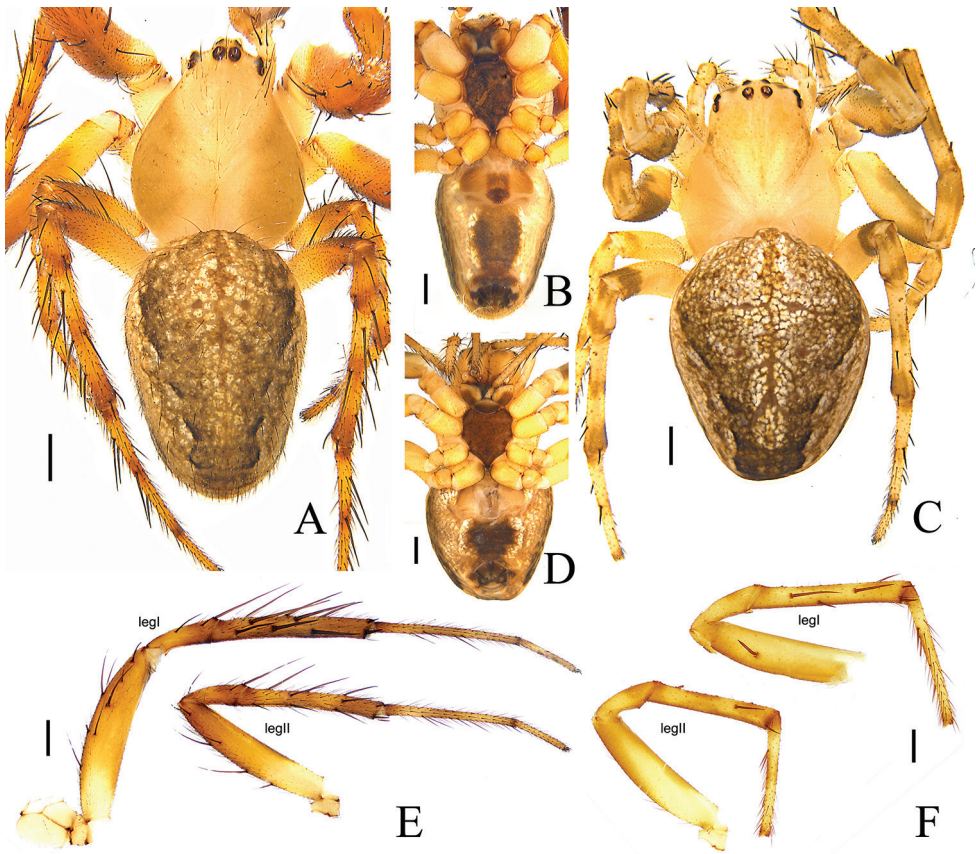


Figure 6. *Araneus digitatus* sp. nov., male (holotype, **A, B, E**), female (**C, D, F**) **A, C** habitus, dorsal view **B, D** habitus, ventral view **E, F** leg I and II, prolateral view. Scale bars: 0.5mm.

Palp (Fig. 7). Patella with 2 macrosetae. Tibia wider than long, ventral side bulging in prolateral view. Tegulum slightly bulging ventrally. Median apophysis V-shaped, dorsal ramus finger-shaped with pointed tip, ventral ramus with many teeth. Conductor membranous, with swollen tip and a spur on the base. Subterminal apophysis 1 broad, slightly curved; subterminal apophysis 2 strongly curved, invisible on unexpanded palp. Terminal apophysis membranous, finger-shaped curved, slightly overlapping the conductor. Embolus curved clockwise, distally thin and straight, with a cap on the top, slightly overlapping the conductor.

Female (allotype) (Fig. 6C, D, F): total length 5.20. Carapace 2.63 long, 2.14 wide, light yellowish, cervical and radial grooves distinct. Eye sizes and interdistances: AME, 0.07; ALE, 0.08; PME, 0.11; PLE, 0.11; AME–AME, 0.17; AME–ALE, 0.33; PME–PME, 0.13; PME–PLE, 0.35; MOL, 0.33, MOA, 0.34; MOP, 0.36. Sternum dark brown. Chelicerae pale yellow. Endites brown, distal end pale yellow. Labium dark brown, distal part pale yellow. Legs yellow, with dark brown annuli. Spination: tibia I: 2d, 5p, 2r; tibia II: 2d, 2p, 2r. Leg lengths: I, 7.95 (2.39, 2.98,

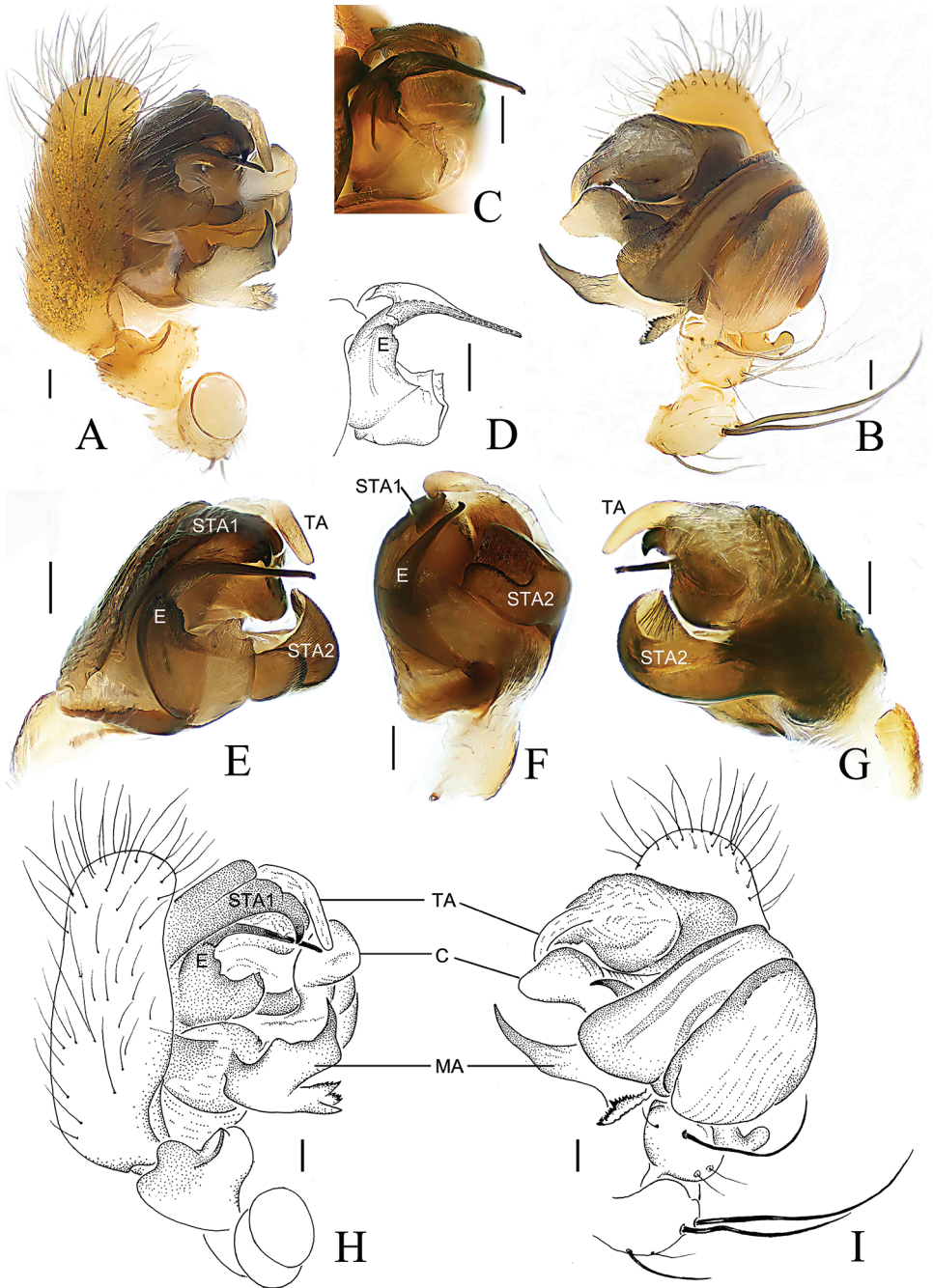


Figure 7. *Araneus digitatus* sp. nov., male holotype (palp, **A–D, H, I**; endoparsatus **E–G**) **A, E, H** prolateral view **B, I, G** ventral view **C, D** embolus, prolateral view **F** lateral view. Abbreviations: C = conductor; E = embolus; MA = median apophysis; STA = subterminal apophysis; TA = terminal apophysis. Scale bars: 0.1 mm.

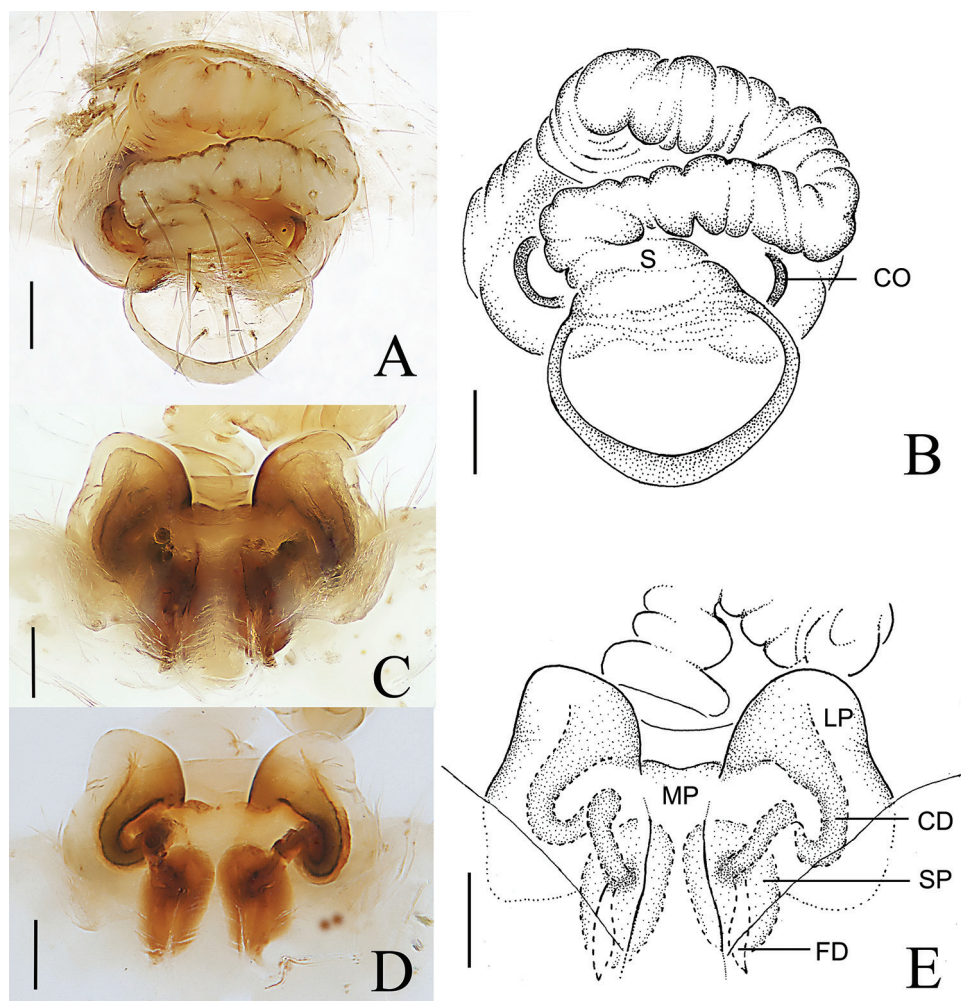


Figure 8. *Araneus digitatus* sp. nov., female (epigyne, **A–E**) **A, B** ventral view **C–E** posterior view. Abbreviations: CD = copulatory duct; CO = copulatory opening; FD = fertilization duct; LP = lateral plate; MP = median plate; S = scape; SP = spermatheca. Scale bars: 0.1mm.

1.80, 0.78); II, 7.21 (2.28, 2.64, 1.62, 0.67); III, 4.75 (1.65, 1.65, 0.95, 0.50); IV, 6.78 (2.17, 2.37, 1.59, 0.65). Abdomen 3.27 long, 2.61 wide, color and pattern same as in male.

Epigyne (Fig. 8). Epigyne almost as wide as long in ventral view; scape S-shaped, with one helical turn, wrinkled, tip cordiform and widened distinctly; median plate longer than wide, tongue-shaped; lateral plates slightly longer than wide, expanded laterally; basal lamellae absent. Copulatory openings located ventro-laterally. Copulatory ducts twisted. Spermathecae small and oval, almost touching each other.

Distribution. Known only from the type locality.

***Araneus wulongensis* Song & Zhu, 1992**

Figs 9–12

Araneus wulongensis Song and Zhu 1992: 170, fig. 6A, B (♀).*Araneus wulongensis*: Song and Li 1997: 415, fig. 18A, B (♀).*Araneus wulongensis*: Yin et al. 1997: 153, fig. 69a–c (♀).*Araneus wulongensis*: Song et al. 1999: 242, fig. 141O–P (♀).

Examined material. 1♂ 2♀, **CHINA, Chongqing Province:** Pengshui County, Mowei Mountain, 29.16068N, 108.03687E, 1548 m, 23.05.2017, G.C. Zhou et al. leg. (HNU–CQ–IV–1702); 1♀, Nanchuan Region, Sanquan County, Jinfou Mountain, 29.06446N, 107.19152E, 1167 m, 13.08.2015, X.J. Peng et al. leg. (HNU–CQ–IV–1506).

Diagnosis. This species (Figs 10, 11) resembles *A. digitatus* sp. nov. (Figs 7, 8), but can be distinguished by: 1) embolus sickle-shaped vs almost C-shaped in *A. digitatus* sp. nov.; 2) having 1 subterminal apophysis vs having 2 subterminal apophyses in *A. digitatus* sp. nov.; 3) terminal apophysis sclerotized, broad vs membranous, finger-

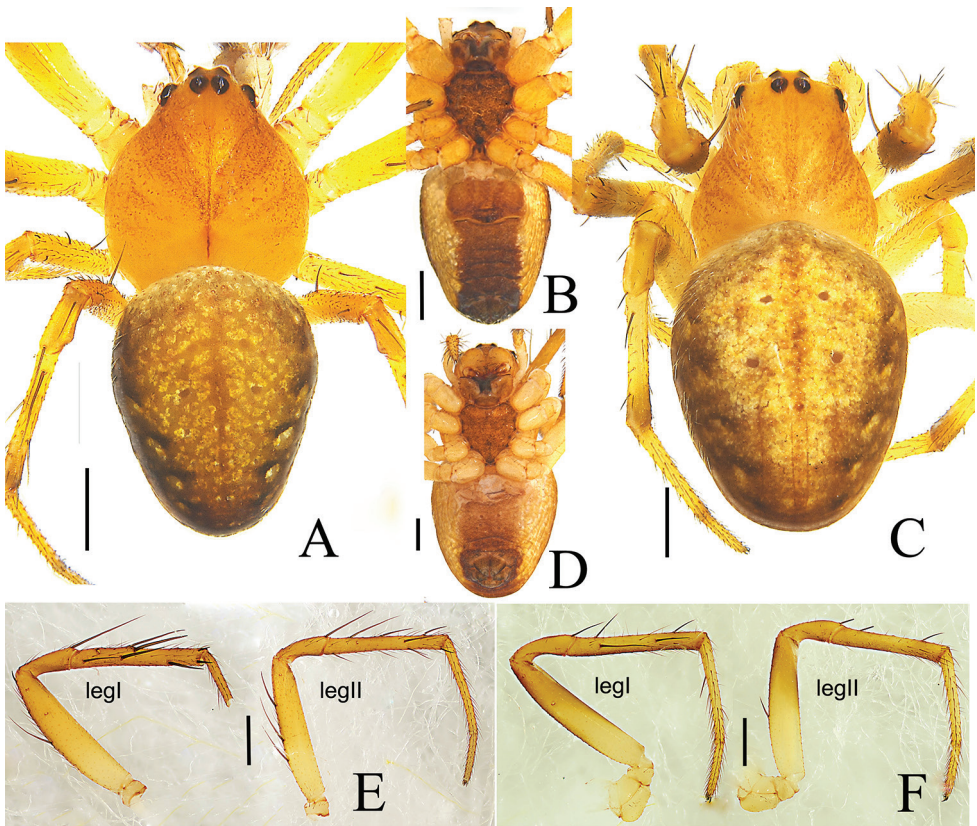


Figure 9. *Araneus wulongensis* Song & Zhu, 1992, male (A, B, E), female (C, D, F) A, C habitus, dorsal view B, D habitus, ventral view E, F leg I and II, prolateral view. Scale bars: 0.5 mm.

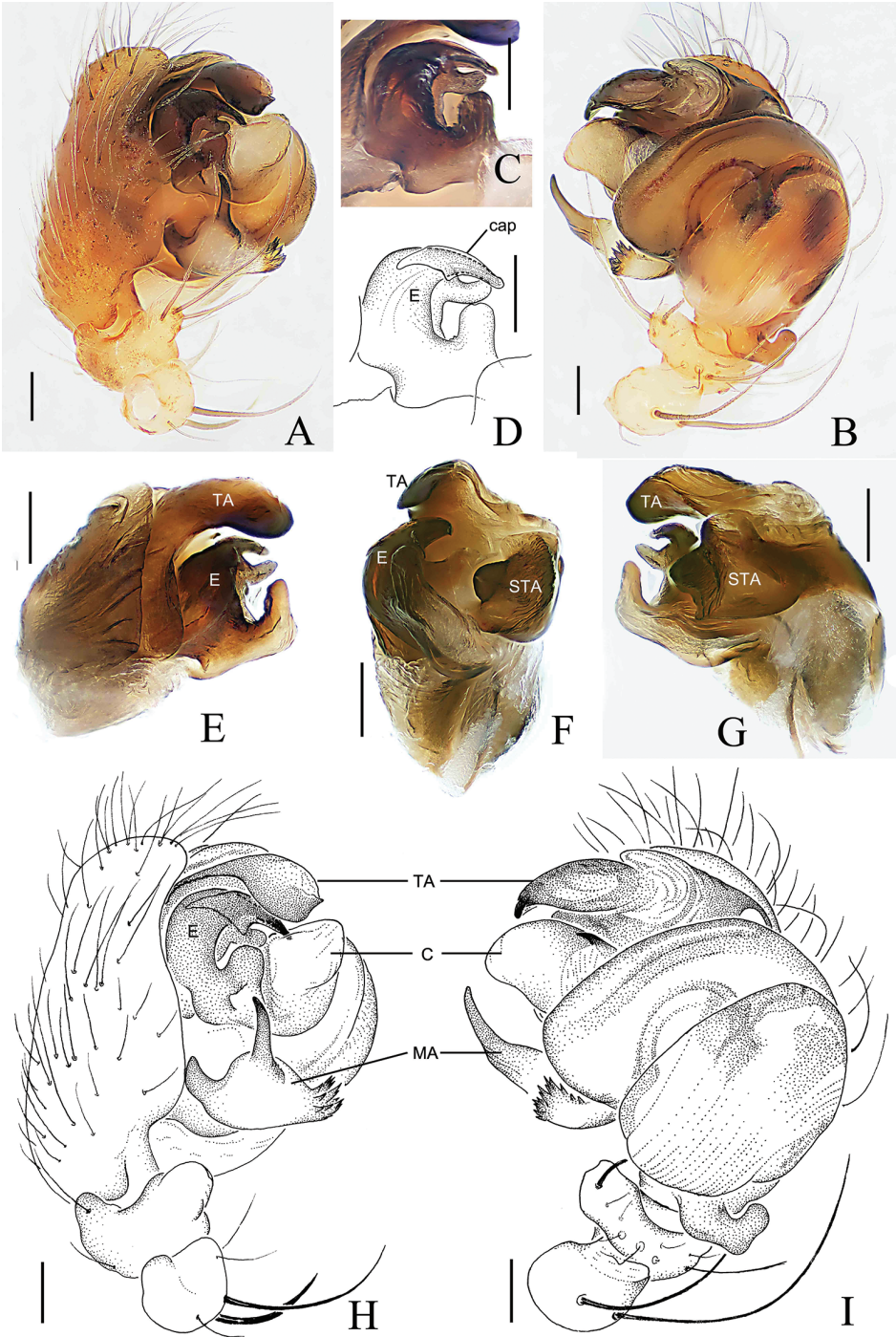


Figure 10. *Araneus wulongensis* Song & Zhu, 1992, male (palp, **A–D, H, I**; endoparatus **E–G**) **A, E, H** pro-lateral view **B, G, I** ventral view **C, D** embolus **F** lateral view. Abbreviations: C = conductor; E = embolus; MA = median apophysis; STA = subterminal apophysis; TA = terminal apophysis. Scale bars: 0.1 mm.

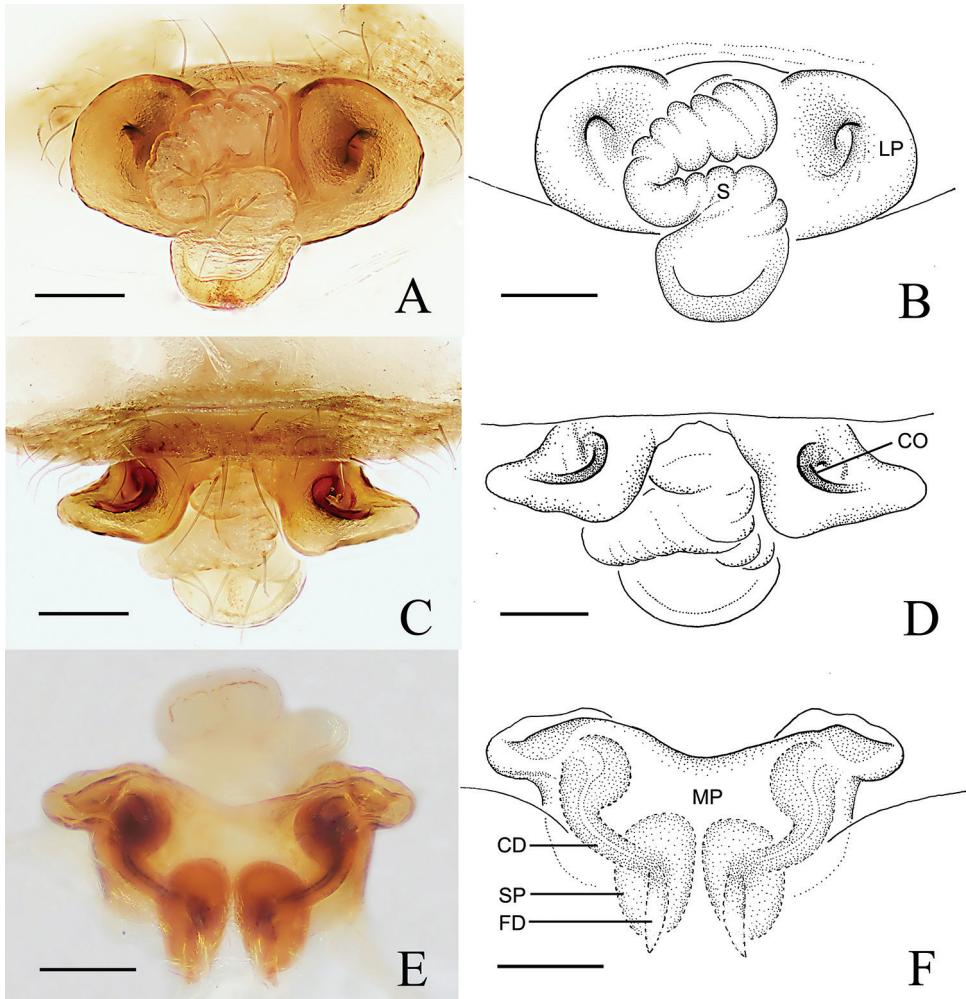


Figure 11. *Araneus wulongensis* Song & Zhu, 1992, female epigyne **A, B** ventral view **C, D** anterior view **E, F** posterior view. Abbreviations: CD = copulatory duct; CO = copulatory opening; FD = fertilization duct; LP = lateral plate; MP = median plate; S = scape; SP = spermatheca. Scale bars: 0.1 mm.

shaped in *A. digitatus* sp. nov.; 4) epigyne wider than long in ventral view vs epigyne almost as wide as long in *A. digitatus* sp. nov.; 5) copulatory openings located ventro-laterally vs present on the anterio-dorsal side in *A. digitatus* sp. nov.

Description. Male (HNU-CQ-IV-1702) (Fig. 9A–B, E). Total length 2.87. Carapace 1.48 long, 1.26 wide, yellow; fovea, cervical, and radial grooves distinct. Eye sizes and interdistances: AME, 0.08; ALE, 0.06; PME, 0.09; PLE, 0.07; AME–AME, 0.13; AME–ALE, 0.14; PME–PME, 0.07; PME–PLE, 0.18; MOL, 0.23; MOA, 0.26; MOP, 0.21. Sternum dark brown. Chelicerae yellowish brown. Endites yellow to brown. Labium dark brown, distal part pale yellow. Legs yellow, with no annuli. Tibia with several strong spines, tibia I: 3d, 7p; tibia II: 3d, 6v, 4p, 1r. Leg lengths: I,



Figure 12. Collection localities for *Araneus conexus* sp. nov., *Araneus digitatus* sp. nov., and *Araneus wulongensis* Song & Zhu, 1992 in China.

5.19 (1.61, 1.89, 1.17, 0.52); II, 4.61 (1.41, 1.73, 0.98, 0.49); III, 2.77 (1.00, 0.84, 0.56, 0.37); IV, 4.29 (1.22, 1.33, 0.91, 0.44). Abdomen 1.64 long, 1.20 wide, oval, dorsum yellowish brown, laterally with 4 pairs of white crescentic markings and 4 pairs of sigillae, posterior 2 pairs indistinct, folium inconspicuous. Venter with dark-brown, median band, sides light yellow. Spinnerets dark brown.

Palp (Fig. 10). Patella with 2 macrosetae. Tibia wider than long, ventral side bulging in prolateral view. Median apophysis V-shaped, dorsal ramus long, finger-shaped, ventral ramus longer than wide, with many teeth. Conductor as long as wide, membranous, with truncate terminal and a spur on the base. Subterminal apophysis wider than long, sclerotized, distal end with a protuberance at the center in retrolateral view, invisible on unexpanded palp. Terminal apophysis sclerotized, with grooved tip. Embolus thick, sickle-shaped, with a cap pointing downward.

Female (Fig. 9C–D, F). Total length 3.26. Carapace 1.45 long, 1.20 wide, fovea indistinct, cervical and radial grooves distinct. Eye sizes and interdistances: AME, 0.07; ALE, 0.07; PME, 0.09; PLE, 0.08; AME–AME, 0.13; AME–ALE, 0.19; PME–PME, 0.09; PME–PLE, 0.23; MOL, 0.25; MOA, 0.26; MOP, 0.24. Sternum dark brown.

Chelicerae yellowish brown. Endites yellowish brown. Labium dark brown, distal part pale. Legs yellow, with no annuli. Tibia with several strong spines, tibia I spines: 2d, 3p, 2r; tibia II spines: 2d. Leg lengths: I, 5.14 (1.63, 1.95, 1.04, 0.52); II, 4.47 (1.52, 1.65, 0.82, 0.48); III, 2.67 (0.85, 0.83, 0.56, 0.43); IV, 3.98 (1.37, 1.34, 0.87, 0.40). Abdomen 2.09 long, 1.62 wide, color and pattern same as in male.

Epigyne (Fig. 11). Epigyne wider than long; scape S-shaped, wrinkled, tip widened distinctly; lateral plates almost round, with a median depression in ventral view; median plate wider than long, almost rectangular; basal lamellae absent. Copulatory openings located on the antero-dorsal side of the epigyne (Fig. 11C, D). Copulatory ducts slightly curved. Spermathecae oval, almost touching each other.

Distribution. Known only from Chongqing, China (WSC 2019).

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Ten new species of the spider genus *Sinoderces* Li & Li, 2017 from China, Laos and Thailand (Araneae, Psilodercidae)

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Abstract

Ten new species of the spider family Psilodercidae Machado, 1951 are described from tropical East Asia, including five species found in China: *Sinoderces luohanensis* Li & Li, **sp. nov.** (♂♀), *S. xueae* Li & Li, **sp. nov.** (♂♀), *S. taichi* Li & Li, **sp. nov.** (♂♀), *S. wenshanensis* Li & Li, **sp. nov.** (♂♀), *S. aiensis* Li & Li, **sp. nov.** (♂♀); three are from Laos: *S. khanensis* Li & Li, **sp. nov.** (♂♀), *S. phathaoensis* Li & Li, **sp. nov.** (♂♀), *S. kieoensis* Li & Li, **sp. nov.** (♂); and the rest are from Thailand: *S. saraburiensis* Li & Li, **sp. nov.** (♂), *S. dewaroopensis* Li & Li, **sp. nov.** (♂♀). Types of all new species are deposited in the Institute of Zoology, Chinese Academy of Sciences in Beijing, China.

Keywords

Biodiversity, endemism, ochyroceratids, taxonomy, tropical spiders

Introduction

A great diversity of spiders of the family Psilodercidae Machado, 1951 has evolved throughout the zoogeographic regions of Indo-Burma, Sundaland, the Philippines and Wallacea. To date, 141 psilodercid species have been recorded from the various

countries collectively known as “Tropical East Asia” (Li and Quan 2017; World Spider Catalog 2019). They are small, fragile, web-spinning spiders that inhabit dark, damp places, such as leaf litter, tree buttresses and caves. Previously classified as a subfamily within Ochyroceratidae Fage, 1912, Wunderlich (2004) opined that they deserved a family rank as they share several characters that distinguish them from other ochyrocercids (*sensu* Ochyroceratinae): they have book-lungs; their posterior tracheal opening is closer to the spinnerets than other ochyroceratids; they have only 0–3 cheliceral promarginal teeth (as opposed to 6–7 in other ochyroceratids); unlike other ochyroceratids, their labium is not incised; and the position of the bulb is usually at the end of the cymbium, and not near the middle as in other ochyroceratids. The group was subsequently elevated to its own family (Wunderlich 2008).

The genus *Sinoderces* Li & Li, 2017 is currently included in the family Psilodercidae. Only two *Sinoderces* species have been documented so far, namely *S. exilis* (Wang & Li, 2013) and *S. nawanensis* Li & Li, 2017, both from China. In the present paper, we describe ten new species of *Sinoderces* from China, Laos and Thailand.

Material and methods

All specimens were collected in China, Thailand and Laos (Fig. 22), and preserved in 95% ethanol. Types of all new species are deposited in the Institute of Zoology, Chinese Academy of Sciences in Beijing, China. Specimens were examined and measured using a Leica M205 C stereomicroscope. Morphological details were studied with an Olympus BX41 compound microscope. Photos were taken with an Olympus C7070 wide zoom digital camera (7.1 megapixels) mounted on an Olympus SZX12 stereomicroscope. The images were montaged using Helicon Focus 6.7.1 image stacking software. The map was generated using ArcView GIS 10.2. All measurements are in millimeters (mm). Leg measurements are shown as total length (femur, patella, tibia, metatarsus, and tarsus). Leg segments were measured from the retrolateral side. Carapace length was measured from the anterior eye row to the carapace posterior margin. Terminology follows that of Deeleman-Reinhold (1995), Tong and Li (2007), and Li et al. (2014).

Taxonomy

Family Psilodercidae Machado, 1951

Genus *Sinoderces* Li & Li, 2017

Type species. *Sinoderces nawanensis* Li & Li, 2017

Diagnosis. The genus is distinguished (together with *Thaiderces* Li & Li, 2017) from all the other genera in Psilodercidae by the absence of an apical protrusion on the male cymbium. It is distinguished from the genus *Thaiderces* by the presence of a single tooth on the cheliceral retromargin and the long embolus of the palpal bulb (Liu et al. 2017).

Cheliceral promargin with lamina, retromargin with a tooth or denticle; palpal bulb with long embolus; conductor present or absent-if present, then embolus and conductor separated basally; female with two pairs of elongate, curved spermathecae (Liu et al. 2017).

***Sinoderces khanensis* Li & Li, sp. nov.**

<http://zoobank.org/697B62E8-0DFC-49AA-8DD8-A21FE6F35692>

Figs 1, 2, 21, 22

Types. Holotype: ♂, Khan Cave, 5.35 km west of Viengkio Village, Vang Vieng District, Vientiane Province, Laos, 18°55.592'N, 102°23.718'E, 270 m, 01.XI.2012, Yao Z. leg. **Paratypes:** 1♂2♀, same data as holotype.

Etymology. The specific name refers to the cave where type material was collected; adjective.

Diagnosis. Male *Sinoderces khanensis* sp. nov. can be recognized by the overall slender configuration of the palp, with two spines on the cymbium (Fig. 1B). The male clypeus has two apophyses (Fig. 2E). In the female, the spermathecae are extraordinarily elongated and shaped like the front of headband worn by the Chinese mythological Monkey King, Sun Wukong-two blunt ends that meet and curl upward (Fig. 2A).

Description. Male (holotype). Total length 2.33; carapace 1.02 long, 0.75 wide; abdomen 1.28 long, 0.70 wide. Clypeus light brown, with two apophyses. Carapace round, light yellow, with brown lateral margins and a wide median brown band, which is noticeably broader in the mid-section (Fig. 2E). Cheliceral promargin with one tooth, connected to a lamina, retromargin with a small tooth (Fig. 21A). Labium light brown. Sternum brown. Legs brownish yellow, with dark brown joints. Leg measurements: I missing, II 7.82 (2.20, 0.20, 2.33, 2.17, 0.92), III 5.54 (1.60, 0.20, 1.80, 1.52, 0.42), IV 8.52 (2.56, 0.20, 2.64, 2.28, 0.84). Abdomen elongated, with small black stripes, the color tone darkens progressively from front to back (Fig. 2E). Spinnerets black.

Male palp (Fig. 1A–D): The overall color is pale yellow. Bulb light yellow, conical. Needle-like embolus arising distally from bulb, straight; no conductor. Tibia with numerous long setae and two conspicuous spines. Long femur with sparse hairs.

Female (one of the paratypes). Size and color similar to male (Fig. 2C, D). Total length 1.92; carapace 0.63 long, 0.72 wide; abdomen 1.29 long, 0.76 wide. Clypeus dark brown. Carapace round, darker than that of the male. Labium and sternum dark brown, a white spot in the middle of sternum. Legs brownish yellow, with darkish brown joints. Leg measurements: I missing, II 6.06 (1.56, 0.19, 1.94, 1.56, 0.81), III 4.71 (1.25, 0.19, 1.38, 1.20, 0.69), IV 7.14 (2.03, 0.20, 2.19, 1.84, 0.88). Abdomen elongated, dorsum color tone darkens progressively towards the posterior end; and ventrum with numerous white spots and other markings. Spinnerets dark brown.

Epigyne (Fig. 2A, B): Shaped like a mouth with a thick lip (Fig. 2B). It has two pairs of spermathecae: a pair of small and spherical spermathecae connected to a pair

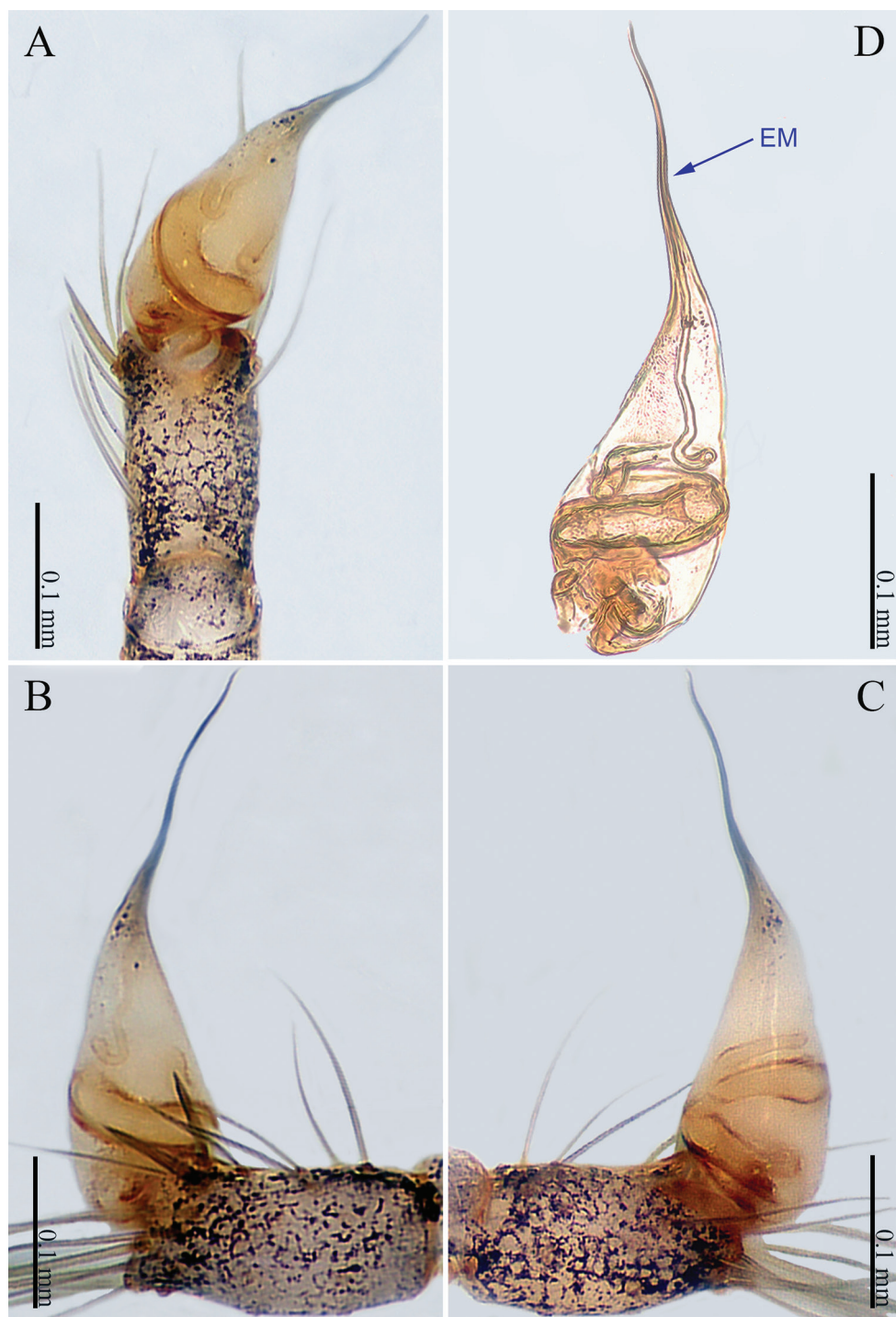


Figure 1. *Sinoderces khanensis* Li & Li, sp. nov., male holotype **A** left palp, ventral view **B** left palp, prolateral view **C** left palp, retrolateral view **D** right palpal bulb, prolateral view. Abbreviation: EM embolus.

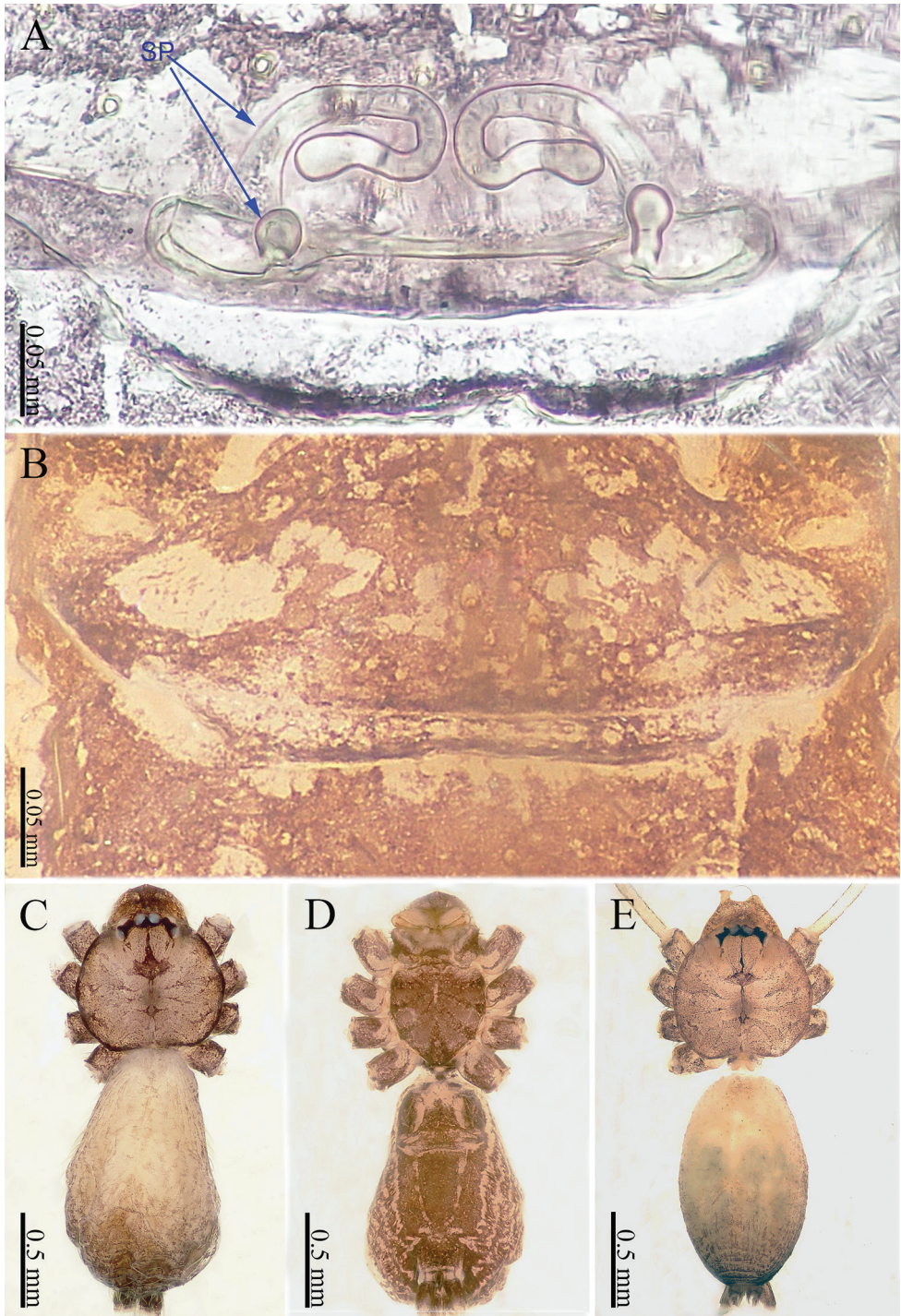


Figure 2. *Sinoderces khanensis* Li & Li, sp. nov., male holotype and female paratype **A** internal genitalia, dorsal view **B** female epigastric furrow, ventral view **C** female habitus, dorsal view **D** female habitus, ventral view **E** male habitus, dorsal view. Abbreviation: SP spermathecae.

of highly elongated and looped spermathecae. The spermathecae conjure an image of the headband worn by the Chinese mythological Monkey King with two blunt ends that meet and curl upward (Fig. 2A).

Distribution. Known only from the type locality (Fig. 22).

Natural history. Collected at a cave's entrance at an elevation of 270 m.

***Sinoderces luohanensis* Li & Li, sp. nov.**

<http://zoobank.org/1E9870D7-4BBD-4DE1-81EA-5E43F9672D05>

Figs 3, 4, 21, 22

Types. Holotype: ♂, outside of Luohan Cave, Suwei Town, Mu Village, Nanning City, Guangxi Zhuang Autonomous Region, China, 22°32.600'N, 108°03.390'E, 270 m, 9.V. 2015, Chen Z. and Li F. leg. **Paratypes:** 3♀, same data as holotype.

Etymology. The specific name refers to the name of the cave; adjective.

Diagnosis. *Sinoderces luohanensis* sp. nov. resembles *S. nawanensis* in shape and size (Fig. 4C–E). Males can be distinguished from the latter by the pointed tip of the conductor (vs. blunt tip in *S. nawanensis*) (Fig. 3). Females can be distinguished by the hairless upper part of abdomen (vs. a row of hairs on the same position in *S. nawanensis*) (Fig. 4B). The two pairs of spermathecae have a similar shape, but the terminus of the long pair of spermathecae bends upward in *S. luohanensis* sp. nov. (vs. bending downward in *S. nawanensis*) (Fig. 4A).

Description. Male (holotype). Total length 1.66; carapace 0.66 long, 0.71 wide; abdomen 1.00 long, 0.64 wide. Carapace round, brown, with darker brown lateral margins. Carapace with large, brown, fork-shaped pattern in the middle (Fig. 4E). Clypeus brown. Cheliceral promargin with two teeth, followed by a lamina; retromargin with no tooth (Fig. 21B). Labium brown. Sternum brown. Legs brownish yellow, with dark brown joints. Leg measurements: I 8.32 (2.28, 0.25, 2.50, 2.16, 1.13) II 6.43 (1.84, 0.25, 1.88, 1.58, 0.88), III 5.05 (1.44, 0.25, 1.50, 1.25, 0.61), IV 7.26 (2.00, 0.25, 2.21, 1.90, 0.90). Abdomen elongated, wrinkled posteriorly. Spinnerets brown (Fig. 4E).

Male palp (Fig. 3A–D): The overall structure is sickle-shaped. Conductor tip pointed. Embolus curved. Bulb yellow, oval. Conductor and embolus clearly separated, with bases at the distal end of the bulb. Terminal tibia hump with long hairs. Femur and trochanter light yellow with isolated hairs.

Female. Color similar to male, and body size slightly larger than males (Fig. 4C–E). Abdomen darker than that in males. Clypeus brown. Carapace round, darker than that of males. Labium and sternum dark brown. Measurements: total length 2.20; carapace 0.64 long, 0.70 wide; abdomen 1.25 long, 0.55 wide. Legs brownish yellow, the joint is dark brown. Leg measurements: I 6.53 (1.75, 0.25, 2.00, 1.63, 0.90), II 5.20 (1.37, 0.25, 1.58, 1.25, 0.75), III 4.31 (1.13, 0.25, 1.25, 1.03, 0.65) IV 6.16 (1.72, 0.25, 1.91, 1.50, 0.78). Abdomen elongated, dorsum with white spots and wrinkles, ventrum with white rings. Epigyne pale yellow. Spinnerets brown.

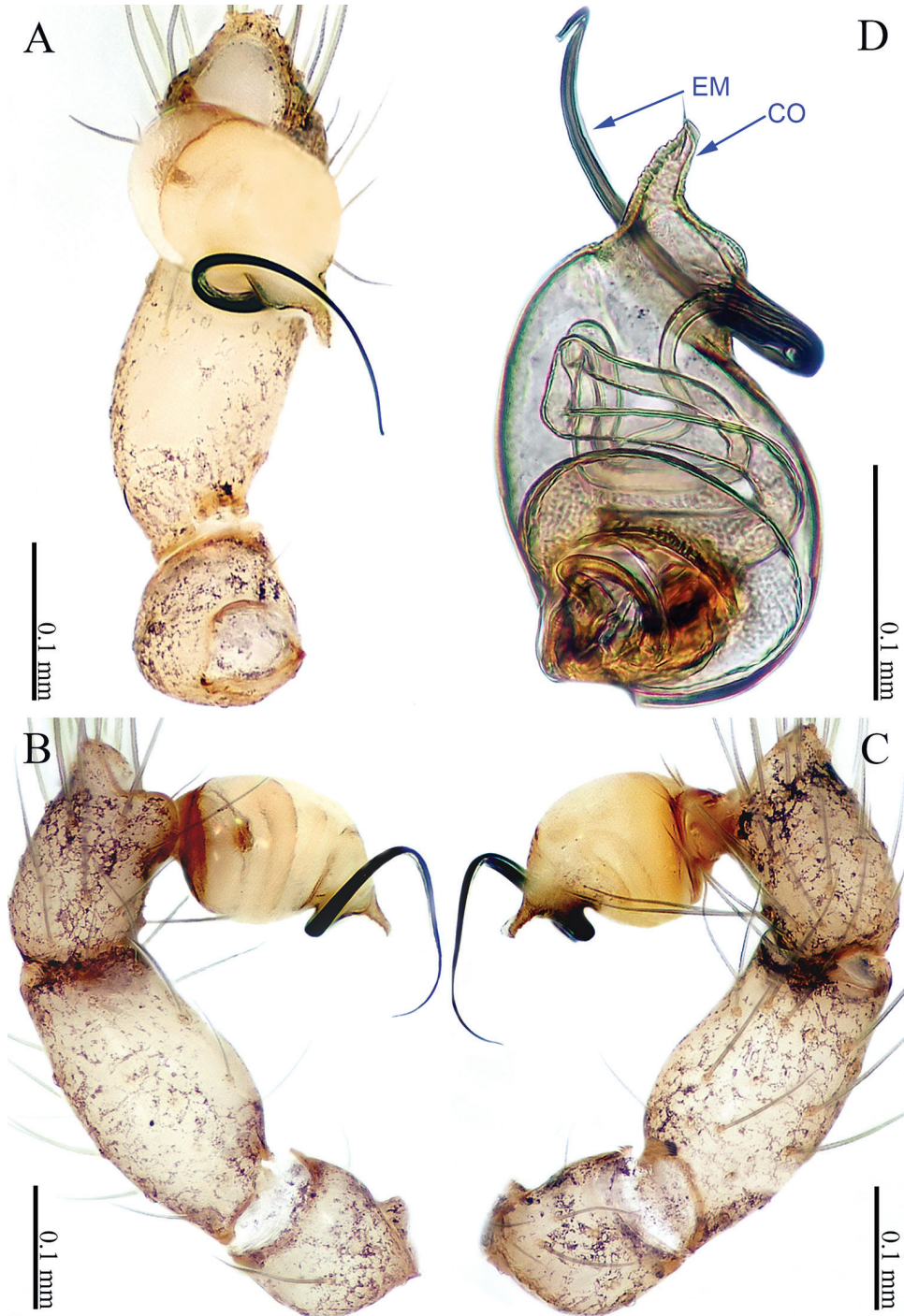


Figure 3. *Sinoderces luohanensis* Li & Li, sp. nov., left pedipalp of male holotype **A** palp, ventral view **B** palp, prolateral view **C** palp, retrolateral view **D** palpal bulb, ventral view. Abbreviations: CO conductor, EM embolus.

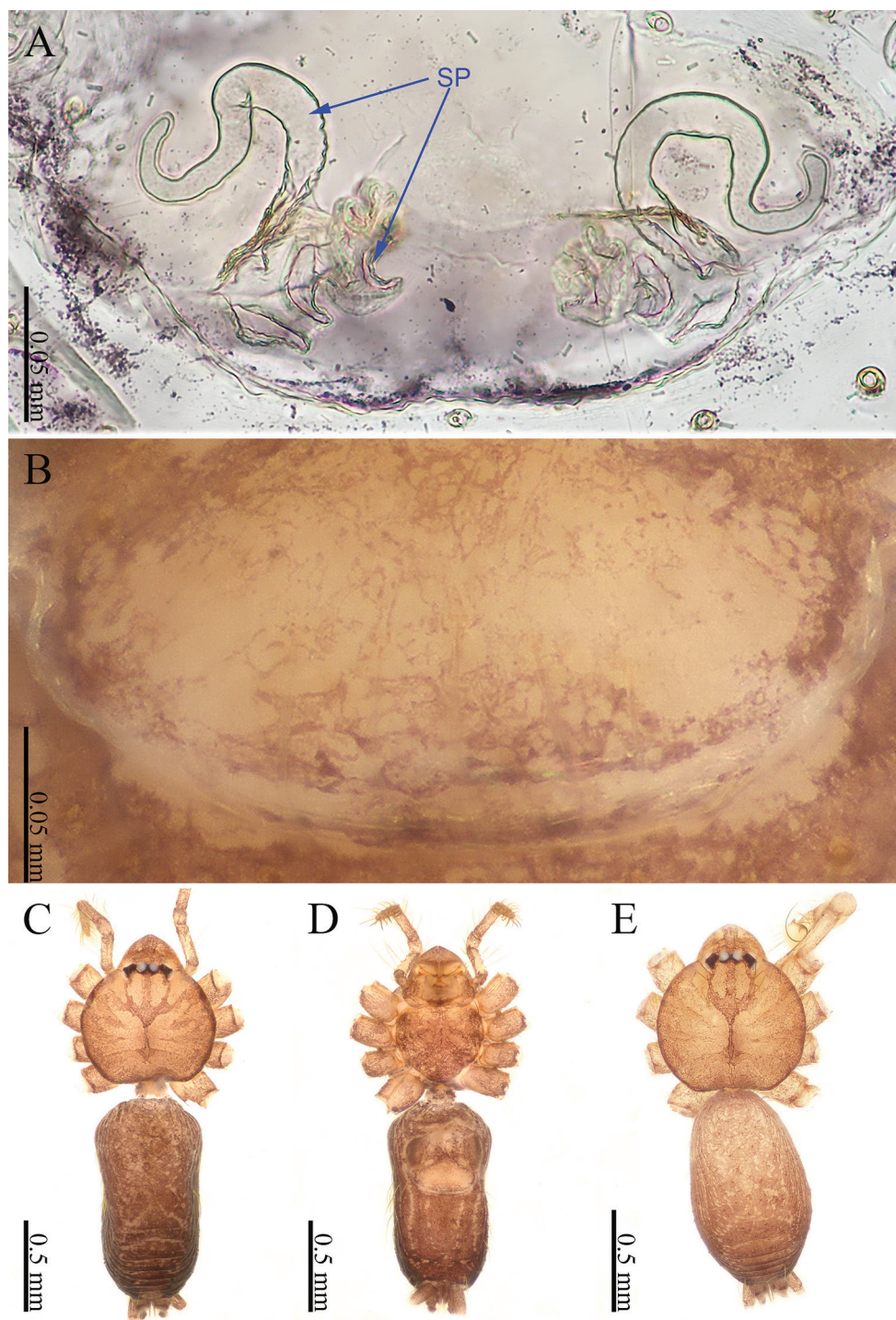


Figure 4. *Sinoderces luohanensis* Li & Li, sp. nov., male holotype and female paratype **A** internal genitalia, dorsal view **B** female epigastric furrow, ventral view **C** Female habitus, dorsal view **D** female habitus, ventral view **E** male habitus, dorsal view. Abbreviation: SP spermathecae.

Epigyne (Fig. 4A, B): Epigynal area lighter in color than other parts of the abdomen. Two pairs of elongated, curved spermathecae. Terminus of the lateral pair of spermathecae bends upward (Fig. 4A).

Distribution. Known only from the type locality (Fig. 22).

Natural history. Collected at a cave entrance at an elevation of 196 m.

***Sinoderces phathaoensis* Li & Li, sp. nov.**

<http://zoobank.org/A0255BE4-7363-4F92-BD0F-DCCDB72D4561>

Figs 5, 6, 21, 22

Types. Holotype: ♂, Pha Thao Cave, Vang Vieng District, 11.95 km north of Viengkio Village, Vientiane Province, Laos, 19°01.749'N, 102°25.954'E, 290 m, 03.XII.2012, Yao Z. leg. **Paratypes:** 3♀, same data as holotype

Etymology. The specific name refers to the name of cave; adjective.

Diagnosis. *Sinoderces phathaoensis* sp. nov. resembles *S. kioensis* sp. nov. in having a similar shaped bulb in males. Males can be distinguished by the curved embolus, almost half as long as the bulb (Fig. 5B, C), in contrast to the straight embolus, less than half the bulb length in *S. kioensis* sp. nov. (Fig. 18B–D). The bulb of *S. phathaoensis* sp. nov. tapers and narrows more sharply (Fig. 5) than that of *S. kioensis* sp. nov. (Fig. 18). The male clypeus has two crotched apophyses.

Description. Male (holotype). Total length 1.84; carapace 0.64 long, 0.70 wide; abdomen 1.20 long, 0.60 wide. Carapace round, light yellow, with brown lateral margins and a trifurcate mark in the center of the carapace (Fig. 6E). Clypeus slanting and darker brown, medially with one pair of bifurcate apophyses. Labium light yellow. Sternum yellow. The opisthosoma darkens anteriorly to posteriorly (Fig. 6E). Cheliceral promargin with one tooth, connected to a lamina, retromargin with one small tooth (Fig. 21C). Leg measurements: I missing, II missing, III missing, IV missing. Abdomen elongated, wrinkles posteriorly; the color darkens towards the posterior end (Fig. 6E). Spinnerets yellow.

Male palp (Fig. 5A–D): The whole structure is relatively simple. Bulb yellow, conical. Embolus arising distally from the bulb, no conductor. Tibia projected distally. Tibia dark yellow, femur and trochanter light yellow.

Female (one of the paratypes). Size and color similar to male (Fig. 6C–E). Total length 1.90; carapace 0.64 long, 0.70 wide; abdomen 1.26 long, 0.60 wide. Carapace brown, with brown lateral margins and a trifurcate mark in the center of carapace (Fig. 6C). Clypeus brown. Endites and labium dark brown. Sternum brown. Legs brownish yellow, with dark brown joints. Leg measurements: I missing, II missing, III 5.58 (1.60, 0.20, 1.70, 1.44, 0.64), IV – (2.20, 0.25, –, –, –). Abdomen wrinkled posterodorsally; the color darkens from anterior to posterior. Ventrums with white rings (Fig. 6E). Spinnerets dark yellow.

Epigyne (Fig. 6A, B): The epigyne is wide and extends to the edge of the abdomen (Fig. 6B). Two pairs of curved spermathecae, the anterior pair of spermathecae resemble a germinating seedling, and the other pair is like a twisted hook (Fig. 6A).

Distribution. Known only from the type locality (Fig. 22).

Natural history. Collected in a cave entrance at an elevation of 290 m.

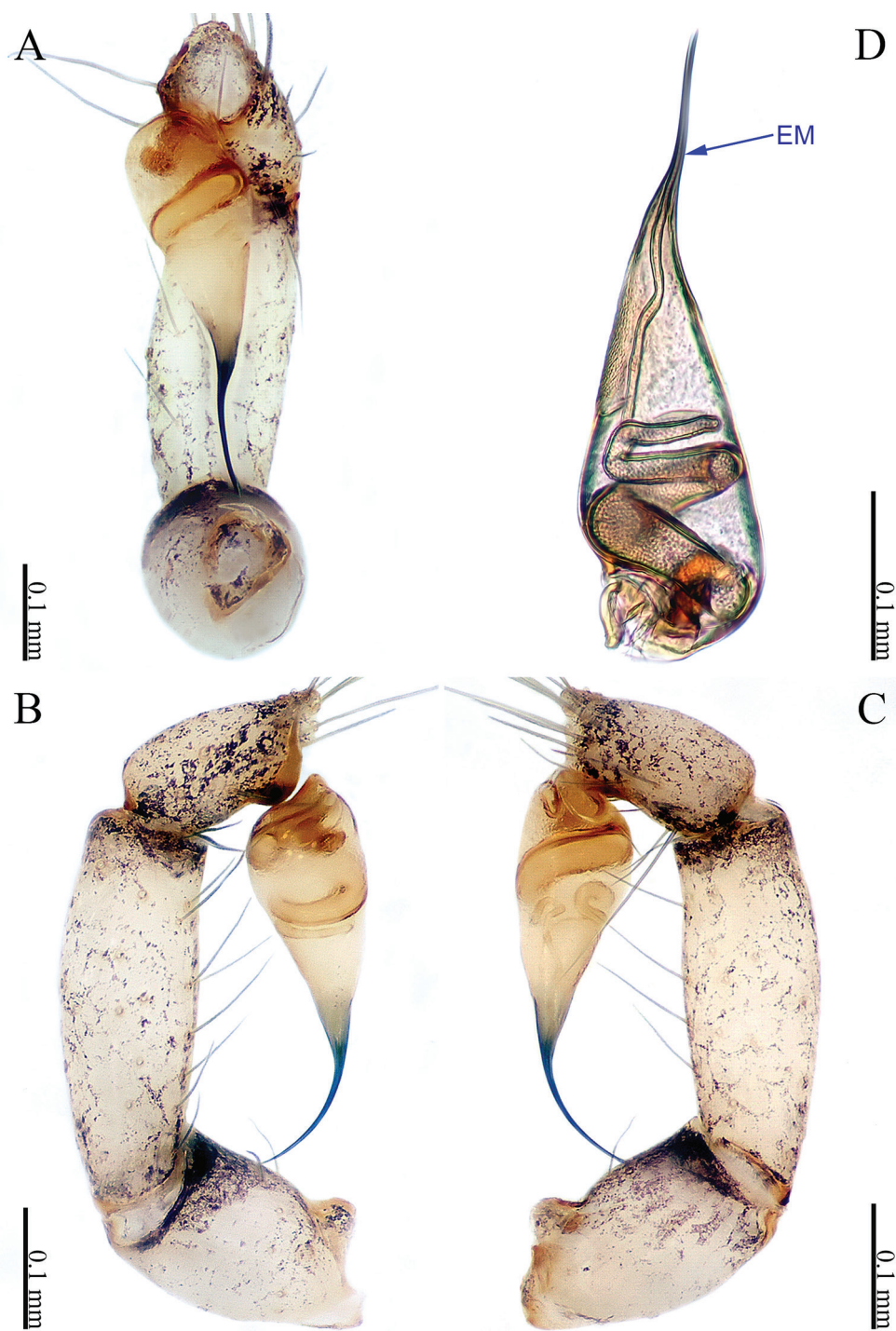


Figure 5. *Sinoderces phathaoensis* Li & Li, sp. nov., left pedipalp of male holotype **A** palp, ventral view **B** palp, prolateral view **C** palp, retrolateral view **D** palp bulb, ventral view. Abbreviation: EM embolus.

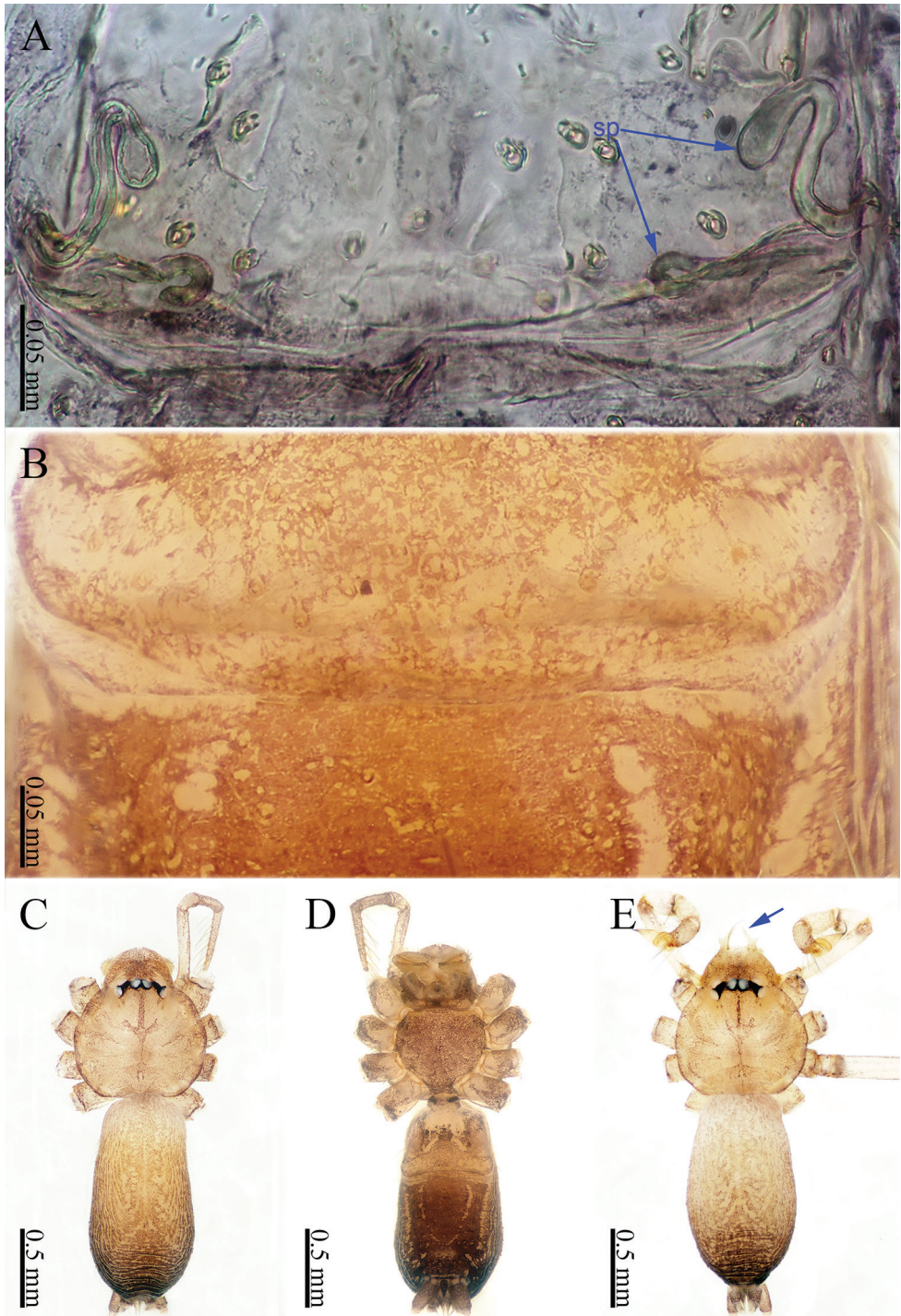


Figure 6. *Sinoderces phathaoensis* Li & Li, sp. nov., male holotype and female paratype **A** internal genitalia, dorsal view **B** female epigastric furrow, ventral view **C** female habitus, dorsal view **D** female habitus, ventral view **E** male habitus, dorsal view (Arrow: apophysis). Abbreviation: SP spermathecae.

***Sinoderces dewaroopensis* Li & Li, sp. nov.**

<http://zoobank.org/73BC9150-2CA1-4BAD-A9A8-EFC1D0D3A600>

Figs 7, 8, 21, 22

Types. Holotype: ♂, Dewaroop Cave 1, Pak Chong Distict, Musee Village, Nakhon Ratchasima Province, Thailand, 14°33.708'N, 101°24.064'E, 397 m, 23.X.2014, Zhao H., Li Y. and Chen Z. leg. **Paratype:** 1 ♀, same data as holotype.

Etymology. The specific name refers to the name of the cave; adjective.

Diagnosis. *Sinoderces dewaroopensis* sp. nov. can be distinguished from all other known species of the genus by the large apical protrusion on the cymbium (Fig. 7) and a characteristically lamellar embolus. Females can be distinguished by one pair of spherical spermathecae (Fig. 8A)

Description. Male (holotype). Total length 1.44; carapace 0.76 long, 1.69 wide; abdomen 1.06 long, 0.54 wide. Carapace round, pale yellow. The overall color is light yellow (Fig. 8E). Cheliceral promargin with one tooth, connected to a lamina; retro-marginal with one small tooth (Fig. 21D). Clypeus light brown (Fig. 8E). Labium and sternum almost transparent. Legs light yellow, with dark yellow joints. Legs measurements: I 11.03 (3.20, 0.31, 3.28, 3.16, 1.08), II 11.03 (3.08, 0.31, 3.36, 3.20, 1.08), III 11.63 (3.32, 0.31, 3.72, 3.20, 1.08), IV 8.07 (2.28, 0.31, 2.44, 2.20, 0.84). Abdomen elongated, with pale yellow (Fig. 8E). Spinnerets pale yellow.

Male palp (Fig. 7A–D): Bulb pale yellow, conical. Embolus arising distally from the bulb, slightly curved; no conductor; tibia with a stout apical protrusion, tipped with many bristles (Fig. 7A). Femur and trochanter light yellow with few hairs.

Female (one of the paratypes). Size and color similar to male, but slightly larger and darker (Fig. 8C, D). Total length 1.55; carapace 0.55 long, 0.65 wide; abdomen 1.00 long, 0.55 wide. Carapace round, yellow. Clypeus brown (Fig. 8C). Labium and sternum yellow. Legs light yellow, the joint is dark. Leg measurements: I 9.14 (2.48, 0.25, 2.72, 2.53, 1.16) II 7.06 (1.88, 0.25, 2.05, 1.98, 0.90) III 5.71 (1.53, 0.25, 1.65, 1.50, 0.78), IV 7.81 (2.18, 0.25, 2.33, 2.00, 1.05). Abdomen elongated, dorsum with black spots and wrinkles, ventrum darkens posteriorly (Fig. 8C). Spinnerets yellow.

Epigyne (Fig. 8A, B): Some bristles on the epigynum (Fig. 8B). It has one pair of global spermathecae (Fig. 8A).

Distribution. Known only from the type locality (Fig. 22).

Natural history. Collected at a cave entrance at an elevation of 397 m.

***Sinoderces xueae* Li & Li, sp. nov.**

<http://zoobank.org/AC29E243-6C39-45BD-A604-01533D919603>

Figs 9, 10, 21, 22

Types. Holotype: ♂, Limu Mountain Town, Hainan Province, China. 19°12.002'N, 109°43.710'E, 591 m, 25.III.2012, Chen Z. leg. **Paratype:** 1 ♀, same data as holotype.

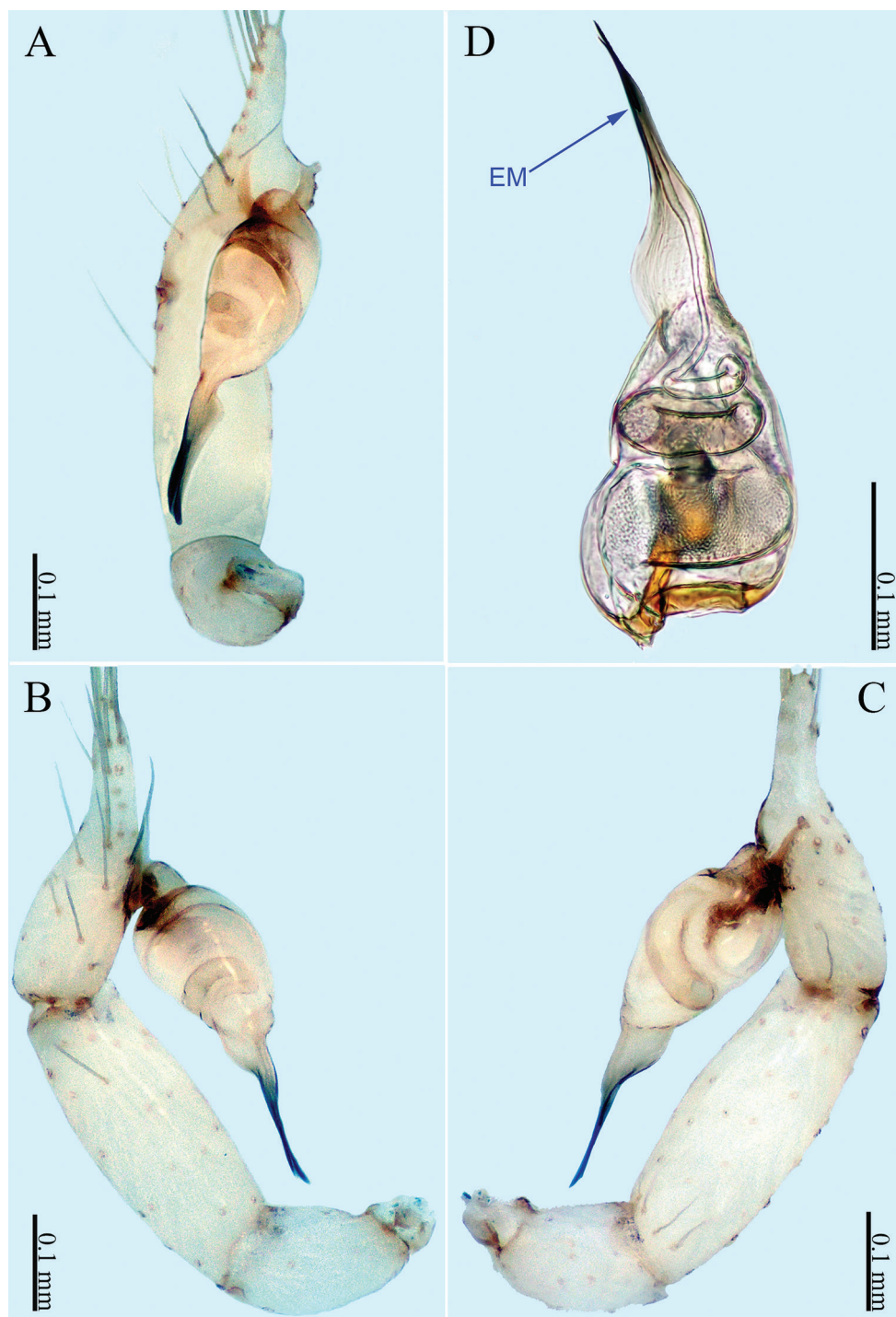


Figure 7. *Sinoderces dewaroopensis* Li & Li, sp. nov., right pedipalp of male holotype **A** palp, ventral view **B** palp, prolateral view **C** palp, retrolateral view **D** palpal bulb, ventral view. Abbreviation: EM embolus.

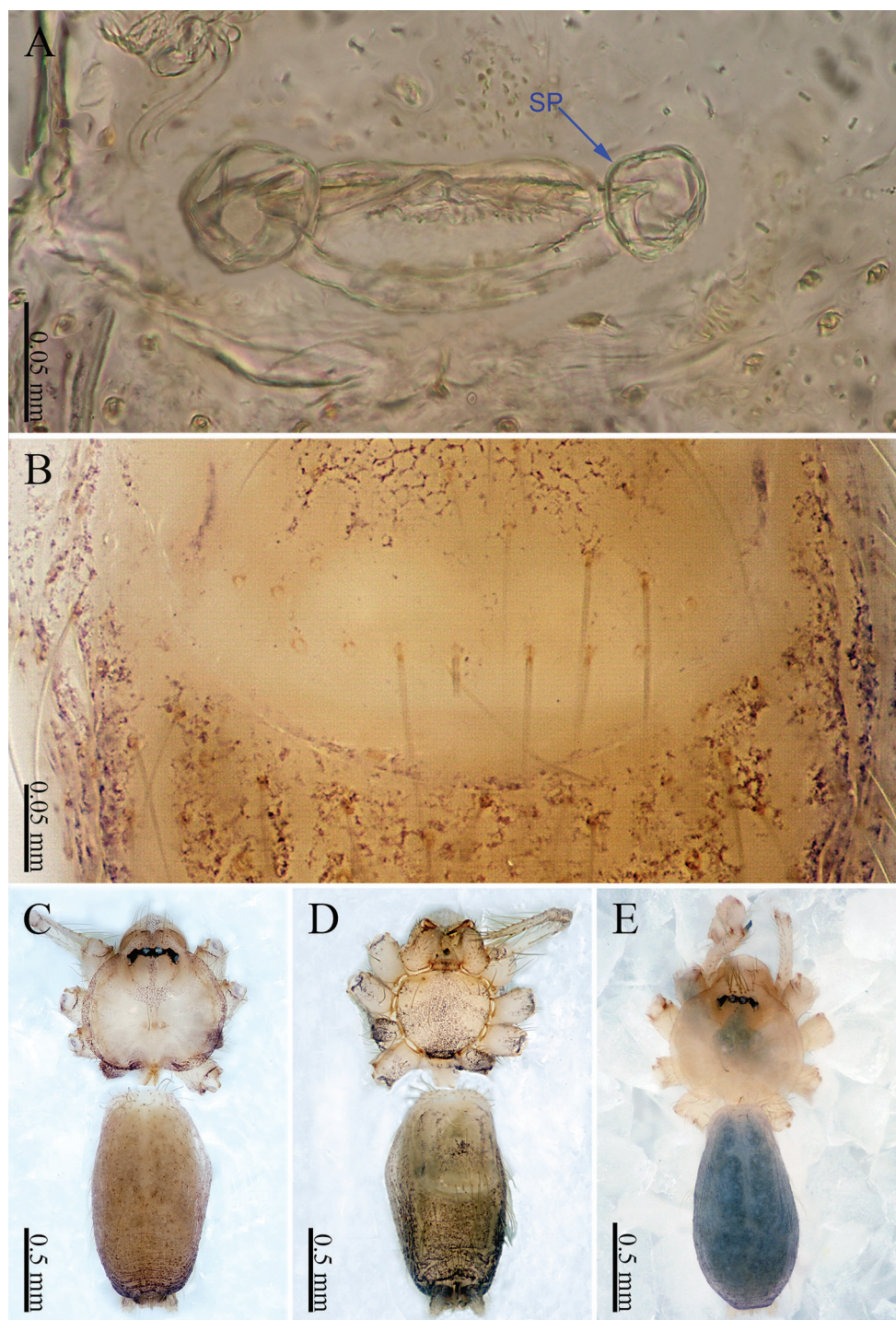


Figure 8. *Sinoderes dewaroopensis* Li & Li, sp. nov., male holotype and female paratype **A** internal genitalia, dorsal view **B** female epigastric furrow, ventral view **C** female habitus, dorsal view **D** female habitus, ventral view **E** male habitus, dorsal view. Abbreviation: SP spermathecae.

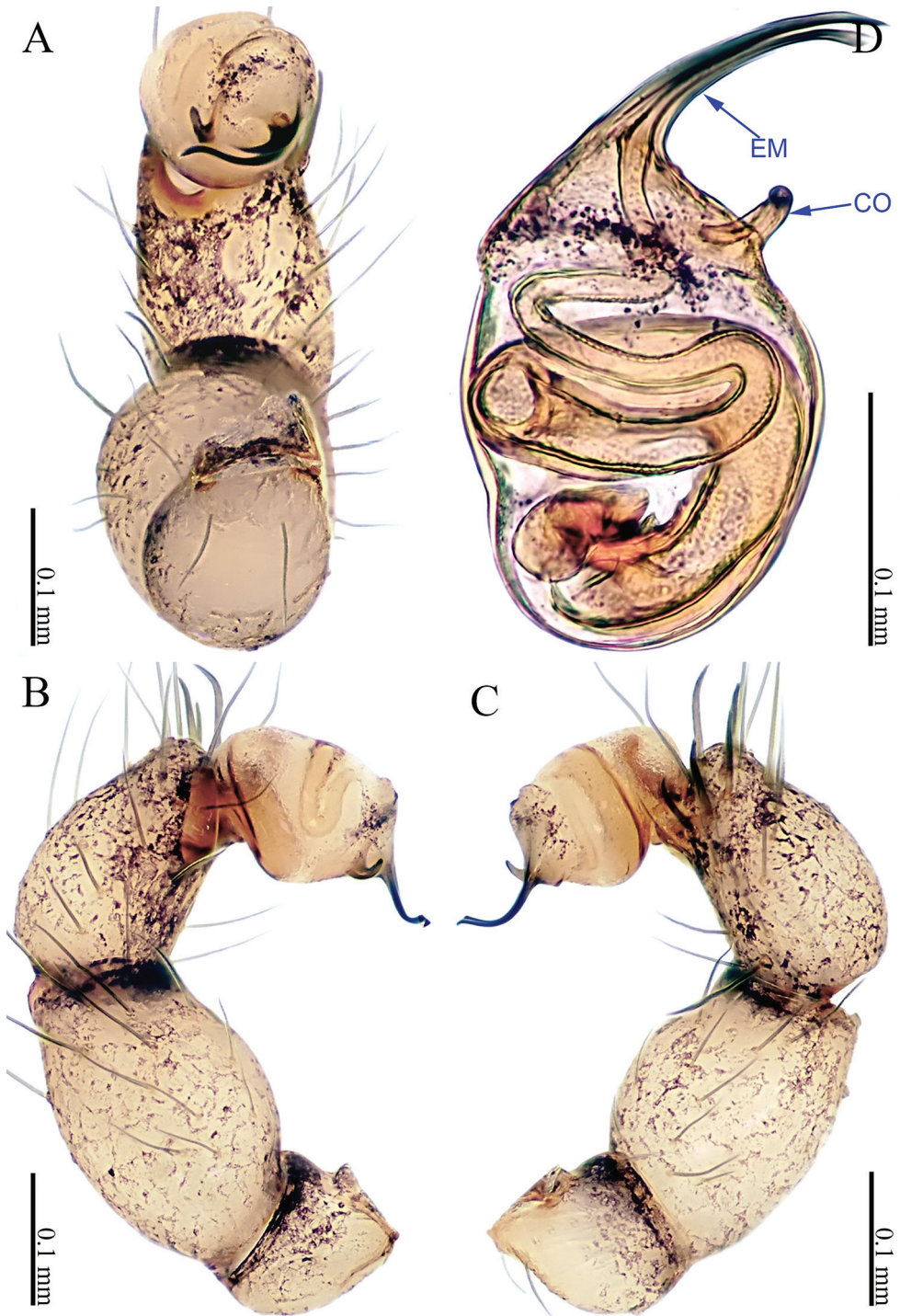


Figure 9. *Sinoderces xueae* Li & Li, sp. nov., male holotype **A** palp, ventral view **B** palp, prolateral view **C** palp, retrolateral view **D** palpal bulb, ventral view Abbreviations: CO conductor, EM embolus.

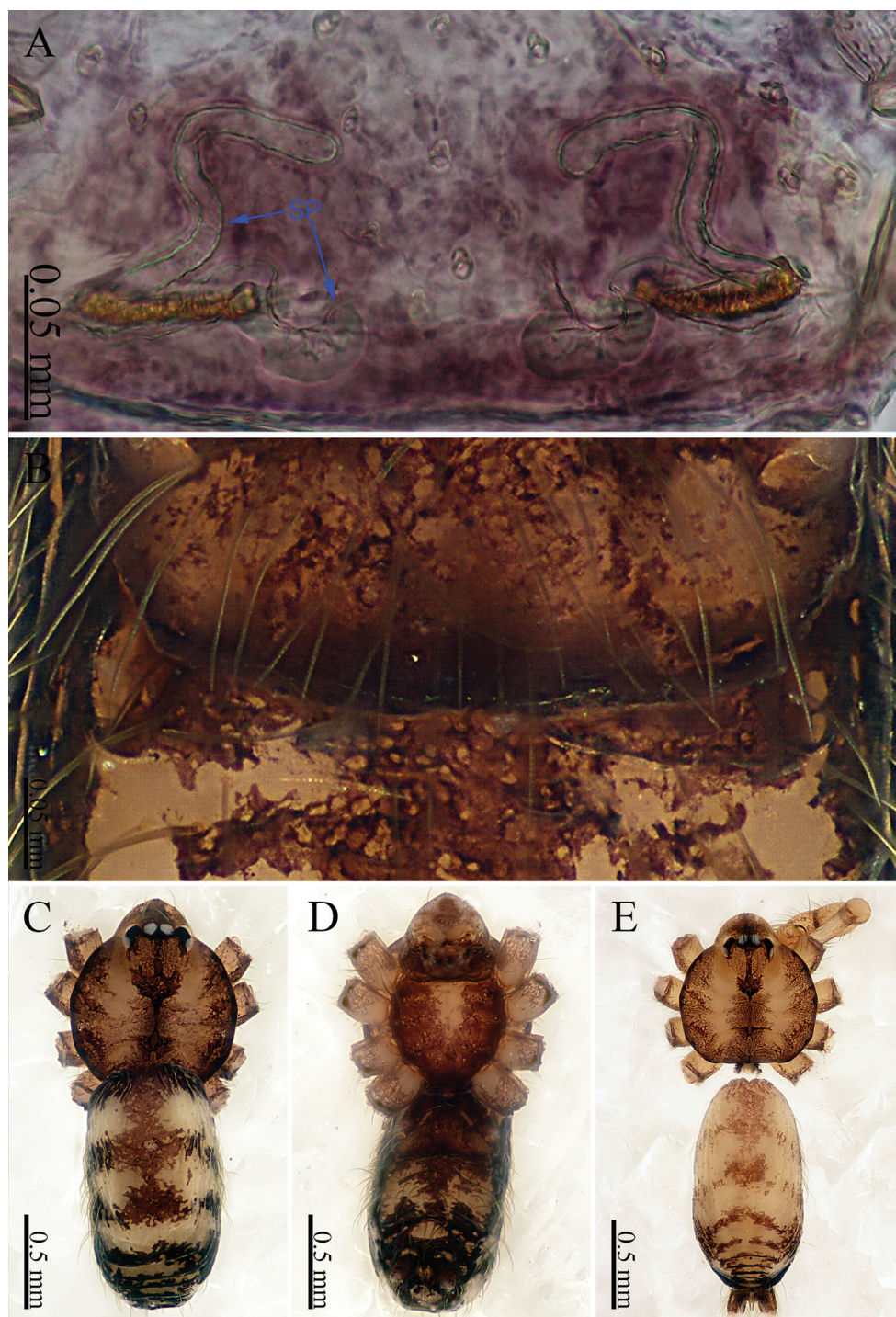


Figure 10. *Sinoderces xueae* Li & Li, sp. nov., male holotype and female paratype **A** internal genitalia, dorsal view **B** female epigastric furrow, ventral view **C** female habitus, dorsal view **D** female habitus, ventral view **E** male habitus, dorsal view. Abbreviation: SP spermathecae.

Etymology. This name is in honor of Wenjing Xue, a good friend of the first author of the paper who has been helpful to his study and life. The case is feminine and genitive.

Diagnosis. *Sinoderces xueae* sp. nov. resembles *S. taichi* sp. nov. in having a similarly shaped conductor and embolus. However, the males can be distinguished by the following: five spines on the distal part of the palpal cymbium, vs. six in *S. taichi* sp. nov.; the slightly sigmoid embolus and short conductor (Fig. 9) vs. a coiled embolus and long conductor in *S. taichi* sp. nov. The margin of the epigyne of *S. xueae* sp. nov. is thin (Fig. 10B) whereas in *S. taichi* sp. nov. thick (Fig. 12B).

Description. Male (holotype). Total length 1.94; carapace 0.66 long, 0.72 wide; abdomen 1.28 long, 0.59 wide. Carapace round, brown, with dark brown lateral margins and one wide median brown band, clypeus yellow and chelicerae dark brown (Fig. 10E). Cheliceral promargin with one tooth, followed by a lamina, retromargin with a small tooth (Fig. 21E). Labium brown. Sternum brown (Fig. 10E). Legs yellow, joints darker. Legs measurements: I missing, II 6.26 (1.35, 0.25, 2.13, 1.80, 0.73), III 4.93 (1.40, 0.25, 1.43, 1.25, 0.60), IV 7.26 (2.00, 0.25, 2.25, 1.93, 0.83,). Abdomen elongated, with black lines posteriorly, black anterior lines brownish and expanded medially, and splotches ventrally sp. Spinnerets brown.

Male palp (Fig. 9A–D): The overall color is yellow, bulb dark yellow, ovate; embolus arising retrolaterally and distally from the bulb, slightly sigmoid. Conductor arising prolaterally and proximally from the bulb. Embolus and conductor slightly separated (distance less than a diameter of the bulb). Tibia with five spines distally (Fig. 9B). Femur and trochanter yellow with few hairs.

Female (one of the paratypes). Females are darker than males (Fig. 10C, D). Total length 2.08; carapace 0.63 long, 0.63 wide; abdomen 1.45 long, 0.53 wide. Carapace round, brown. Clypeus and chelicerae dark brown (Fig. 10C). Endites dark yellow. Labium and sternum brown. Legs light yellow, joints darker. Leg measurements: I 4.86 (1.20, 0.20, 1.50, 1.24, 0.72), II 3.89 (1.03, 0.20, 1.16, 0.97, 0.53), III 4.95 (1.25, 0.20, 1.44, 1.28, 0.78), IV 3.36 (0.91, 0.20, 0.94, 0.78, 0.53). Abdomen elongated, dorsum wrinkled, with black rings, ventrum with large black spots (Fig. 10C, D). Spinnerets black.

Epigyne (Fig. 10A, B): Some bristles present above the epigyne (Fig. 10B). Internal genitalia with two pairs of spermathecae, curved, the anterior pair is longer than the posterior pair (Fig. 10A). The whole entire spermathecal structure is symmetrical.

Distribution. Known only from the type locality (Fig. 22).

Natural history. Collected in pristine forests.

***Sinoderces taichi* Li & Li, sp. nov.**

<http://zoobank.org/91D5EBDE-5C57-4325-BB99-7D19906C45ED>

Figs 11, 12, 21, 22

Types. Holotype: ♂, Lingshui Town, Hainan Province, China. 18°43.777'N, 109°51.740'E, 03.IV.2012, Chen Z. leg. **Paratypes:** 2♀, same data as holotype.

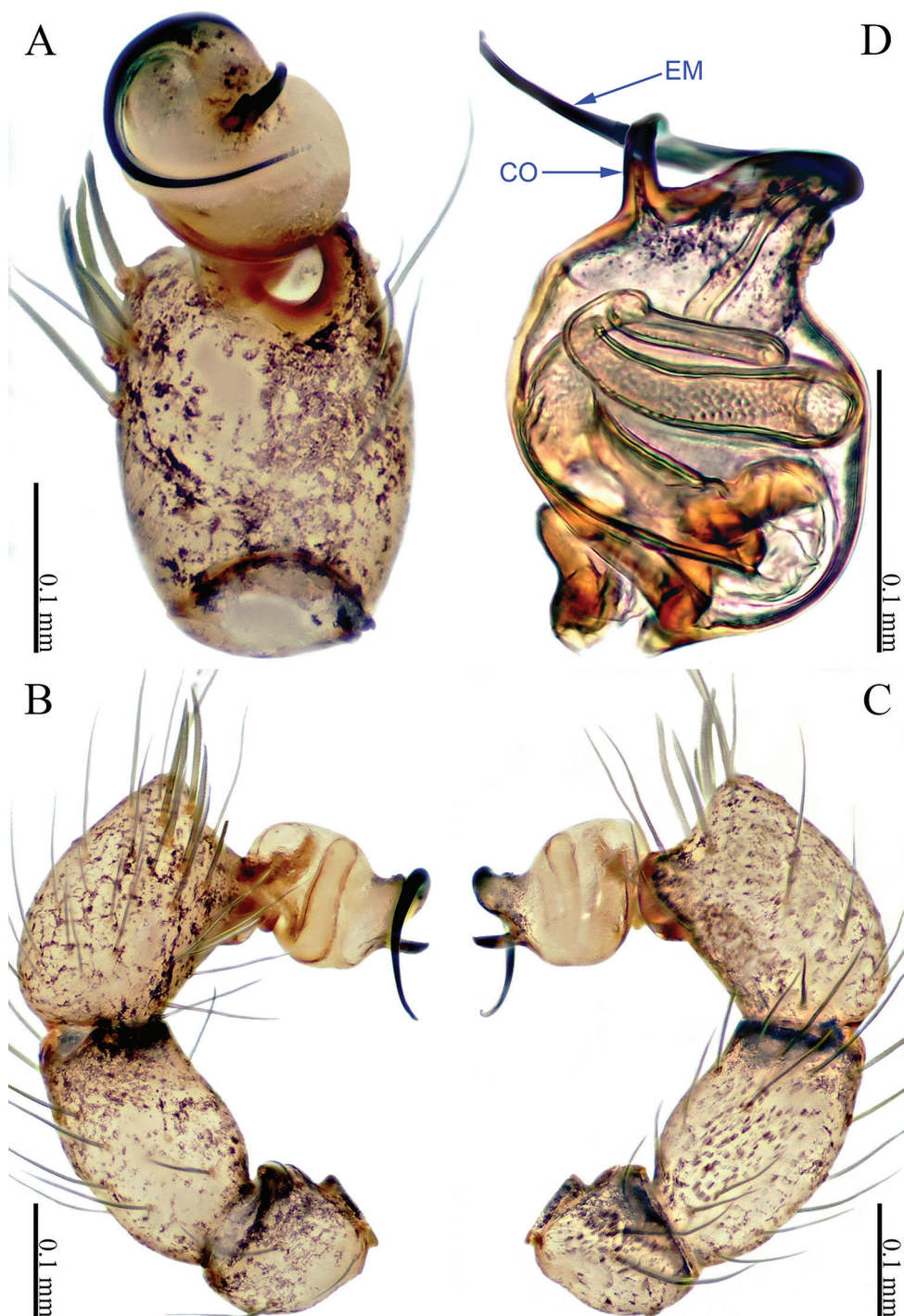


Figure 11. *Sinodermes taichi* Li & Li, sp. nov., male holotype **A** palp, ventral view **B** palp, prolateral view **C** palp, retrolateral view **D** palpal bulb, ventral view Abbreviations: CO conductor, EM embolus.

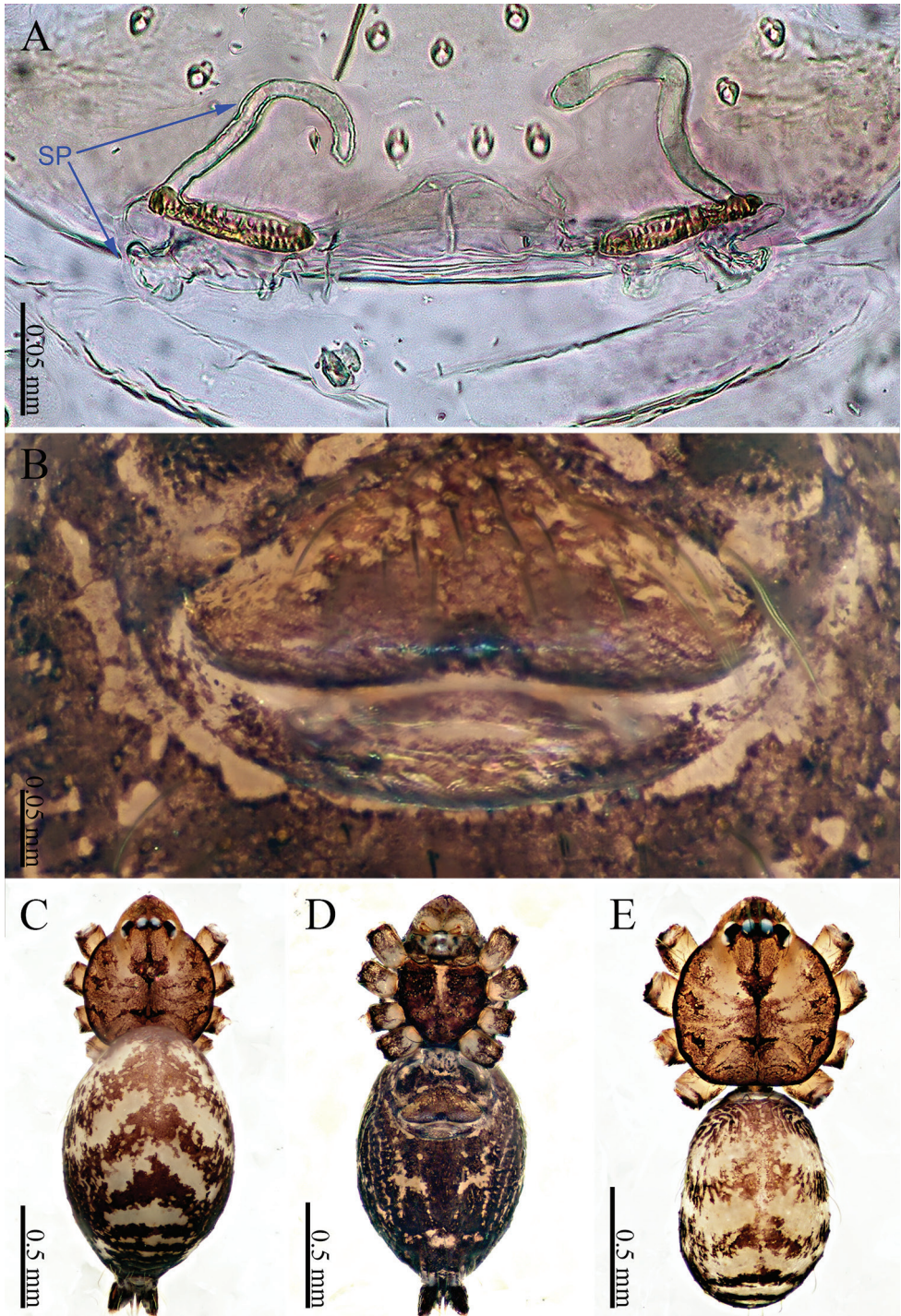


Figure 12. *Sinoderces taichi* Li & Li, sp. nov., male holotype and female paratype **A** internal genitalia, dorsal view **B** female epigastric furrow, ventral view **C** female habitus, dorsal view **D** female habitus, ventral view **E** male habitus, dorsal view. Abbreviation: SP spermathecae.

Etymology. In ventral view (Fig. 11A), the embolus and conductor resemble the yin-yang symbol representing the philosophy behind the Chinese martial art of Taichi; noun in apposition.

Diagnosis. *Sinoderces taichi* sp. nov. resembles *S. xueae* sp. nov. in having a similarly shaped conductor and embolus. However, the males can be distinguished by the following: six spines on the distal part of the palpal cymbium, as against vs. five in *S. xueae* sp. nov.; a coiled embolus and long conductor. The edge margin of the epigyne is very thick (Fig. 12B).

Description. Male (holotype). Total length 1.56; carapace 0.70 long, 0.67 wide; abdomen 0.86 long, 0.64 wide. Carapace round, brown, with dark brown margins and a narrow, brown median line behind ocular area (Fig. 12E). Clypeus dark yellow and chelicerae dark yellow. Cheliceral promargin with one tooth, followed by a lamina, retromargin with one small tooth (Fig. 21F). Endites dark yellow. Labium brown. Sternum dark yellow. Legs brown, joints darker. Leg measurements: I 8.72 (2.44, 0.20, 2.88, 2.40, 0.80), II missing, III 4.98 (1.50, 0.20, 1.40, 1.20, 0.68), IV 7.32 (2.00, 0.20, 2.28, 1.84, 1.00). Abdomen wrinkled posterodorsally, with wide brown markings (Fig. 12E). Spinnerets black.

Male palp (Fig. 11B): Short and thick. Bulb dark yellow, ovate. Embolus arising prolaterally and proximally from the bulb, coiled (Fig. 11). Conductor arising retrolaterally and distally from the bulb. Embolus and conductor slightly separated (distance less than diameter of bulb). Distal part of the tibia with a row of six spines. Femur and trochanter dark yellow with few hairs.

Female (one of the paratypes). Size and color similar to the male but slightly larger and darker (Fig. 12C, D). Total length 2.125; carapace 0.63 long, 0.63 wide; abdomen 1.50 long, 0.88 wide. Carapace round and brown. Clypeus brown. Chelicerae dark yellow. Endites dark yellow. Labium and sternum dark brown. Legs brown, joints dark. Leg measurements: I 5.28 (1.32, 0.20, 1.64, 1.30, 0.82), II missing, III 3.48 (0.90, 0.20, 0.90, 0.86, 0.62), IV 4.92 (1.22, 0.20, 1.52, 1.24, 0.74). Abdomen elongated, dorsum with regular black rings and wrinkles, ventrum with yellow spots (Fig. 12C, D). Spinnerets black.

Epigyne (Fig. 12A, B): Some bristles present above the epigyne (Fig. 12B). The anterior pair is a symmetric c shape. The anterior pair are tubular structures. The posterior pairs are membranous (Fig. 12A).

Distribution. Known only from the type locality (Fig. 22).

Natural history. Collected in pristine forest within a protected zone.

***Sinoderces wenshanensis* Li & Li, sp. nov.**

<http://zoobank.org/34E03784-9051-4EF7-96E2-E36BD6ADA28C>

Figs 13, 14, 21, 22

Types. Holotype: ♂, Radio and television station hill, Xiqiao County, Wenshan, Yunnan Province, China, 23°25.980'N, 104°40.392'E, 1556 m, 17.V.2015, Li F. and Chen Z. leg. **Paratypes:** 2♀, same data as holotype.



Figure 13. *Sinoderces wenshanensis* Li & Li, sp. nov., male holotype **A** palp, ventral view **B** palp, prolateral view **C** palp, retrolateral view **D** palpal bulb, ventral view Abbreviations: CO conductor, EM embolus.

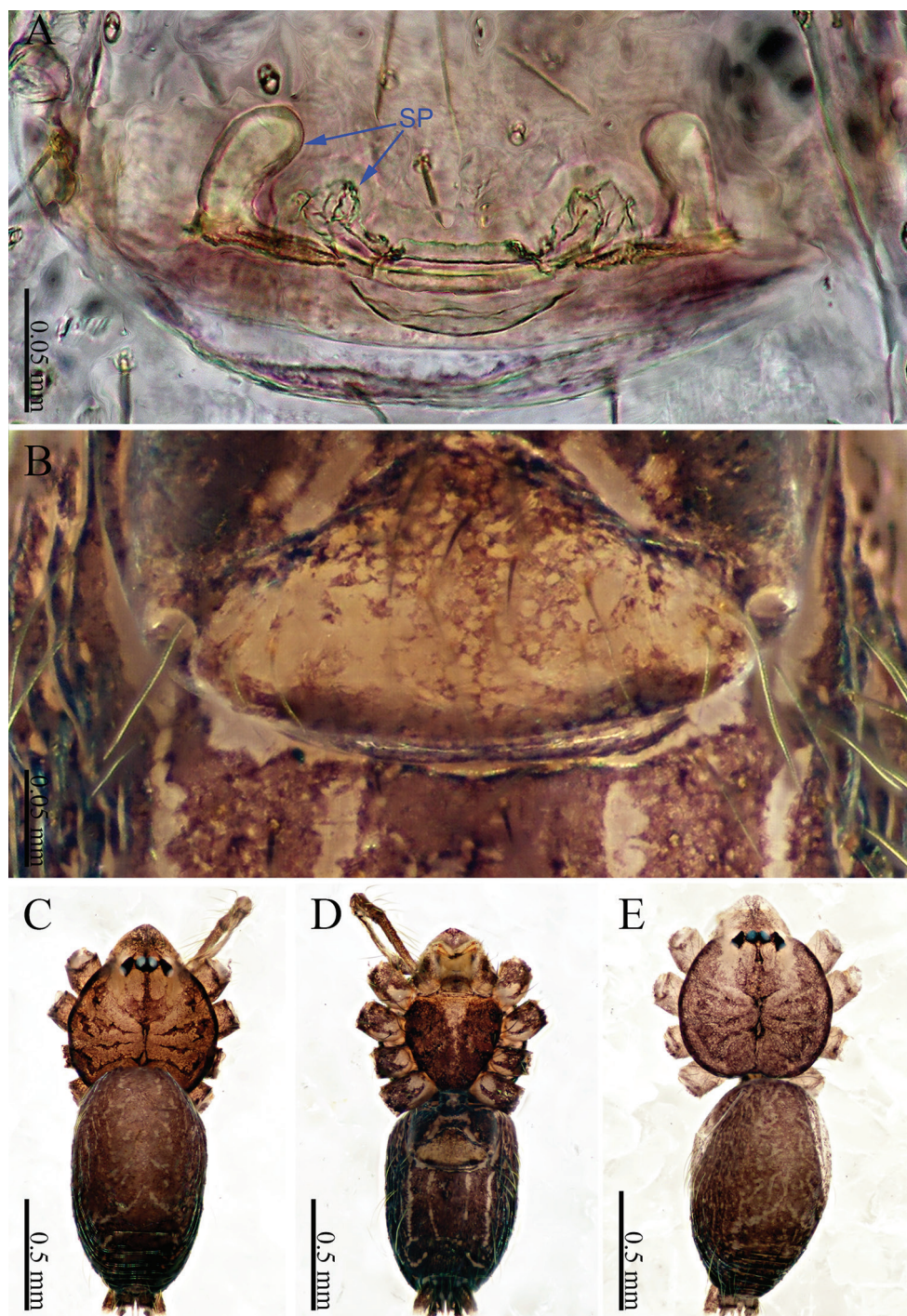


Figure 14. *Sinoderces wenshanensis* Li & Li, sp. nov., male holotype and female paratype **A** internal genitalia, dorsal view **B** female epigastric furrow, ventral view **C** female habitus, dorsal view **D** female habitus, ventral view **E** male habitus, dorsal view. Abbreviation: SP spermathecae.

Etymology. The specific name refers to the name of the hill at the type locality; adjective.

Diagnosis. *Sinoderces wenshanensis* sp. nov. can be distinguished from all other known species by the nearly parallel conductor and embolus (Fig. 13D). The conductor is membranous (Fig. 13B–D). Palp nearly light yellow. Entrance duct is visible even before soaking them in lactic acid. Epigyne resembles a fan. Females have two pairs of spermathecae, with the inner pair together resembling the smile of a smiley face and the outer pair protruding anteriorly (Fig. 14A, B)

Description. Male (holotype). Total length 1.72; carapace 0.62 long, 0.70 wide; abdomen 1.10 long, 0.60 wide. Carapace round, dark brown, with dark brown margins (Fig. 14E). Clypeus light brown. Chelicerae light yellow. Cheliceral promargin with one tooth, followed by a lamina; retromargin with one small tooth (Fig. 21G). Endites yellow. Labium light brown. Sternum dark brown. Legs brown, joints dark. Leg measurements: I missing, II missing, III missing, IV 7.05 (1.87, 0.25, 2.25, 1.75, 0.93). The abdomen is slightly distorted from preservation (Fig. 14E). Opisthosoma brown. Spinnerets brown.

Male palp (Fig. 13): Bulb light, ovate, Conductor almost parallel to the palpal axis. Embolus arising terminally from the bulb, straight and needle-like. Conductor arising close to embolus, membranous. Embolus and conductor completely separated. Tibia, femur and trochanter light yellow with hairs.

Female (paratype). Similar to male in color and general features (Fig. 14C, D). Sternum heart-shaped. Total length 1.72; carapace 0.63 long, 0.70 wide; abdomen 1.09 long, 0.61 wide. Carapace round and brown. Clypeus brown and chelicerae yellow. Endites dark yellow. Labium and sternum brown. Legs brown, joints dark. Leg measurements: I 6.78 (1.75, 0.31, 2.00, 1.72, 1.00), II 5.15 (1.31, 0.31, 1.56, 1.25, 0.72), III 4.13 (1.09, 0.31, 1.16, 0.94, 0.63), IV 6.06 (1.56, 0.31, 1.91, 1.47, 0.81). Abdomen elongated, with yellow pinstripe dorsally and ventrally.

Epigyne (Fig. 14A, B): fan-like, brown, with sparse hairs. Other features described under Diagnosis (Fig. 14A, B).

Distribution. Known only from the type locality (Fig. 22).

Natural history. Collected from leaf litter at an elevation of 1556 m.

***Sinoderces aiensis* Li & Li, sp. nov.**

<http://zoobank.org/7DA0FEFC-FB00-457A-B1C4-757D6199B78E>

Figs 15, 16, 21, 22

Types. Holotype: ♂, Ai Cave, Baoyou Village, Qicha Town, Changjiang li autonomous County, Hainan Province, China. 19°6.068'N, 109°1.200'E, 125 m, 18.XII. 2014, Zhao Z. and Shao L. leg. **Paratypes:** 1♂2♀, same data as holotype.

Etymology. The specific name refers to the name of the cave; adjective.

Diagnosis. *Sinoderces aiensis* sp. nov. can be distinguished from all other known species by the light-colored bulb, a curved conductor with a slightly curved tip (Fig. 15) and an embolus shaped like the Nike swoosh logo (Fig. 15B, C). There is a finger-like

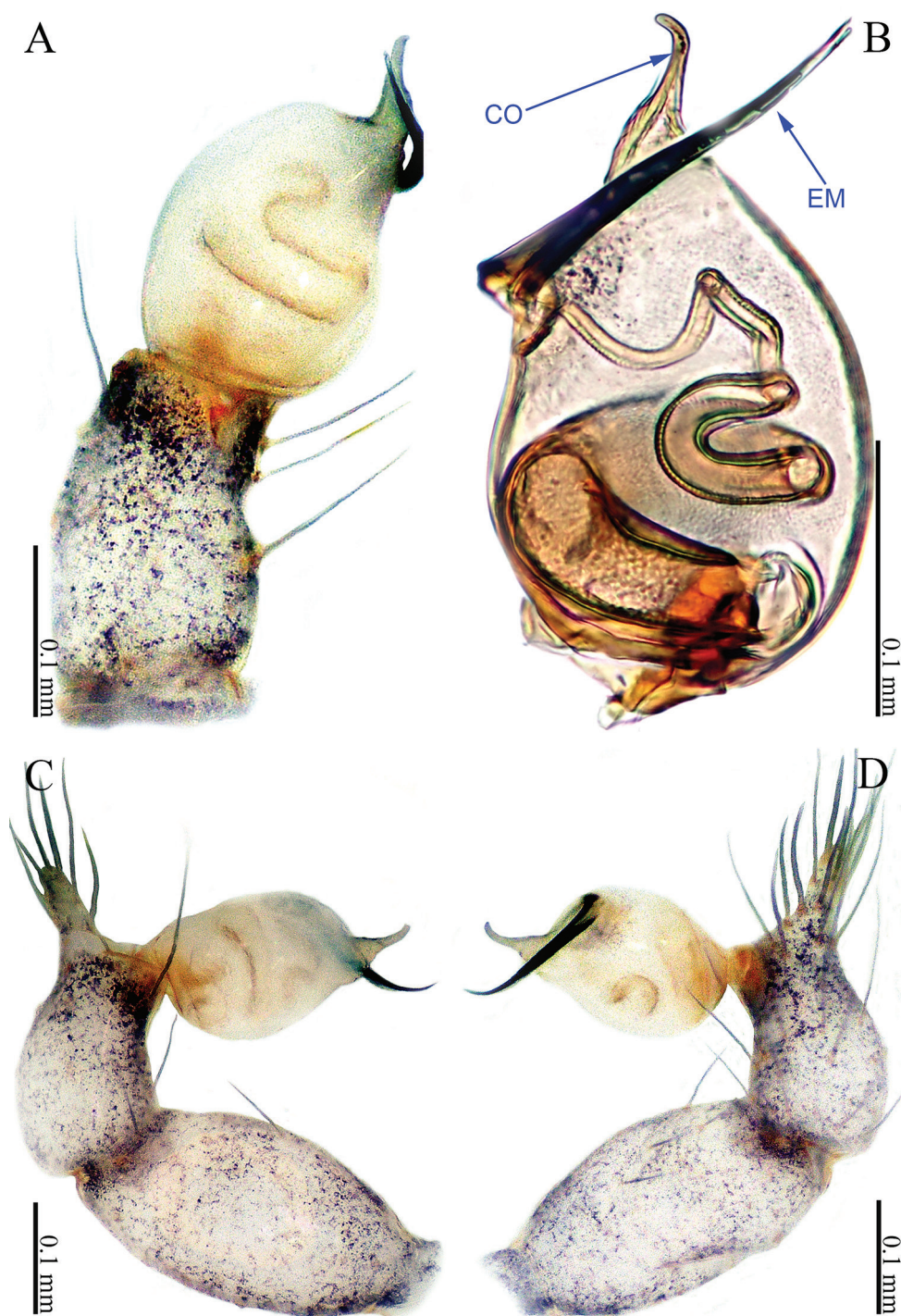


Figure 15. *Sinoderces aiensis* Li & Li, sp. nov., male holotype **A** palp, ventral view **B** palp, prolateral view **C** palp, retrolateral view **D** palpal bulb, ventral view. Abbreviations: CO conductor, EM embolus.

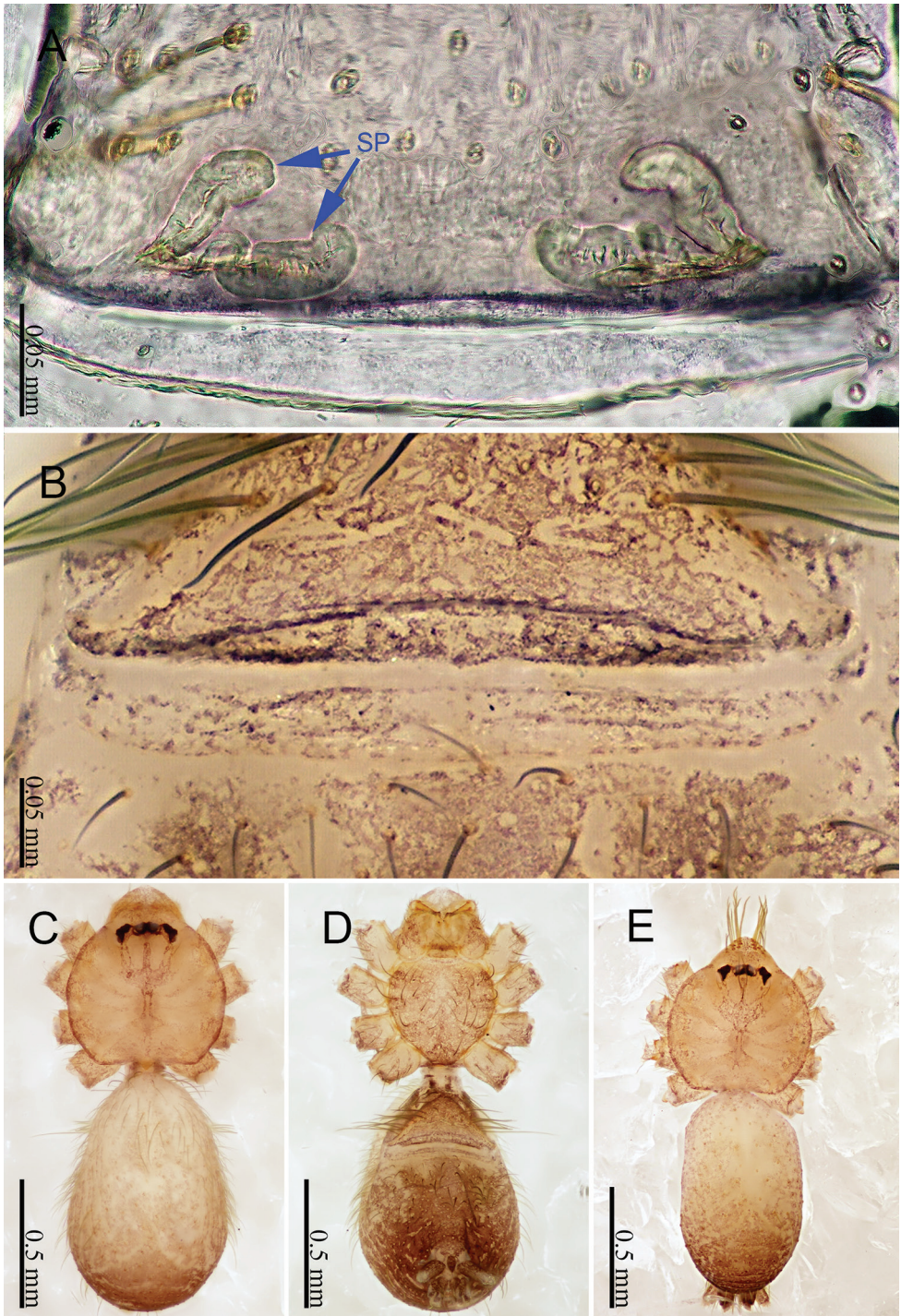


Figure 16. *Sinoderces aiensis* Li & Li, sp. nov., male holotype and female paratype **A** internal genitalia, dorsal view **B** female epigastric furrow, ventral view **C** female habitus, dorsal view **D** female habitus, ventral view **E** male habitus, dorsal view. Abbreviation: SP spermathecae.

projection at the junction of the tarsus and the tibia. Females may be recognized by the antler-like spermathecae (Fig. 16A).

Description. Male (holotype). Total length 1.31; carapace 0.54 long, 0.50 wide; abdomen 0.77 long, 0.43 wide. Carapace round, light yellow, with darker yellow margins and a narrow, dark yellow median line behind ocular area (Fig. 16E). Clypeus and chelicerae yellow. Cheliceral promargin with one tooth, followed by a lamina, retromargin with one small tooth (Fig. 21H). Endites and labium dark yellow. Sternum yellow. Legs light yellow. Leg measurements: I missing, II missing, III missing, IV 4.14 (1.10, 0.20, 1.20, 1.20, 0.44). Abdomen elongated, gradually darkens from anterior to posterior (Fig. 16E). Spinnerets dark yellow.

Male palp (Fig. 15): The palp is almost light yellow. Bulb light, ovate; conductor with a slightly curved tip and the embolus like the Nike swoosh logo. Tibia with a stout apical protrusion, the protrusion with many bristles (Fig. 15B). Oval femur with hairs.

Female (one of the paratypes). Similar to male in light color and general features (Fig. 16C, D) but bigger than males. Total length 1.48; carapace 0.53 long, 0.63 wide; abdomen 0.95 long, 0.63 wide. Carapace yellow. Clypeus and chelicerae dark yellow. Endites and labium dark yellow. Sternum yellow. Legs light yellow. Leg measurements: I 5.36 (1.41, 0.16, 1.72, 1.38, 0.69), II missing, III missing, IV 5.03 (1.31, 0.16, 1.59, 1.31, 0.66). Abdomen elongated, gradually darkens from front to back (Fig. 16 C, D). Spinnerets dark yellow.

Epigyne (Fig. 16A, B): Dark yellow, with two hair tufts (16 B). Two pairs of spermathecae that resemble antlers. (Fig. 16A).

Distribution. Known only from the type locality (Fig. 22).

Natural history. Collected from a cave at an elevation of 125 m.

***Sinoderces saraburiensis* Li & Li, sp. nov.**

<http://zoobank.org/35A1C550-4CCC-4198-8FA0-7864BA50C55F>

Figs 17, 18, 21, 22

Types. Holotype: ♂, Tham Bo Pla Cave, Kaeng Koi District, Song Khon Village, Saraburi Province, Thailand, 14°39.625'N, 100°58.115'E, 73 m, 20. X. 2014, Zhao H., Li Y. and Chen Z. leg.

Etymology. The specific name is derived from the type locality; adjective.

Diagnosis. *Sinoderces saraburiensis* sp. nov. can be distinguished from all other known species by the swan-like shape of the palp (Fig. 17). Embolus heavily sclerotized. Palpal tibia with a slight bump. No conductor.

Description. Male (holotype). Total length 1.82; carapace 0.65 long, 0.72 wide; abdomen 1.18 long, 0.56 wide. Carapace round, light yellow, with dark lateral margins. Anterior margin of cephalic region distinctly elevated. Clypeus yellow. Chelicerae light yellow. Cheliceral promargin with one tooth, connected to a lamina; retromargin toothless (Fig. 21I). Endites dark yellow. Labium yellow. Sternum dark yellow. Legs light yellow. Leg measurements: I 13.61 (3.75, 0.31, 4.05,

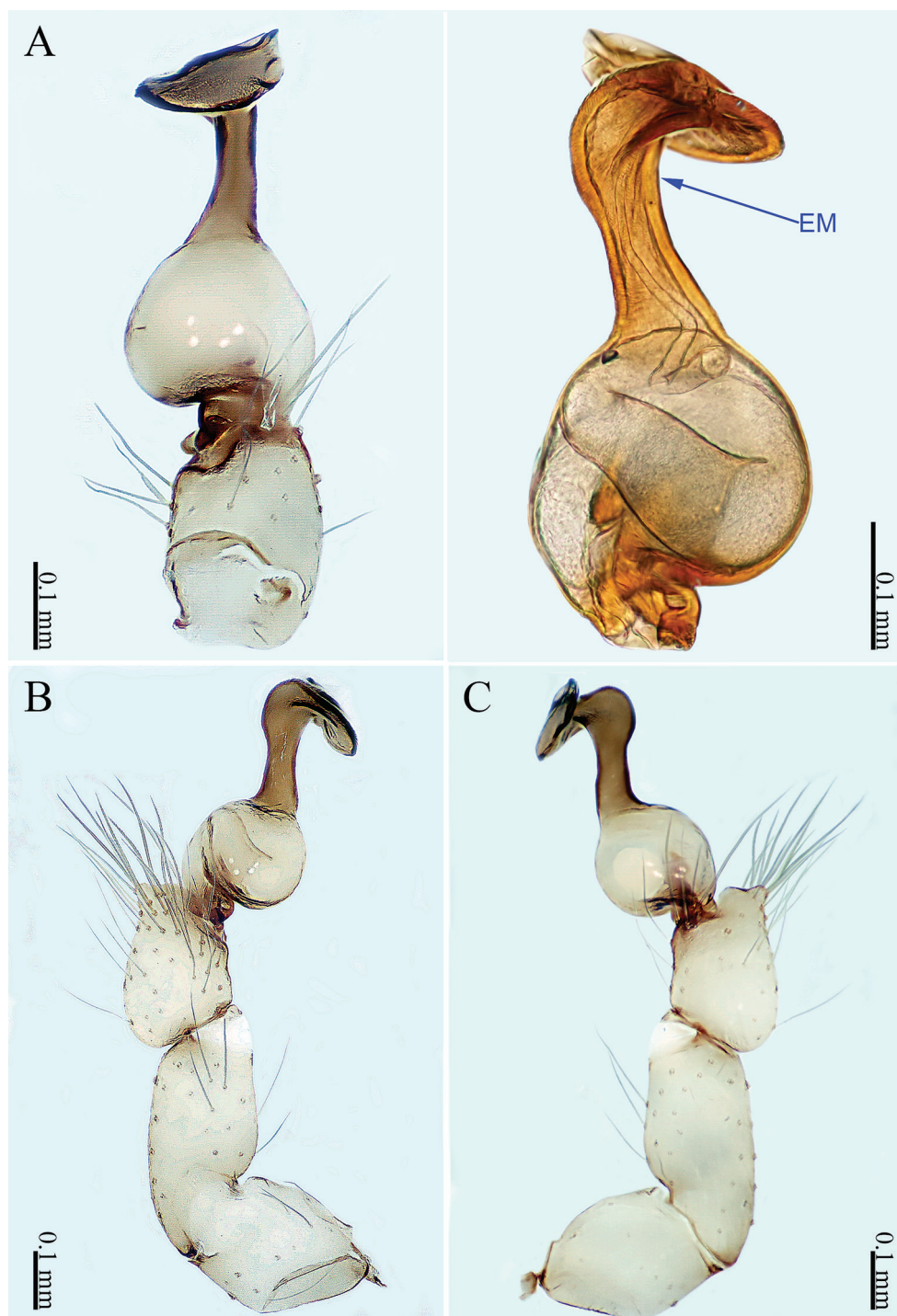


Figure 17. *Sinoderces saraburiensis* Li & Li, sp. nov., male holotype **A** palp, ventral view **B** palp, prolateral view **C** palp, retrolateral view **D** palpal bulb, ventral view Abbreviation: EM embolus.

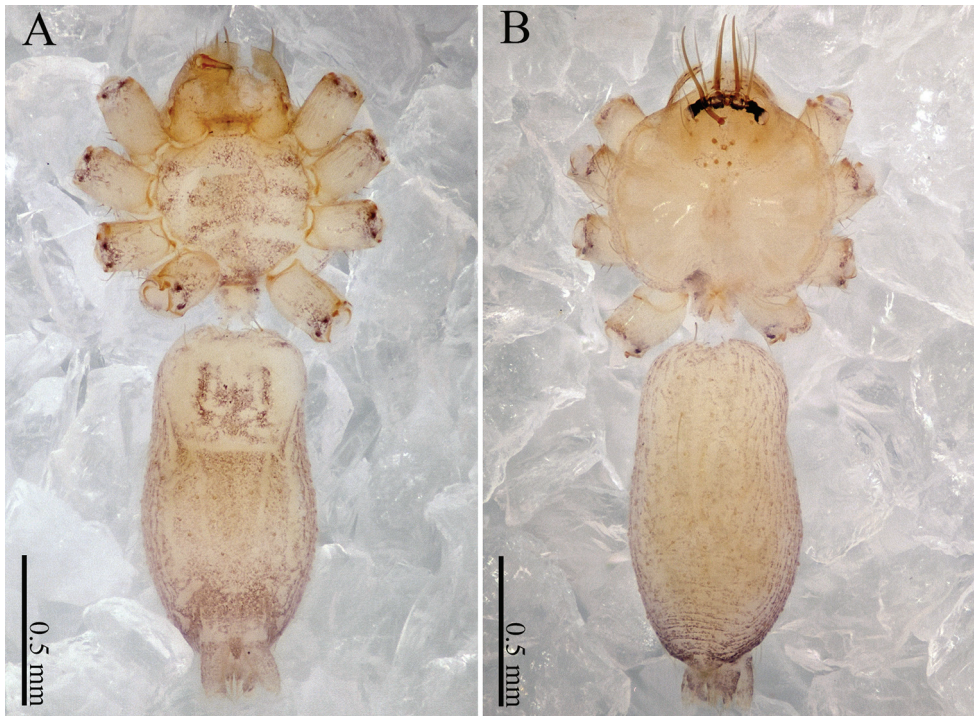


Figure 18. *Sinoderces saraburiensis* Li & Li, sp. nov., male holotype **A** male habitus, ventral view **B** male habitus, dorsal view.

4.15, 1.35), II 9.49 (2.50, 0.31, 2.81, 2.78, 1.09), III 6.75 (1.90, 0.25, 2.20, 1.80, 0.60), IV 9.87 (2.72, 0.25, 3.00, 2.81, 1.09). The color of the abdomen gradually darkens posteriorly.

Male palp (Fig. 17): Bulb pale yellow, ovate. Embolus shaped like a swan; the top of tarsus darker than the rest. Embolus is grossly extended and twisted apically. No conductor. Tibia with a slight bump densely covered by bristles. Femur with sparse hairs.

Distribution. Known only from the type locality (Fig. 22).

Natural history. Collected in a cave at an elevation of 73 m.

***Sinoderces kioensis* Li & Li, sp. nov.**

<http://zoobank.org/D54B881A-0256-4A59-A7BF-0B07E0BC9F27>

Figs 19, 20, 21, 22

Types. Holotype: ♂, Kio Cave, Vang Vieng District, 10.37 km north of Viengkio Village, Vientiane Province, Laos, 19°00.880'N, 102°25.902'E, 286 m, 2.XII.2012, Yao Z. leg.

Etymology. The specific name refers to the name of the cave at the type locality; adjective.

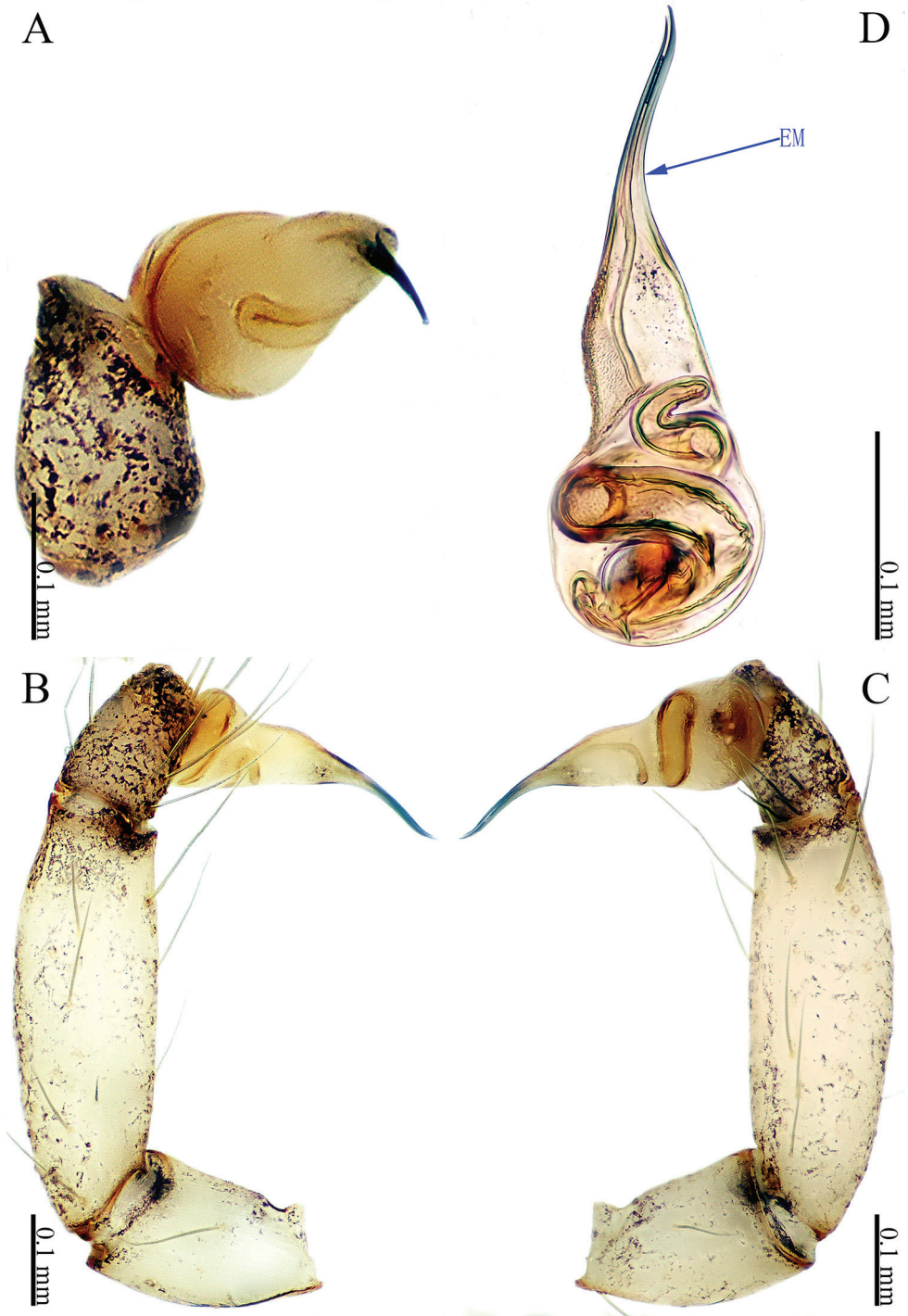


Figure 19. *Sinoderces kioensis* Li & Li, sp. nov., male holotype **A** palp, ventral view **B** palp, prolateral view **C** palp, retrolateral view **D** palpal bulb, ventral view Abbreviation: EM embolus.

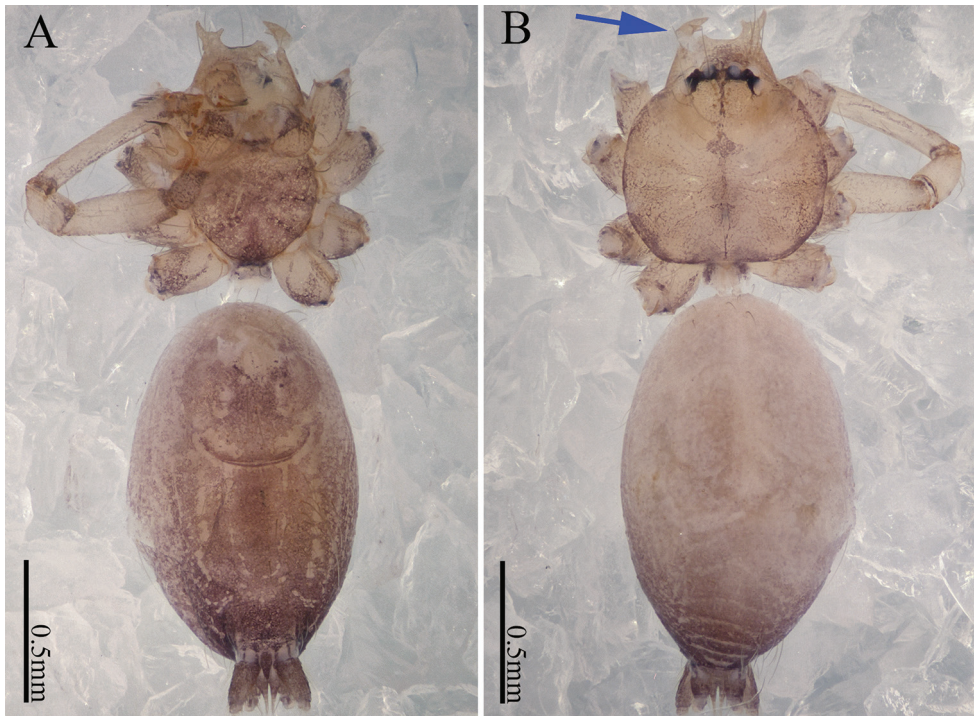


Figure 20. *Sinoderces kioensis* Li & Li, sp. nov., male holotype **A** male habitus, ventral view **B** male habitus, dorsal view (Arrow: apophysis).

Diagnosis. *Sinoderces kioensis* sp. nov. resembles *S. phathaoensis* sp. nov. in having a similar shaped bulb in males. Males can be distinguished from by the straight embolus, with less than half the bulb length in *S. kioensis* sp. nov. (Fig. 18B–D), in contrast with to the curved, embolus almost half as long as the bulb (Fig. 5 B, C). The bulb of *S. kioensis* sp. nov. (Fig. 18) is thicker and more blunt than that of *S. pathaoensis* sp. nov. (Fig. 5).

Description. Male (holotype). Total length 2.28; carapace 0.72 long, 0.78 wide; abdomen 1.56 long, 0.63 wide. Carapace round, yellow, with brown lateral margins. The brown line is close to the center with a circular brown spot. Clypeus brown, medially with one pair of bifurcate apophyses. Chelicerae dark yellow. Cheliceral promargin with one tooth, connected to a lamina, retromargin with one small tooth (Fig. 21J). Endites brown. Labium brown. Sternum dark yellow. Leg measurements: I missing, II missing, III missing, IV missing. Abdomen elongated; dorsum dark brown, with yellow stripe; ventrum dark yellow; the color of the abdomen gradually darkens from anterior to posterior.

Male palp (Fig. 18): Bulb yellow, conical. The center of the bulb with slight constriction. Embolus arising distally from bulb, straight. No conductor. Tibia dark yellow. Femur and trochanter light yellow.

Distribution. Known only from the type locality (Fig. 22).

Natural history. Collected in a cave at an elevation of 286 m.

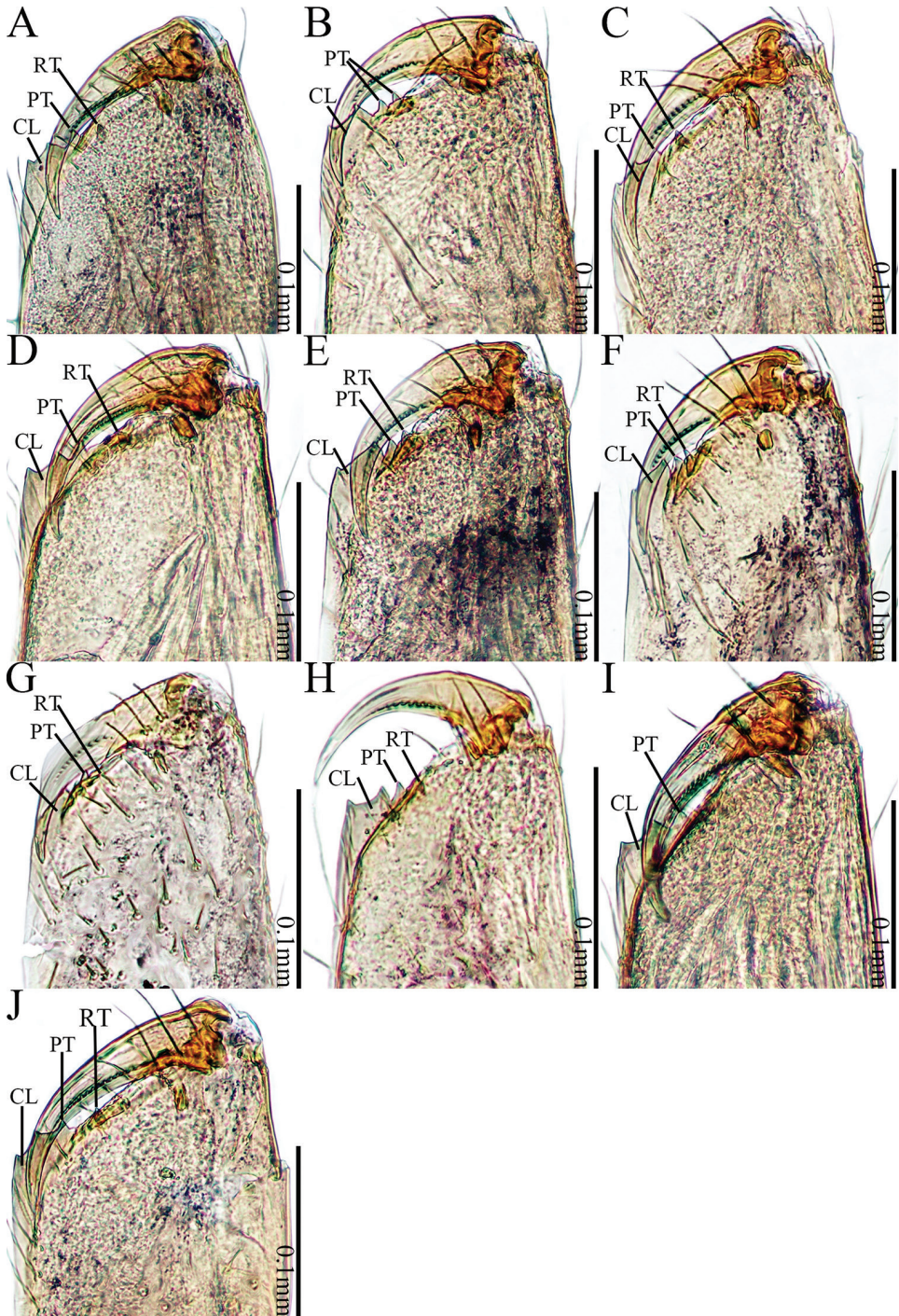


Figure 21. Cheliceral retromargin **A** *Sinoderces khanensis* sp. nov. **B** *S. luohanensis* sp. nov. **C** *S. phathaoensis* sp. nov. **D** *S. dewaroopensis* sp. nov. **E** *S. xueae* sp. nov. **F** *S. taichi* sp. nov. **G** *S. wenshanensis* sp. nov. **H** *S. aiensis* sp. nov. **I** *S. saraburiensis* sp. nov. **J** *S. kieoensis* sp. nov. Abbreviations: RT retromargin teeth, PT promarginal teeth, CL cheliceral laminal.

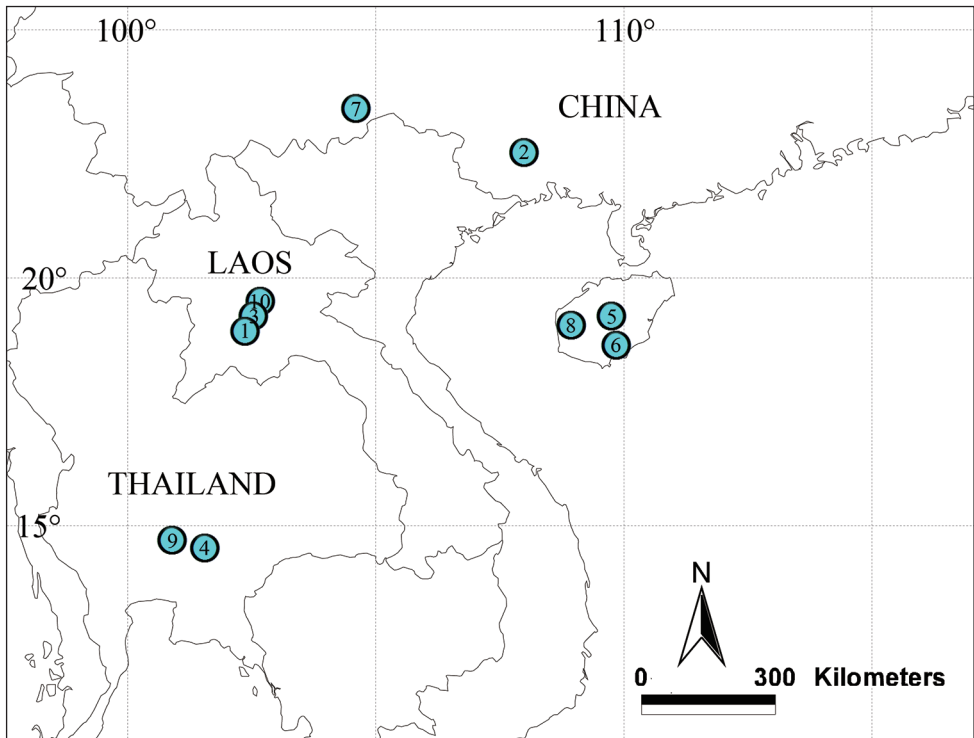


Figure 22. Distribution of ten new *Sinoderces* in China, Laos and Thailand 1 *Sinoderces khanensis* sp. nov. 2 *S. luohanensis* sp. nov. 3 *S. phathaoensis* sp. nov. 4 *S. dewaroopensis* sp. nov. 5 *S. xueae* sp. nov. 6 *S. taichi* sp. nov. 7 *S. wenshanensis* sp. nov. 8 *S. aiensis* sp. nov. 9 *S. saraburiensis* sp. nov. 10 *S. kioensis* sp. nov.

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Three new species of the genus *Coddingtonia* from Asia (Araneae, Theridiosomatidae)

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Abstract

The current paper expands knowledge of the genus *Coddingtonia* Miller, Griswold & Yin, 2009. Based on morphological characters and molecular data, three species are documented as new to science: *C. erhuan* Feng & Lin, **sp. nov.** (♀) from China, *C. lizu* Feng & Lin, **sp. nov.** (♀) from China, and *C. huifengi* Feng & Lin, **sp. nov.** (♂♀) from Indonesia. The type of *C. euryopoides* Miller, Griswold & Yin, 2009 is also reexamined. DNA sequences (COI), detailed illustrations of habitus, male palp and epigyne are provided for these four species, as well as a key and a distribution map for *Coddingtonia* species.

Keywords

China, Indonesia, new genus record, new species, ray spider, taxonomy

Introduction

Coddingtonia was originally established by Miller et al. (2009) as a monotypic genus based on *C. euryopoides* Miller et al., 2009 from the Gaoligong Mountains in South-west China. Labarque and Griswold (2014) reported two *Coddingtonia* species from Laos and Malaysia. Currently the genus *Coddingtonia* contains three valid species distributed in China, Laos, Thailand, and Malaysia (Lopardo and Hormiga 2015; World Spider Catalog 2019).

In a recent collection of theridiosomatids from China and Indonesia, we found three members of *Coddingtonia* and propose them as species new to science. Detailed diagnoses, descriptions, and identifying illustrations are provided for each. This work also represents the first record of this genus from Indonesia.

Materials and methods

All specimens were preserved in 95% ethanol. Specimens were examined and measured with a Leica M205 C stereomicroscope. Further details were studied using an Olympus BX53 compound microscope mounted with a Canon EOS 60D wide zoom digital camera (8.5 megapixels). Male and female copulatory organs were examined and photographed after they were dissected and detached from the bodies. Vulvae were treated with lactic acid before being photographed. The digital images were montaged using Helicon Focus 3.10 image stacking software (Khmelik et al. 2006). All measurements in the paper are in millimeters. Leg measurements are given in the following sequence: total length (femur, patella, tibia, metatarsus, and tarsus).

Abbreviations in figures are as follows:

C	conductor;	GD	glandular ducts;
CD	copulatory ducts;	LG	lateral grooves;
CP	central pit;	LW	lateral wing;
CY	cymbium;	MA	median apophysis;
E	embolus;	S	spermathecae;
EA	mesial embolic apophysis;	ST	subtegulum;
FD	fertilization ducts;	T	tegulum.

A partial fragment (636 bp) of the mitochondrial gene cytochrome *c* oxidase subunit I (COI) was amplified and sequenced in order to check the genetic distance between morphologically close related species and confirm identifications and the sex pairing accuracy. For the same reasons, sequences of *Coddingtonia euryopoides* Miller et al., 2009 were also included.

The primers used are as following: LCO1490 (5'-GGTCAACAAATCATCAT-AAAGATATTGG-3') and HCO2198 (5'-TAAACTTCAGGGTGACCAAAAAA TCA-3'). Raw sequences were edited and assembled using BioEdit v.7.2.5 (Hall 1999) and the uncorrected pairwise distance between the species was calculated using MEGA7.0.14 (Kumar et al. 2016). All sequences were incorporated in GenBank and the accession numbers are provided in Table 1. Results of the comparison between the genetic distances are shown in Table 2.

All examined materials are deposited in the Natural History Museum of Sichuan University in Chengdu (**NHMSU**), China, except the holotype of *C. euryopoides*, which is deposited in the School of Life Sciences, Hunan Normal University in Changsha (**HNU**), China.

Table 1. Voucher specimen information.

Species	Sample	GenBank accession number	Geographical coordinates
<i>C. erhuan</i> sp. nov.	1♂ juv.	MN211319	27°08.28'N, 098°49.34'E
	1♀	MN211318	
<i>C. euryopoides</i>	1♂ juv.	MN211317	24°49.73'N, 098°45.60'E
	1♀	MN211316	
<i>C. lizu</i> sp. nov.	1♂ juv.	MN211313	18°35.86'N, 109°25.61'E
	1♀	MN211312	
<i>C. huifengi</i> sp. nov.	1♂	MN211315	00°15.74'S, 100°18.49'E
	1♀	MN211314	

Table 2. Uncorrected genetic pairwise distance (lower triangle) and standard errors (upper triangle) of the COI partial sequence between species discussed in the text.

Species		1		2		3		4	
		♀	♂ juv.	♀	♂ juv.	♀	♂ juv.	♀	♂
1	<i>C. erhuan</i> sp. nov.	♀	0.000	0.014	0.014	0.015	0.015	0.015	0.015
		♂ juv.	0.000	0.014	0.014	0.015	0.015	0.015	0.015
2	<i>C. euryopoides</i>	♀	0.135	0.135	0.000	0.016	0.016	0.016	0.016
		♂ juv.	0.135	0.135	0.000	0.016	0.016	0.016	0.016
3	<i>C. lizu</i> sp. nov.	♀	0.139	0.139	0.152	0.152	0.000	0.016	0.016
		♂ juv.	0.139	0.139	0.152	0.152	0.000	0.016	0.016
4	<i>C. huifengi</i> sp. nov.	♀	0.137	0.137	0.140	0.140	0.150	0.150	0.000
		♂	0.137	0.137	0.140	0.140	0.150	0.150	0.000

Taxonomy

Family Theridiosomatidae Simon, 1881

Genus *Coddingtonia* Miller et al., 2009

Coddingtonia Miller, Griswold & Yin, 2009: 30.

Luangnam Wunderlich, 2011: 431.

Coddingtonia: Labarque and Griswold 2014: 419 (synonymized with *Luangnam*).

Type species. *Coddingtonia euryopoides* Miller et al., 2009 by original designation.

Diagnosis. The male of *Coddingtonia* may be distinguished from other theridiosomatids by the mesal bristle of the embolic apophysis (Fig. 3A, B, D; Wunderlich 2011: figs 3, 5). The female of *Coddingtonia* can be distinguished from other theridiosomatids by the following combination of characters: spermathecae separated by about one diameter (Figs 1E, F, 2F, G, 4E, F, 5D, E) vs. juxtaposed and partially fused together (Coddington, 1986), long and coiled copulatory ducts surrounding the spermathecae, but lacking that in other theridiosomatids (Figs 1E, F, 2F, G, 4E, F, 5D, E).

Composition. *Coddingtonia anaktakun* Labarque & Griswold, 2014 (Malaysia), *C. erhuan* sp. nov. (China), *C. discobulbus* (Wunderlich, 2011) (Laos), *C. euryopoides* Miller et al. 2009 (China), *C. huifengi* sp. nov. (Indonesia), and *C. lizu* sp. nov. (China).

Distribution. Southern China (Yunnan, Hainan), Laos, Thailand, Malaysia, and Indonesia (Fig. 6).

Key to species of *Coddingtonia**

- 1 Spermatheca round (Figs 1D, E, 2F, G, 4E, F, 5D, E).....2
- Spermatheca oval (Labarque and Griswold 2014: fig. 7E, F).....*C. discobulbus*
- 2 Copulatory duct forms 2 coils (Fig. 4E, F)..... *C. erhuan* sp. nov.
- Copulatory duct with more than 2 coils (Figs 1E, F, 2F, G, 5D, E).....3
- 3 Copulatory duct with 3 coils (Fig. 2F, G)..... *C. huifengi* sp. nov.
- Copulatory duct with more than 3 coils (Figs 1D, E, 5D, E)4
- 4 Copulatory duct with 5 coils (Fig. 5D, E)..... *C. lizu* sp. nov.
- Copulatory duct with 6 or 9 coils (Fig. 1D, E)5
- 5 Copulatory duct with 9 coils (Fig. 1E, F)..... *C. euryopoides*
- Copulatory duct with 6 coils (Labarque and Griswold 2014: fig. 6E, F)
..... *C. anaktakun*

***Coddingtonia euryopoides* Miller et al., 2009**

Fig. 1

Coddingtonia euryopoides Miller et al., 2009: 30, figs 8B, 11E, F (♀); Lopardo and Hormiga 2015: 734, figs 124A–F, 125A–G, 137D (♀).

Material examined. *Holotype* ♀ (CASENT 9022403 in HNU) CHINA: Yunnan Province, Longling County, Mangkuan Township, Zaochang He at Baihualing Village, 25°18.27'N, 98°48.04'E, ca. 1635 m, 2 Jun. 2005, good subtropical broadleaf forest, dusting webs in understory, C. Griswold leg.

Other material examined. 1♀, 3♂ juv. (NHMSU) CHINA: Yunnan Province: Longling County, Longjiang Town, Xiaoheishan Nature Reserve, 24°49.73'N, 98°45.60'E, ca. 2020 m, 22 Aug. 2018, Y. Lin et al. leg. Of them, 1♂ juv. and 1♀ used for sequencing, same data for preceding, GenBank: MN211317 and MN211316; 1♀ (NHMSU): Baoshan City, Tengchong County, Gudong Town, Jiangdong Village, Jiangdong Hill, Luoshui Cave, 24°58.10'N, 98°52.10'E, ca. 1880 m, 16 Nov. 2013, Y. Li & J. Liu leg.

Diagnosis. The male of *C. euryopoides* differs from the males of other species by the mesal bristle of the embolic apophysis describing a semi-loop very close to the embolus base and a semi-loop around the bulb, and the straight median apophysis having a tapering tip (Lopardo and Hormiga 2015: fig. 124B, E, F). The female of *C. euryopoides* can be distinguished from the other five species by having 9 coils of the copulatory ducts (Fig. 1E), whereas other species have fewer coils. Moreover, *C. euryopoides* differs from *C. anaktakun*, *C. discobulbus*, and *C. huifengi* sp. nov. by having a posterior tubercle on the abdomen (Fig. 1A–C), whereas this tubercle is absent in the latter three species.

Description. See Fig. 1A–F and Miller et al. (2009: 30). Male of this species remains unknown.

Distribution. China (Yunnan) and Thailand (Chiang Mai) (Fig. 6).

* Only referring to characters of the vulva

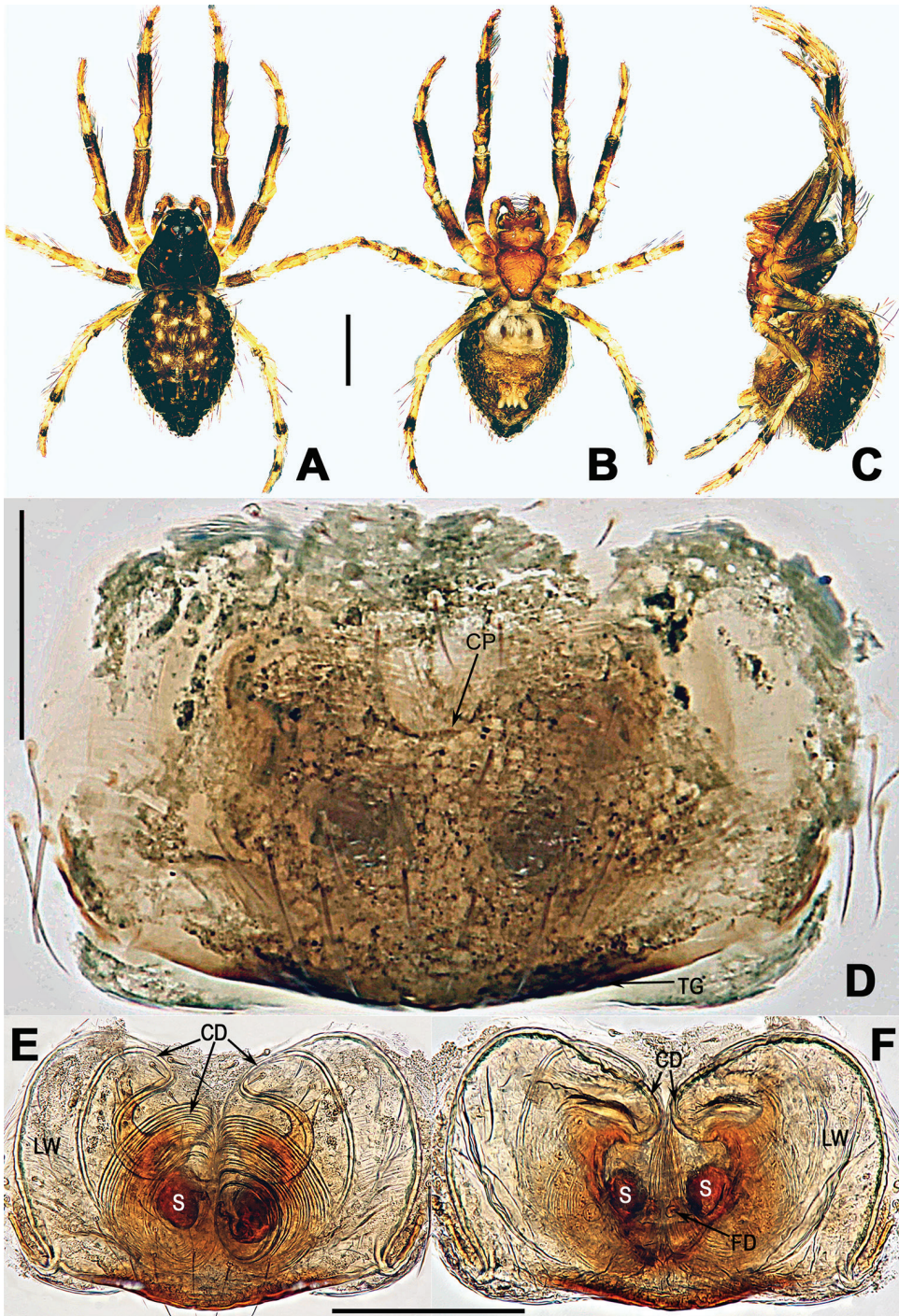


Figure 1. *Coddingtonia euryopoides* Miller et al., 2009, holotype female. **A–C** Habitus **D** epigyne **E, F** vulva (lactic acid-treated) **A, F** dorsal **B, D, E** ventral **C** lateral. Abbreviations: CD copulatory ducts; CP central pit; FD fertilization ducts; GD glandular ducts; LW lateral wings; S spermathecae. Scale bars: 0.50 mm (**A, C**); 0.20 mm (**D–F**).

***Coddingtonia huifengi* sp. nov.**

<http://zoobank.org/2E2BF8FD-526A-4CBF-9EC6-F5E0A7BD64DE>

Figs 2, 3

Type material. *Holotype* ♀, *paratypes* 2♂ and 28♀ (NHMSU) INDONESIA: Kanagarian Matuailia, environs of Batang Lawang Cave, 0°15.74'S, 100°18.49'E, ca. 760 m, 12 Jan. 2014, H. Zhao leg. Two paratypes 1♂ and 1♀ used for sequencing, same data as for preceding, GenBank: MN211315 and MN211314; 1♂, 2♀ (NHMSU) Sumatra, West Sumatra Province, Kab Agam TaBik Simarasok Village, Jorong Koto tuo, 0°14.90'S, 100°28.99'E, ca. 710 m, 11 Jan. 2014, H. Zhao leg.

Etymology. The new species is named after Dr Huifeng Zhao who extensively collected spiders from Southeast Asia.

Diagnosis. The male of this new species differs from the male of *C. euryopoides* by the median apophysis with a distal flexible hook, and the narrower, shorter conductor (Fig. 3A, D); in other similar species the tip is straight and wider and conductor is longer (see Labarque and Griswold 2014: figs 1C, 5D–F). The female can be distinguished from the other five species by having 3 coils (one thick, two thin) of copulatory ducts (Fig. 2F), whereas they are fewer or more in other species. Moreover, *C. huifengi* differs by the lack of a posterior tubercle on the abdomen (Fig. 2A–D) vs. present in *C. euryopoides*, *C. erhuan* sp. nov., and *C. lizu* sp. nov. (Figs 1A–C, 4A–C, 5A, B).

Description. Females (holotype). Carapace nearly pentagonal, dim yellowish, cephalic area moderately raised. Anterior eye row precurved, posterior eye row straight. Sternum heart-shaped, grey yellow, with sparse setae. Mouthparts brown. Femora and patellae dim yellow, other segments brown. Abdomen round, dorsally grey, ventrally deeper, bears sparse long hairs, weakly ossified at hair base (Fig. 2A, B). *Measurements*: total length 2.13. Carapace 1.02 long, 0.97 wide. Clypeus 0.15 high. Sternum 0.48 long, 0.46 wide. Abdomen 1.41 long, 1.35 wide. Length of legs: I 2.78 (0.85, 0.30, 0.73, 0.50, 0.40); II 2.66 (0.84, 0.23, 0.71, 0.47, 0.41); III 1.79 (0.56, 0.16, 0.45, 0.35, 0.27); IV 2.35 (0.79, 0.21, 0.58, 0.43, 0.34).

Epigyne (Fig. 2E–G): epigyne covered with sparse black setae in the central region; with deep central pit and 2 longitudinal grooves close to lateral margins of the plate. Spermathecae barely visible through the integument; LW well developed, like a pair of boxing gloves, swollen sacks with dorso-median glandular ducts; spermathecae globular, separated by one radius; copulatory ducts form an expanded posterolateral loop, and coiled into 2 slender posteromedian loops, finally connecting ventrally on the spermathecae; fertilization ducts arise from the dorsomesal the spermathecae.

Male (one paratype): Somatic features as in Fig. 2A, B and coloration slightly darker than in female. *Measurements*: Total length 1.87. Carapace 0.98 long, 0.93 wide. Clypeus 0.16 high. Sternum 0.46 long, 0.45 wide. Abdomen 0.92 long, 0.89 wide. Length of legs: I 2.33 (0.73, 0.24, 0.61, 0.40, 0.35); II 2.09 (0.66, 0.19, 0.53, 0.39, 0.32); III 1.54 (0.48, 0.15, 0.35, 0.30, 0.26); IV 1.90 (0.61, 0.20, 0.45, 0.36, 0.28).

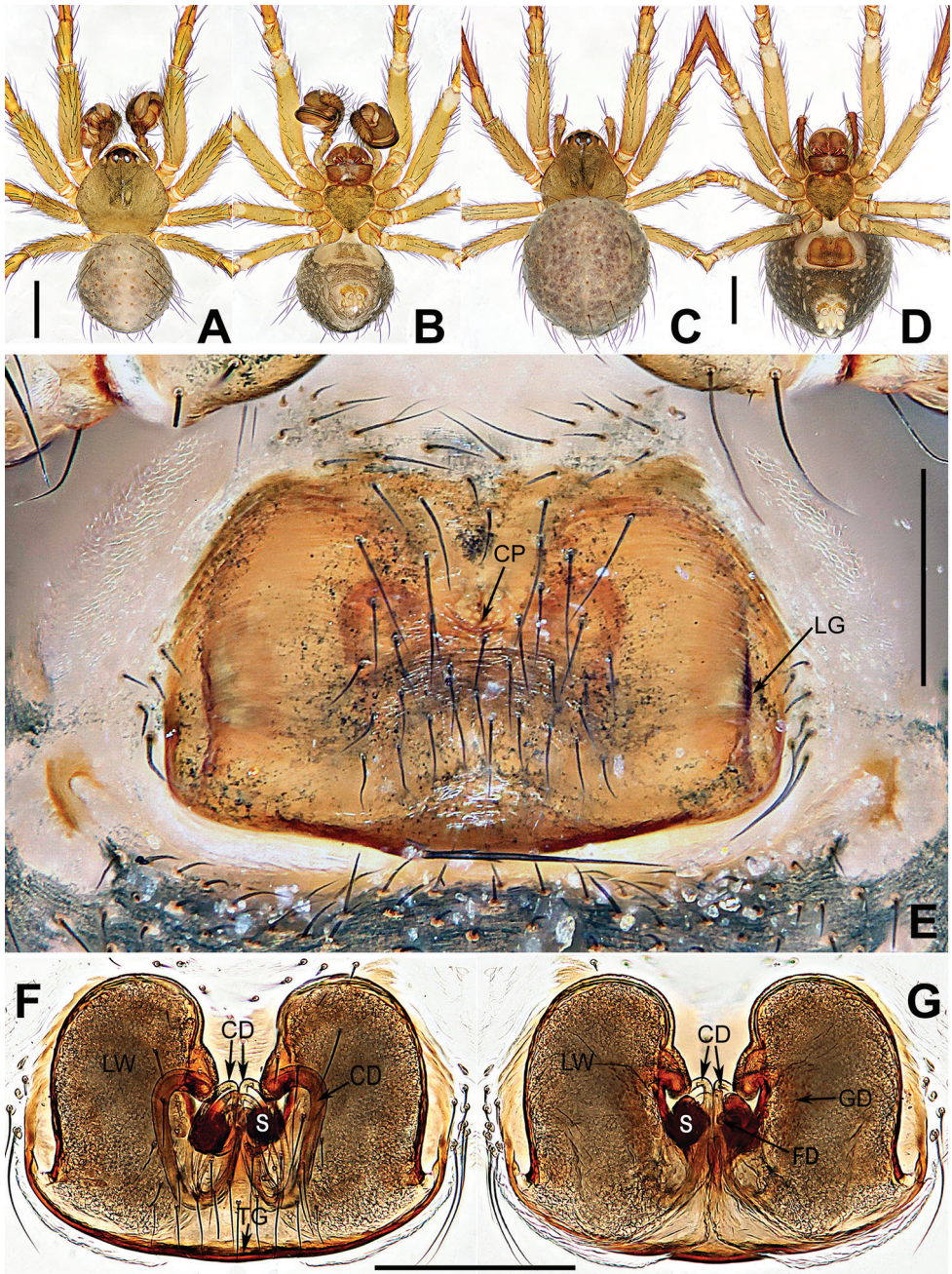


Figure 2. *Coddingtonia huifengi* sp. nov., holotype male (**A, B**) and paratype female (**C–G**). **A–D** Habitus **E** epigyne **F, G** vulva (lactic acid-treated). **A, C, G** dorsal **B, D–F** ventral. Abbreviations: CD copulatory ducts; CP central pit; FD fertilization ducts; GD glandular ducts; LG lateral grooves; LW lateral Wings; TG Transversal groove; S spermathecae. Scale bars: 0.50 mm (**A–D**); 0.20 mm (**E–G**).

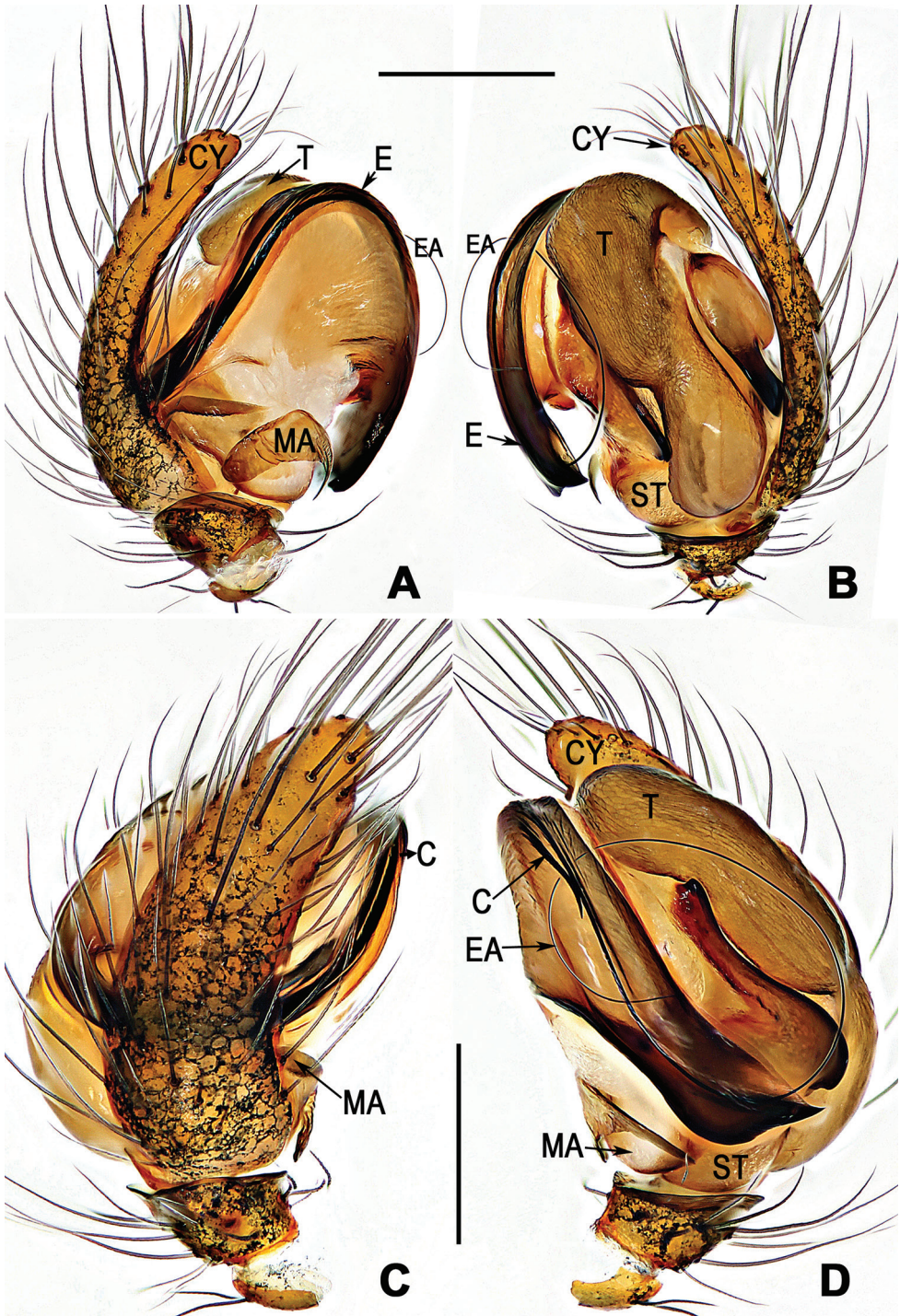


Figure 3. *Coddingtonia huifengi* sp. nov., holotype male. **A–D** Left palp **A** prolateral **B** retrolateral **C** dorsal **D** ventral. Abbreviations: C conductor; E embolus; T tegulum; CY cymbium; EA embolic apophysis; MA median apophysis; ST subtegulum. Scale bars: 0.20 mm.

Palp (Fig. 3A–D): tibia small, cymbium narrow, about 2 times longer than width, with long setae; paracymbium short and small, about of 1/5 cymbial length; tegulum capacious; median apophysis lamellar, subrectangular; conductor disk shaped with a needle-like distal process; mesal bristle of the embolic apophysis describes a semi-loop above the tegulum and cymbium; embolus long, whip-like, extending far beyond the mesial embolic apophysis and coiling into one loop.

Distribution. Known only from the type locality (Fig. 6).

***Coddingtonia erhuan* sp. nov.**

<http://zoobank.org/15CE2D97-4B6B-4CD7-B117-CE15B9FF1A1E>

Fig. 4

Type material. *Holotype* ♀, *paratypes* 5♀ and 1♂ juv. (NHMSU) CHINA: Yunnan Province, Gaoligongshan, the west of Nujiang River, Shibali Village, 27°08.28'N, 98°49.34'E, ca. 1850 m, 19 Aug. 2018, Y. Lin et al. leg.; Two paratypes 1♂ juv. and 1♀ used for sequencing, same data as preceding, GenBank: MN211319 and MN211318.

Other material examined. 2♀ (NHMSU) CHINA: Yunnan Province, Gongshan County, Sijitong Village, on the banks of Nujiang River, 8°03.27'N, 98°35.76'E, ca. 1620 m, 12 Aug. 2018; 1♀ (NHMSU) CHINA: Yunnan Province, Longling County, Mangkuan Town, Baihualing Village, Zaochang River, subtropical broadleaf forest, 25°18.27'N, 98°48.04'E, ca. 1640 m, 21 Aug. 2018; 2♀ (NHMSU) CHINA: Yunnan Province, Longling County, Longjiang Town, Xiaoheishan Nature Reserve, Gucheng Hill, broadleaved deciduous forest, in surface leaf litter, 24°49.73'N, 98°45.55'E, ca. 2010 m, 22 Aug. 2018; 2♀ (NHMSU) CHINA: Yunnan Province, Gongshan County, the road of from Bingzhongluo Town to Puhuasi Temple, broadleaved deciduous forest litter, 28°01.42'N, 98°36.13'E, ca. 1870 m, 12 Aug. 2018, Y. Lin et al. leg.; 1♀ (NHMSU) CHINA: Yunnan Province, Fugong County, Shangpa Village, broadleaves deciduous forest, 26°53.66'N, 98°51.16'E, ca. 1470 m, 2 Jul. 2016, Y. Li leg.

Etymology. Formed from the Chinese words for two (èr 二) and circle (huán 环), referring to the paired loops of copulatory ducts (Fig. 4E); noun.

Diagnosis. This new species can be distinguished from other congeners by the 2 coils of the unilateral copulatory ducts around the spermathecae (Fig. 4E–F). By having a posterior tubercle on the abdomen (Fig. 4A–C) it differs from *C. huifengi* sp. nov. (Fig. 2A–D), *C. anaktakun* and *C. discobulbus* (Labarque and Griswold 2014: figs 5A–C, 6A–C, 7A–C).

Description. Female (holotype): Carapace pear-shaped, black. Sternum tan. Legs dark brown. Abdomen obovate with posterior tubercle, dark black, ventrally darker than dorsally, covers sparse setae (Fig. 4A–C). *Measurements*: Total length 1.66. Carapace 0.62 long, 0.60 wide. Clypeus 0.14 high. Sternum 0.37 long, 0.38 wide. Abdomen 1.21 long, 1.04 wide. Length of legs: I 2.03 (0.65, 0.25, 0.43, 0.39, 0.31); II 1.80 (0.55, 0.23, 0.38, 0.34, 0.30); III 1.39 (0.42, 0.18, 0.26, 0.28, 0.25); IV 1.78 (0.55, 0.23, 0.40, 0.34, 0.26).

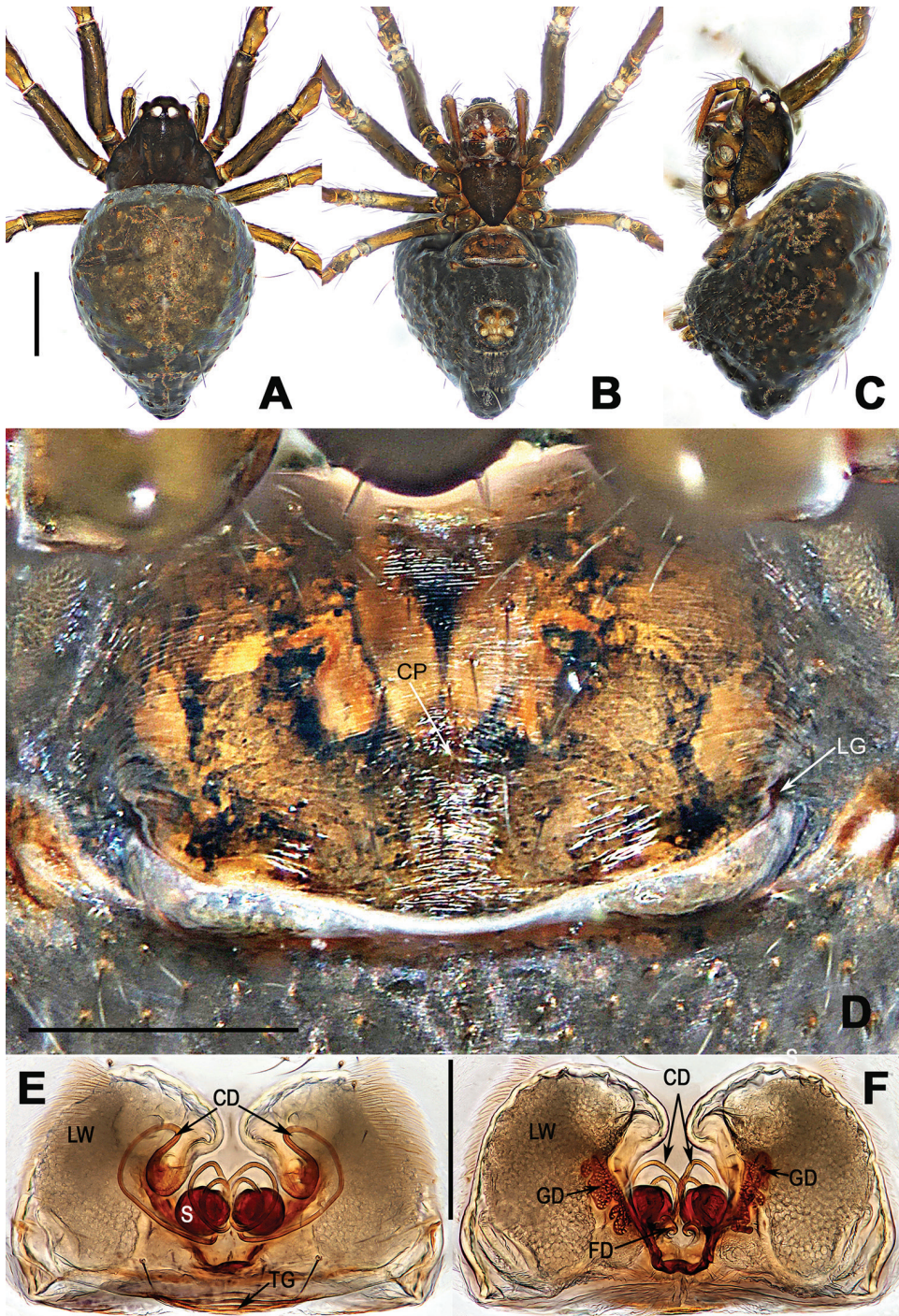


Figure 4. *Coddingtonia erhuan* sp. nov., holotype female. **A–C** Habitus **D** epigyne **E, F** vulva (lactic acid-treated) **A, F** dorsal **B, D, E** ventral **C** lateral. Abbreviations: CD copulatory ducts; CP central pit; FD fertilization ducts; GD glandular ducts; LG lateral grooves; LW lateral wings; TG transversal groove; S spermathecae. Scale bars: 0.50 mm (**A–C**); 0.20 mm (**D–F**).

Epigyne (Fig. 4D–F): plate weakly sclerotized, nearly rectangular, with an indistinct central pit and pair of posterolateral pockets. Spermathecae barely visible through the integument; lateral wings well developed, with sclerotized glandular ducts in the dorso-medial; spermathecae globose, closely spaced and almost adjacent; copulatory ducts form a half loop in the ventral later wings, followed by 2 complete loops surround the spermathecae, and finally connect to the spermathecae (Fig. 4E); fertilization ducts short and twisty, arise from the dorsal side of spermathecae (Fig. 4F).

Male. unknown.

Distribution. Known only from the type locality (Fig. 6).

***Coddingtonia lizu* sp. nov.**

<http://zoobank.org/4DBF94AC-E4F0-4937-BD47-FB9709598596>

Fig. 5

Type material. *Holotype* ♀, *paratypes* 2♀ and 2 juv. ♂ (NHMSU) CHINA: Hainan Province, Sanya City, Baoting County, Maogan Town, Xian'an Stone Cave, 18°35.86'N, 109°25.61'E, ca. 620 m, 24 Nov. 2014, F. Li et al. leg. Two paratypes 1 juv. ♂ and 1♀ used for sequencing, same data as for preceding, GenBank: MN211313 and MN211312.

Etymology. Named for the Lizu people, an ethnic minority that first settled in the Hainan Province. Noun in apposition.

Diagnosis. This new species can be distinguished from the congeners by having 5 loops of unilateral copulatory duct (Fig. 5D; Note: the broken first and fourth loops on the right side of copulatory duct in vulva are due to careless dissection). Moreover, it has a posterior tubercle on the abdomen (Fig. 5A, B), which is absent in *C. anaktakun*, *C. discobulbus*, and *C. huihengi* sp. nov. (Fig. 2A–D; Labarque and Griswold 2014: figs 5A–C, 6A–C, 7A–C).

Description. Female (holotype): Carapace pear-shaped, black. Sternum dim, posteriorly contracted. Femora and tibiae of legs dark, other segments yellow to brown. Abdomen dark black, dorsal color lighter than venter, with posterior tubercle, covers sparse long, stiff setae (Fig. 5A, B). *Measurements*: Total length 1.72. Carapace 0.64 long, 0.61 wide. Clypeus 0.13 high. Sternum 0.40 long, 0.38 wide. Abdomen 1.23 long, 1.05 wide. Length of legs: I 2.06 (0.66, 0.26, 0.43, 0.39, 0.32); II 1.84 (0.56, 0.23, 0.38, 0.35, 0.32); III 1.42 (0.43, 0.19, 0.26, 0.29, 0.25); IV 1.81 (0.56, 0.23, 0.41, 0.34, 0.27).

Epigyne (Fig. 5C–E): weakly sclerotized, nearly rectangular, black pigmentation in the central region; central pit and lateral pockets indistinct. lateral wings well developed, reniform and translucent; spermathecae small and round, separated by approximately one radius; copulatory ducts form a posterolateral auricular loop on the both sides of the lateral wings, followed by 5 loops, and finally connecting ventrally on the spermathecae (Fig. 5D); fertilization ducts short, arise from the dorsal-inner base of spermathecae (Fig. 5E).

Male. unknown.

Distribution. Known only from the type locality (Fig. 6).

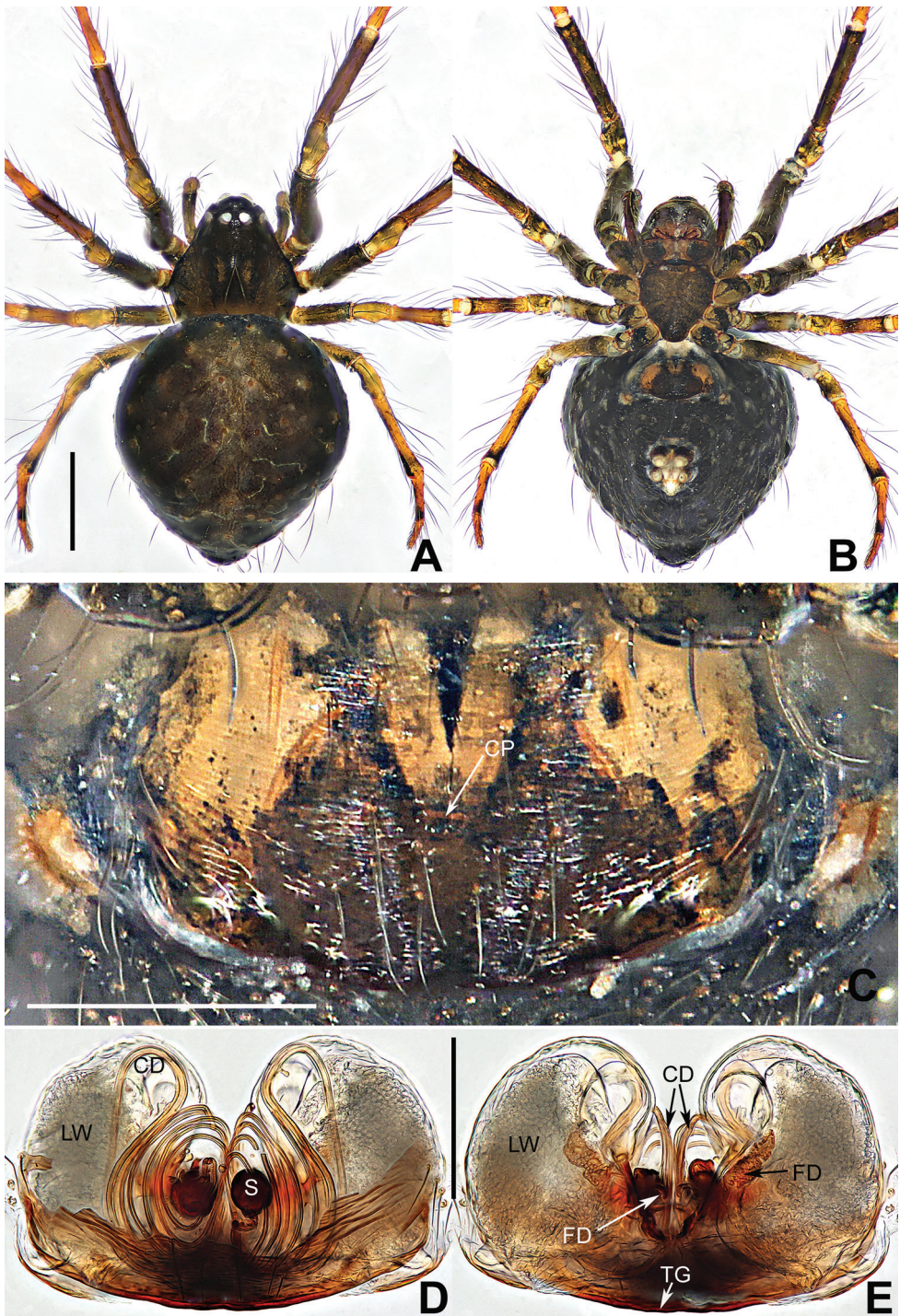


Figure 5. *Coddingtonia lizu* sp. nov., holotype female. **A, B** Habitus **C** epigyne **D, E** vulva (lactic acid-treated) **A, E** dorsal **B–D** ventral. Abbreviations: CD copulatory ducts; CP central pit; FD fertilization ducts; GD glandular ducts; LW lateral wings; S spermathecae. Scale bars 0.50 mm (**A, B**); 0.20 mm (**C–E**).

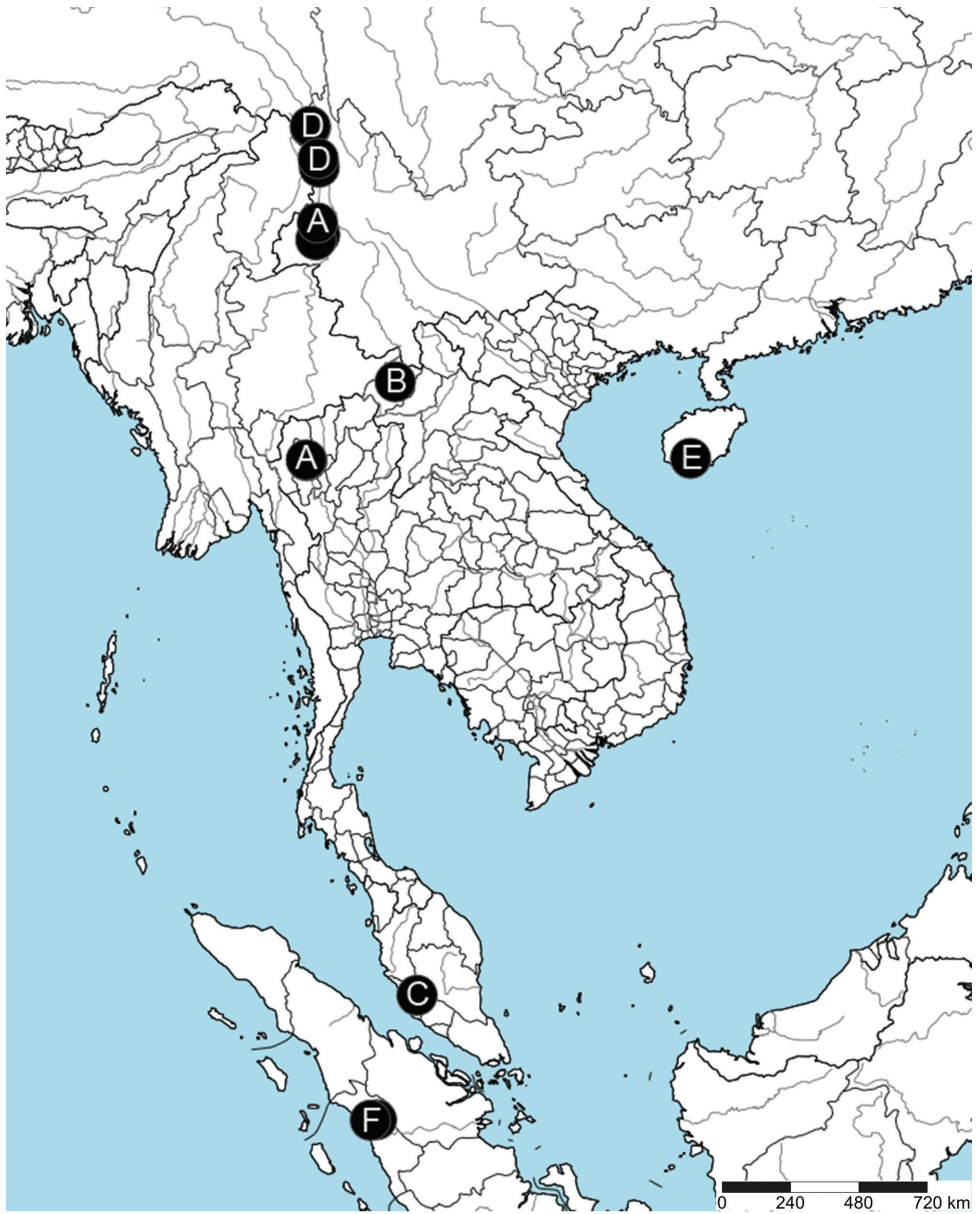


Figure 6. Distribution records of *Coddingtonia* spp. in the world. **A** *C. euryopoides* Miller et al., 2009 **B** *C. discobulbus* Wunderlich, 2011 **C** *C. anaktakun* Labarque & Griswold, 2014 **D** *C. erhuan* sp. nov. **E** *C. lizu* sp. nov. **F** *C. huifengi* sp. nov.

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First record of Cicadellidae (Insecta, Hemiptera, Auchenorrhyncha) from Eocene Sakhalinian amber

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Abstract

Sakhalotettix eocenicus **gen. & sp. nov.**, the first leafhopper reported from middle Eocene Sakhalinian amber, is described and illustrated. The fossil cicadellid resembles modern Xestocephalini and Bathysmatophorini in some respects but, because of its unique combination of traits, cannot be placed with certainty in either group, or in any other modern cicadellid subfamily. It is, therefore, considered to be *incertae sedis* within Cicadellidae.

Keywords

amber insects, Bathysmatophorinae, leafhoppers, morphology, systematic paleontology, Xestocephalini

Introduction

Leafhoppers (Cicadellidae) are one of the 10 largest families of insects and are presently among the most abundant herbivores, occurring in nearly every habitat that supports vascular plants. Although the oldest representatives of the family are recorded from the Lower Cretaceous (Hamilton 1990, 1992), the fossil record of this group remains sparse and poorly documented with fewer than 100 species formally described,

most based on poorly preserved compression fossils (reviewed by Dietrich and Thomas 2018). Fossil cicadellids preserved in amber are known from the Cretaceous (Poinar and Brown 2017), Eocene (Szwedo 2002, 2005, Dietrich and Gonçalves 2014, Dietrich and Thomas 2018) and Miocene (Dietrich and Vega 1995). Many of these fossils have been assigned to modern subfamilies and have been used recently to calibrate molecular time trees (Dietrich et al. 2017, Johnson et al. 2018). The fossil leafhopper described below is important because it is the first representative of the family from middle Eocene Sakhalinian amber and exhibits a combination of morphological characters not yet reported among fossil or modern Cicadellidae. It may therefore contribute to knowledge of the evolution of major lineages of this family.

Numerous amber insects were collected in the south of Sakhalin Island, Russian Far East, by an expedition of the Paleontological Institute of Academy of Science of USSR in 1972 (Zherikhin 1978). Amber occurs on a beach near the village of Starodubskoye, Dolinsk District near the Naiba River mouth, Okhotsk Sea. The same fossil resin was found nearby at the Naiba River embedded in the coal of the Naibuchi Formation (Zherikhin 1978, Kodrul 1999).

The age of Sakhalinian amber has remained controversial for a long time (Kazantsev and Perkovsky 2019, and references therein). T.M. Kodrul (1999) convincingly demonstrated using geological and paleobotanical data a middle Eocene age of the Naibuchi Formation, in which Sakhalinian amber was found in situ (see also Baranov et al. 2015, Marusik et al. 2018). Rarity of ants and composition of mosses found in Sakhalinian amber confirm swampy environments in the Sakhalinian amber forest (Ignatov and Perkovsky 2013, Radchenko and Perkovsky 2016).

Sakhalinian amber belongs to the rumanite-type. Common for such fossil resins is a high degree of polymerization of the resin itself and deformation caused by thermal metamorphism during diagenesis. Insect inclusions in rumanite-type (particularly Sakhalinian) amber are therefore often deformed and have their internal cavity filled with resin (Rasnitsyn and Quicke 2002). This makes the inclusions more difficult to observe, compared to those European Baltic and Rovno succinite-type ambers. Sakhalinian amber is characterized by the small size of the pieces and supposedly rapid loss of viscosity (Kazantsev and Perkovsky 2019).

So far, about 1250 amber inclusions of insects and arachnids have been recorded from Sakhalinian amber, with aphids and chironomids most prevalent (Batelka et al. 2019, and references therein). Very unusual for amber faunas is the rarity of adult beetles in comparison with beetle larvae (Kazantsev and Perkovsky 2019).

Leafhoppers and planthoppers compose 23% of all hemipterans in a representative collection of late Eocene Rovno amber (Perkovsky et al. 2007) and 10% of all hemipterans in a representative collection of Eocene Baltic amber (Sontag 2003), but less than 0.3% of all hemipterans in middle Eocene Sakhalinian amber, possibly due to the small size of the pieces and low viscosity of the resin (our data).

Small typhlocybina nymphs jump less actively than other Auchenorrhyncha living in open habitats, and instead move laterally when danger threatens (Olmi et al., submitted). They are common in Rovno and Baltic ambers, but absent in Sakhalinian amber. So, apparently, they were very uncommon in the Sakhalinian amber

forest. The new leafhopper described below is the only Auchenorrhyncha specimen known from Sakhalinian amber and only the second hemipteran species described from this amber (Shcherbakov 2007).

Material and methods

The amber specimen was photographed using a Leica M165C microscope with Leica DFC 420 camera. Morphological terminology follows Dietrich (2005). Studied material is housed in the Paleontological Institute of the Russian Academy of Sciences, Moscow (PIN).

Systematic Paleontology

Order Hemiptera Linnaeus, 1758

Suborder Auchenorrhyncha Duméril, 1806

Infraorder Cicadomorpha Evans, 1946

Superfamily Membracoidea Rafinesque, 1815

Family Cicadellidae Latreille, 1825, *incertae sedis*

***Sakhalotettix* gen. nov.**

<http://zoobank.org/7B8DD598-9497-476D-8D7C-8A18441CCDD9>

Type species. *Sakhalotettix eocenicus* sp. nov.

Diagnosis. This genus differs from other known leafhoppers in having the following combination of traits: head with ocelli on crown near anterior margin distant from eyes; lateral frontal sutures well developed ventromesad of ocelli; frontoclypeus moderately convex, separated from eye by nearly half its width; gena emarginate below eye, exposing flaplike proepisternum; front femur row AV (anteroventral) with several short setae; female pregenital sternite nearly as long as all preceding sternites combined and acutely emarginate posteriorly.

Description. Small, moderately slender. Head broad, crown moderately produced medially, texture uniformly shagreen, coronal suture extended nearly to anterior margin; anterior margin rounded in dorsal view, transition from crown to face broadly rounded, without transverse carinae. Ocelli well developed, on crown near anterior margin, approximately equidistant between eyes and midline, separated from lateral frontal suture by approximately one ocellar diameter, approximately even with anterior margins of eyes. Lateral frontal suture well developed, extended dorsad from antennal ledge then arched below ocelli and becoming obsolete near midline; temporal suture extended laterad of ocellus. Face broad, strongly convex, lower half closer to horizontal than vertical. Frontoclypeus irregularly rugose with distinct transverse muscle impressions, separated from mesal eye margin by approximately half frontoclypeal width; antennal ledges carinate but not strongly produced; antennal base well separated from

eye, antenna shorter than half head width. Gena concavely emarginate below eye, exposing flaplike proepisternum. Lorum narrow, well separated from genal margin. Anteclypeus convex, tapered distally, extended beyond normal curve of gena. Rostrum extended slightly beyond front tronchanters.

Pronotum approximately as wide as head, moderately convex, finely punctate with numerous transverse striations, anterior margin slightly produced, lateral margin carinate, slightly shorter than eye, posterior margin slightly emarginate.

Front femur moderately broad basally, abruptly narrowed in distal two-thirds, seta AM1 enlarged and situated near ventroapical margin, row AV with numerous short setae extended over most of length, PV with several long, fine setae; tibia cylindrical, dorsal rows with numerous short setae and few widely spaced longer setae approximately as long as tibial width, row AV with approximately 14 macrosetae becoming progressively longer from base to apex, PV with fewer setae, restricted to distal half; tarsus three-fourths length of tibia. Middle femur broader and slightly shorter than front femur, setae of femur and tibia inconspicuous. Hind femur nearly reaching lateral margin of pronotum in repose; tibia with all four longitudinal setal rows well differentiated.

Pregenital abdominal sternite (VII) nearly as long as all preceding sternites combined, posterior margin deeply and acutely emarginate with lateral lobes acute.

Etymology. The genus name, a masculine noun, combines the name of the type locality with “*tettix*”, a common suffix used in cicadellid genus names.

***Sakhalotettix eocenicus* sp. nov.**

<http://zoobank.org/3BE52080-FD1E-4704-A98F-CC31E97AB4D0>

Figs 1, 2

Description. Structural features as in genus description.

Measurements. Body length 4.2 mm; head width 1.3 mm; front femur length 0.8 mm, tibia length 0.95 mm; middle femur length 0.65 mm.

Material examined. *Holotype*, female (?) PIN 3387/1085, Starodubskoye, Sakhalinian amber. middle Eocene.

Etymology. The species name, *eocenicus*, refers to the age of the fossil.

Discussion

The fossil described above is moderately well preserved but several important structures, including the wings, hind legs, and abdominal terminalia are poorly visible. Nevertheless, the imperfect preservation of the specimen only partly accounts for the difficulty in placing *Sakhalotettix* within the current higher classification of Cicadellidae. In overall size and shape, the specimen resembles *Xestocephalus* Van Duzee (Aphrodinae, Xestocephalini), a modern cosmopolitan genus also recorded from lower-middle Miocene Dominican amber (Dietrich and Vega 1995). Two genera of Aphrodinae were previously described from the late Eocene (Baltic amber; Dietrich

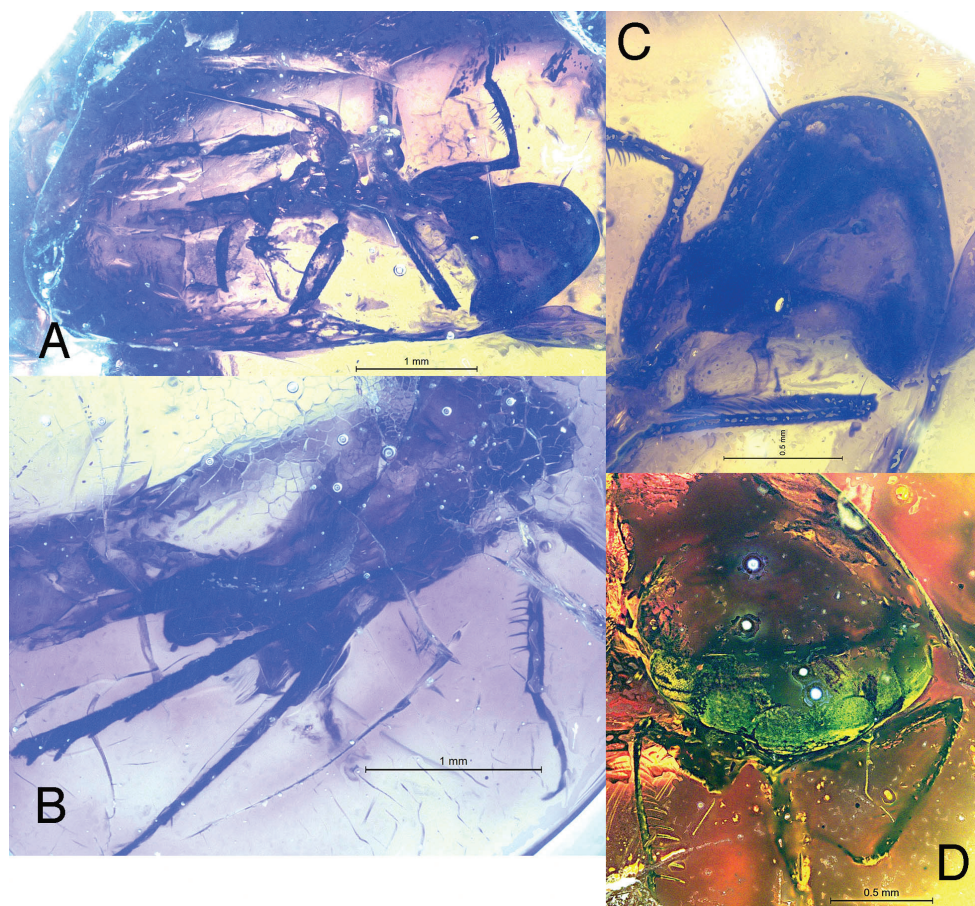


Figure 1. *Sakhalotettix eocenicus* gen. & sp. nov., holotype female **A** habitus, left ventrolateral view **B** habitus, right ventrolateral view **C** detail of head and prothorax, left ventrolateral view **D** head and part of thorax, anterodorsal view.

and Gonçalves 2014), but *Sakhalotettix* differs from these and modern aphrodines in having the gena concavely emarginate below the eye, exposing the proepisternum, and the distance between the eye and the frontoclypeus relatively broad. In the latter respects, *Sakhalotettix* resembles Bathysmatophorinae, a group represented by a few extant genera restricted to the Holarctic region but also recorded from late Eocene Baltic amber (Szwedo and Gebicki 1998, Szwedo 2005, Dietrich and Gonçalves 2014). However, in contrast to *Sakhalotettix*, all known Bathysmatophorinae are relatively large (macropterous adults > 5 mm total length) and have the ovipositor extended well beyond the pygofer apex. Unfortunately, the latter character is not visible in the holotype of *Sakhalotettix eocenicus* and the emarginate gena is shared with several modern subfamilies including Bathysmatophorinae, Cicadellinae, Ledrinae and Ulopinae.

Sakhalotettix is unusual in having the lateral frontal sutures well delimited ventromesad of the ocelli and extended nearly to the midline of the head. This presumably plesiomorphic trait occurs to various degrees in modern Cicadellinae, which differ in

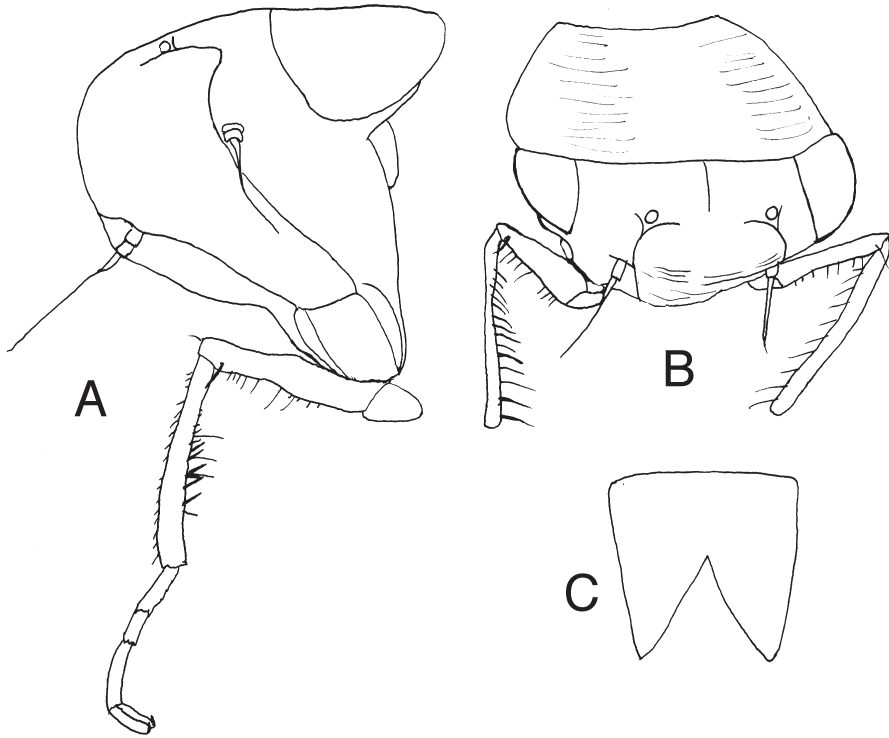


Figure 2. *Sakhalotettix eocenicus* gen. & sp. nov., holotype female **A** head, proepisternum and right front leg (part), left anterolateral view **B** head, pronotum and front legs, anterodorsal view **C** abdominal sternite VII, ventral view.

having the frontoclypeus strongly inflated and the ocelli usually situated well posterad of the anterior eye margins. Thus, based on the characters visible in the fossil, the new genus appears to have mixed affinities to at least three extant subfamilies (Aphrodinae, Bathysmatophorinae and Cicadellinae). Discovery of additional specimens with the wings and hind legs better preserved may help place the fossil with more certainty. For now, the unusual combination of plesiomorphic and apomorphic traits visible in the only specimen prevents us from placing it with confidence in any extant subfamily.

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A review of the genus *Sinocentrus* Yuan (Hemiptera, Membracidae, Centrotinae) with description of a new species from China

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Abstract

A new species of the treehopper genus *Sinocentrus* Yuan, *S. brevicornis* Li & Chen, **sp. nov.** from China, is described and illustrated. A checklist and key to species of the *Sinocentrus* are provided.

Keywords

distribution, morphology, taxonomy, treehopper

Introduction

The treehopper genus *Sinocentrus* was established by Yuan (Yuan and Chou 2002) with only its type species, *S. sinensis* Yuan, 2002, known from one female specimen. The genus was originally placed in the tribe Leptocentrini by Yuan and Chou (2002), but Wallace and Deitz (2004) moved *Sinocentrus* to *incertae sedis*, because specimens were not examined in their study and the morphological characteristics were confounding.

Herein, a new species, *Sinocentrus brevicornis* Li & Chen, sp. nov. from China, is described and illustrated. As a result of this act, the genus *Sinocentrus* now contains two species. A key based on morphological characteristics to distinguish species is provided as well as a map of their geographic distributions.

Materials and methods

General morphological terminology follows Deitz (1975) and Dietrich et al. (2001) except morphology of the female genitalia, which follows Mejdalani (1998). Dry male specimens were used for the descriptions and illustrations. External morphology was observed under a stereoscopic microscope and characters were measured with an ocular micrometer. Measurements are given in millimeters; body length was measured from the apex of the head to the apex of the forewing in repose. Habitus photographs were taken using a NIKON SMZ 25 digital camera and multiple layers were stacked using Helicon Focus 6. The genital segments of the specimens examined were macerated in 10% NaOH and drawn from preparations in glycerin jelly using a Leica MZ 12.5 stereomicroscope. The photographs and the illustrations were imported into Adobe Photoshop CS5 for plate composition and labeling.

The type specimens examined are deposited in the Institute of Entomology, Guizhou University, Guiyang, Guizhou Province, China.

Taxonomy

Sinocentrus Yuan, 2002

Sinocentrus Yuan, 2002: 170.

Type species. *Sinocentrus sinensis* Yuan, 2002: 170, by redescription.

Diagnosis. Large sized. Frontoclypeus distinct. Suprahumeral horns narrow, acuminate, horizontally extended laterally, width between their apex ca 0.5 to 1.0 times body length. Pronotum highly developed, with anterior part strongly inflated and evenly rounded in profile, metopidium vertical, glabrous and minutely punctate without obvious pubescence. Posterior pronotal process strongly elevated above scutellum at base, slender, elongate, evenly tapered toward apex, straight or slightly sinuate, lateral and dorsal carina well developed, apex extended beyond forewing clavus. Scutellum entirely exposed, posterior margin emarginate. Basal one-fifth of forewing with opaque sclerotization, veins M and Cu fused basally to approximately one-fifth to one-fourth of wing length then strongly divergent, veins M+Cu and R fused basally, with 1 m-cu, 2 r-m, and 1 s crossveins. Hindwing vein R branched into R_1 , R_{2+3} , and R_{4+5} , vein M branched into M_{1+2} and M_{3+4} , R_{4+5} and M_{1+2} veins not fused (four apical

cells present), 1 r-m and 1 m-cu crossveins present, apical limbus broad, with wrinkles. Metathoracic trochanter without spines, tibia with 3 rows of cucullate setae.

Remarks. This genus can be distinguished from other oriental Centrotinae genera by the following characters: pronotum highly developed, strongly inflated with anterior part evenly rounded, glabrous with minute punctures and no obvious pubescence, suprahumeral horns extended laterad, posterior pronotal process elevated far above scutellum, scutellum emarginate.

Distribution. China (Hainan, Yunnan) (Fig. 29).

Checklist and distributions of species of *Sinocentrus* Yuan, 2002

S. brevicornis Li & Chen, sp. nov.; China (Hainan)

S. sinensis Yuan, 2002; China (Yunnan); elevation: 1600 m.

Key to species of the genus *Sinocentrus* Yuan

- 1 Forewing veins yellow to light brown, apical limbus hyaline; suprahumeral horns long, width between suprahumeral horns apices nearly as long as body length; posterior pronotal process curved near midlength; scutellum short, width greater than length (Figs 24–28) ***S. sinensis* Yuan**
- Forewing veins black, contrasting with pale membrane, apical limbus black; Width suprahumeral horns short, width between suprahumeral horns apices nearly half length of body; posterior pronotal process nearly straight throughout length; scutellum long, longer than wide (Figs 1–6) ***S. brevicornis* sp. nov.**

Sinocentrus brevicornis Li & Chen, sp. nov.

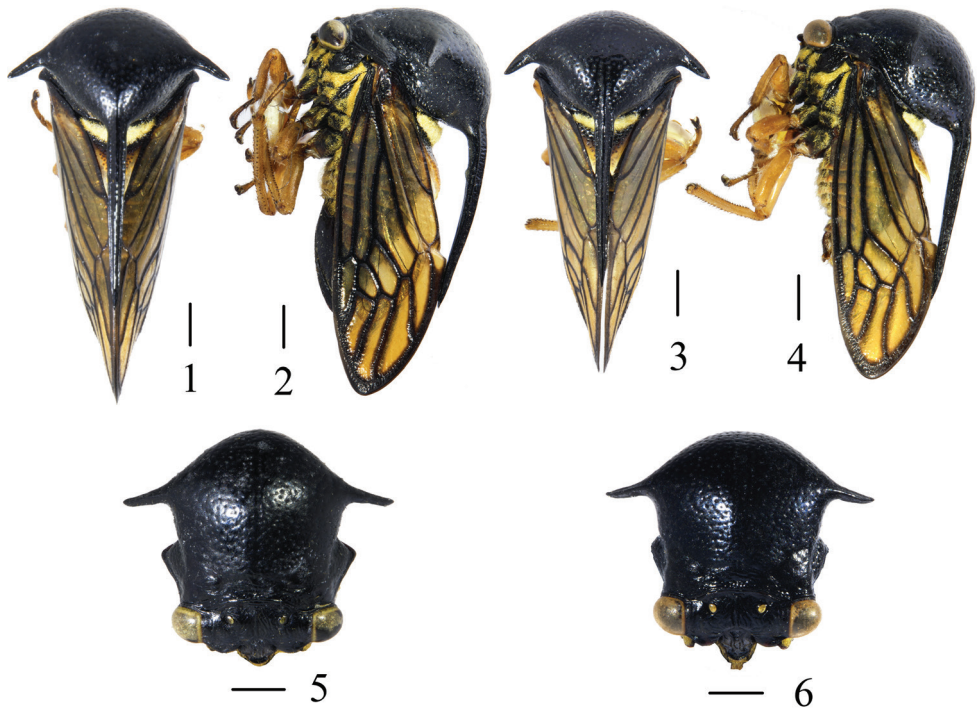
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Figs 1–23

Type material. Holotype: ♂, CHINA: Hainan, Bawangling, 29 April 2017, Hong-Xing Li. **Paratypes:** 2♀, same data as holotype.

Description. Body length: male 8.1 mm ($N = 1$), female 8.9–9.3 mm ($N = 2$); forewing length: male 7.3 mm ($N = 1$), female 7.3–7.9 mm ($N = 2$); width between humeral angles apices: male 3.3 mm ($N = 1$), female 3.5–3.8 mm ($N = 2$); width between suprahumeral horns apices: male 4.6 mm ($N = 1$), female 4.6–5.2 mm ($N = 2$).

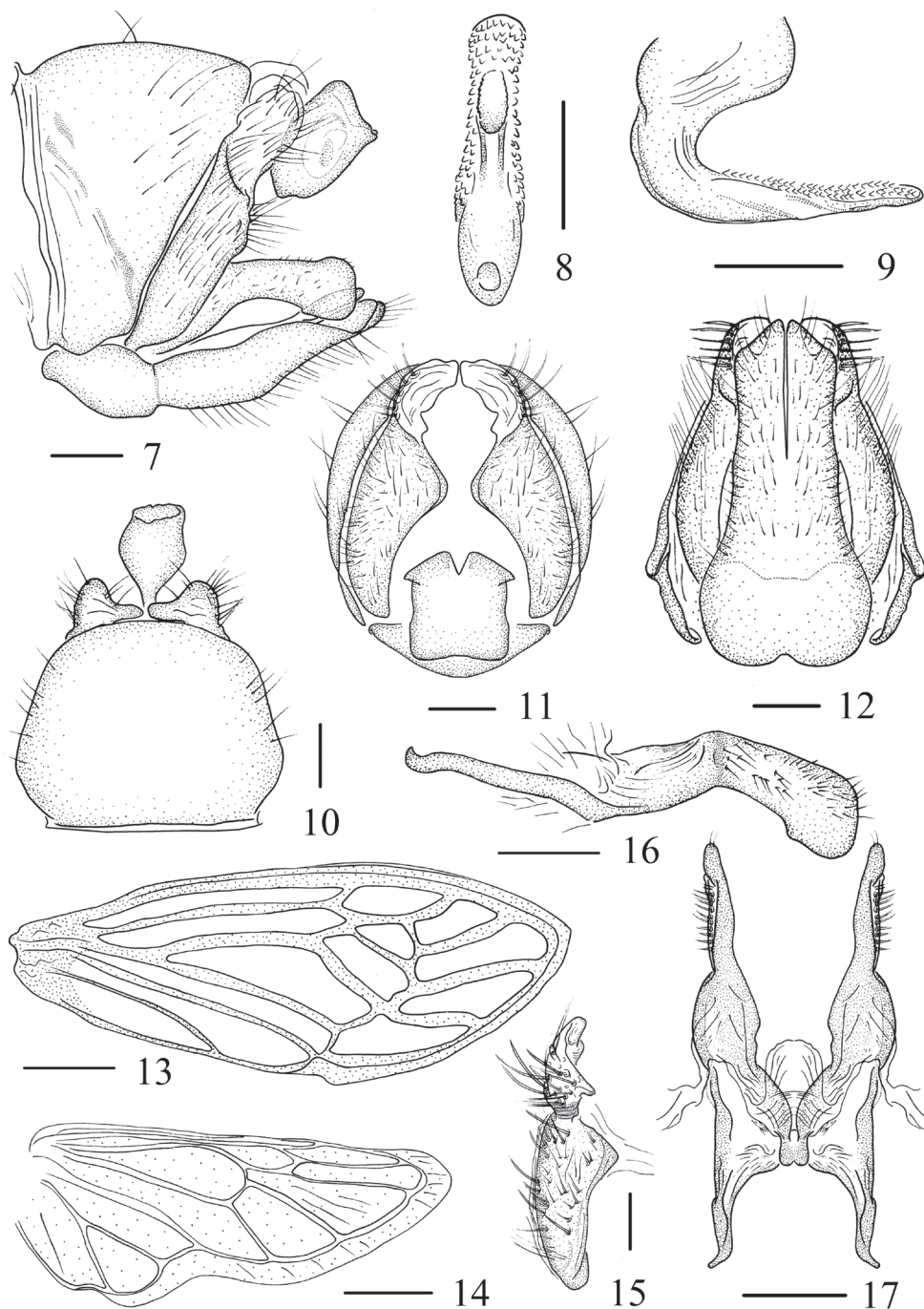
Coloration. General color black with scattered yellow setae. Eyes pale brown with yellow border in males, pale yellow with black markings in females (Figs 5, 6), ocelli yellow hyaline. Basal one-third of scutellum dark brown, covered with yellowish-white



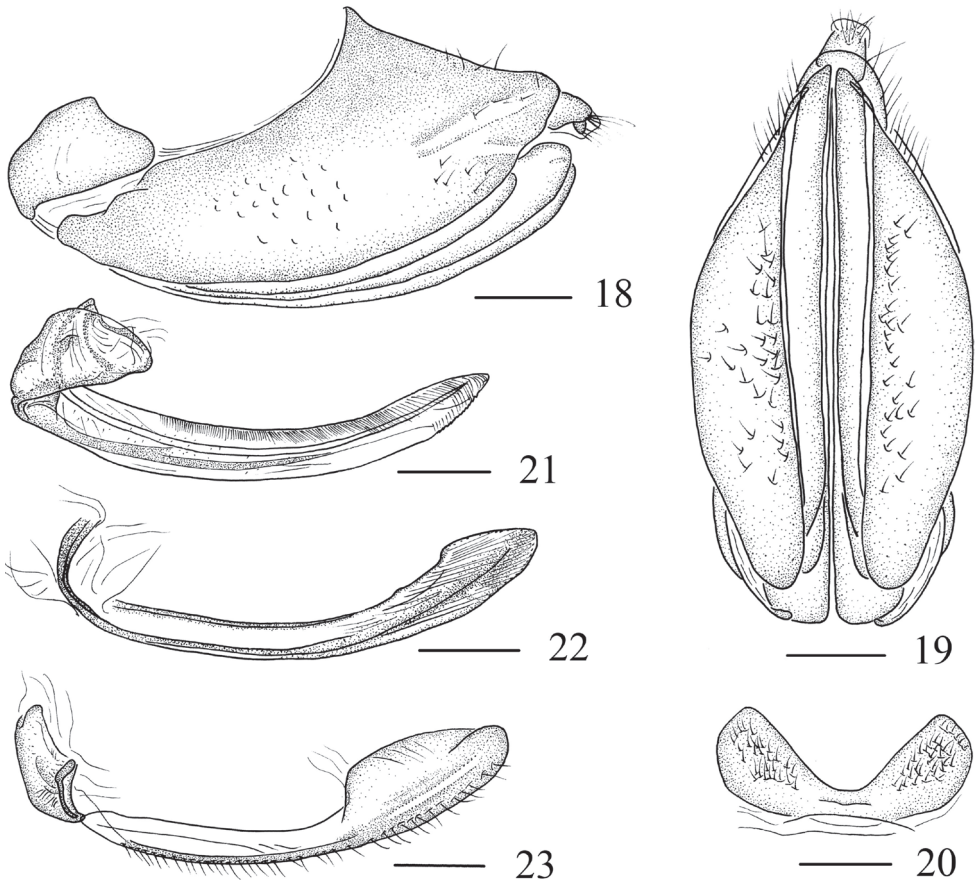
Figures 1–6. *Sinocentrus brevicornis* Li & Chen, sp. nov. **1** female habitus, dorsal view **2** same, lateral view **3** male habitus, dorsal view **4** same, lateral view **5** head and pronotum anterior view, female **6** head and pronotum anterior view, male. Scale bars: 1 mm.

setae, preapical region yellowish-brown with apical white. Forewing pale yellow hyaline, one-fifth of basal, veins and apical limbus black. Hindwing veins pale brown. Thorax black with pale yellowish pubescence; coxae black with yellow pubescence; trochanter, femur, tibia and tarsus yellowish-brown and tarsal claw dark brown. Abdomen reddish-brown with yellow pubescence, basal part of abdomen with a yellow spot of pubescence, apices of terga and sterna pale yellowish.

Head and thorax. Head in anterior view wider than long, ratio: 2.11:1. Vertex with dorsal and ventral margins slightly arcuated and wave-shaped respectively, with wrinkles on surface and a weak median longitudinal carina. Eyes and ocelli oval, ocelli slightly closer to inner margins of eyes less than to each other. Frontoclypeus distinct and trilobed, margin with sparse setae, apices of lateral and median lobes on same plane, more than half of median lobe extending beyond towards ventral margin of vertex, and apex dorsally slightly upturned. Apex of metopidium convex in anterior view. Posterior pronotal process ending at more than half of forewing cell M_{3+4} (last apical cell). Humeral angles triangular with apices somewhat blunt. Suprahumeral horns short, width between horns apices nearly half length of body. Scutellum humped basally, large punctures present, longer than wide, apex extended antero-dorsally male, curved ventrally in female (Figs 2, 4), posterior margin deeply emarginate. Mesotho-



Figures 7–17. *Sinocentrus brevicornis* Li & Chen, sp. nov. **7** male genitalia, lateral view **8** aedeagus, posterior view **9** aedeagus, lateral view **10** male genitalia, dorsal view **11** male genitalia, posterior view **12** male genitalia, ventral view **13** forewing **14** hindwing **15** lateral plate **16** style, right lateral view **17** style, dorsal view. Scale bars: 0.2 mm (**7–12**, **15–17**), 1 mm (**13–14**).



Figures 18–23. *Sinocentrus brevicornis* Li & Chen, sp. nov. **18** female genitalia, lateral view **19** female genitalia, ventral view **20** sternite VII, ventral view **21** valvifer I and valvulae I, lateral view **22** valvulae II, lateral view **23** valvifer II and gonoplac, lateral view. Scale bar: 0.5 mm.

racic femur without ablateral and adlateral cucullate setae. Metathoracic leg cucullate setae row II irregular.

Male genitalia. Pygofer (Figs 7, 11) nearly trapezoidal in lateral view; sternite IX (Fig. 12) depressed medially in ventral view. Anal tube cylindrical-shaped in lateral view. Lateral plate (Figs 7, 11, 15) with membranous dorsoapical lobe extending dorsally, slightly arcuate with setae; part of other surface with setae, margin incurved in posterior view. Basal half of subgenital plates fused, apex acute, obliquely truncate, distributed evenly setae in ventral view (Fig. 12). Style (Figs 16, 17) clasp oriented laterally, one-third compressed apically, weakly angled ventrally, lateral surface with setae; style shank with arch at central section. Base of connective W-shaped, distal part membranous and weakly depressed. Aedeagus in lateral view (Fig. 9) nearly C-shaped, apical four-fifths of surface and margin with reverse serrations, the opening at middle-upper of aedeagus, ovoid.

Female genitalia. Sternite VII (Fig. 20) in ventral view with posterior margin concave, lateral margins convex and surface with setae. Pygofer (Figs 18, 19) in lateral view irregularly quadrilateral, with setae; in ventral view oblong, base slightly acute. Anal tube (Figs 18, 19) small and oval. Valvifer I (Fig. 21) semicircular and thin; valvulae I knife-shaped, apical three-fourths of dorsal surface sculptured, ventral surface of the apex with a row of small toothed processes. Valvifer II (Fig. 23) shoe-shaped in lateral view, dorsal margin membranous. Basal part of valvulae II (Fig. 22) connected to the apex of “sole”, ramus slender, parallel-sided and evenly curved in basal two-thirds, apex slightly broadened with two indistinct and widely spaced dorsal preapical tooth processes; the one-third of apical broaden slightly. Gonoploc (Fig. 23) connected to base of “sole”, apical third expanded, ventral margin with setae.

Distribution. China (Hainan).

Etymology. The word “*brevicornis*” is derived from the Latin words “*brevi-*” and “*cornu*”, referring to having the short suprahumeral horns.

Remarks. This species is similar to *S. sinensis* Yuan, 2002, but differs from the latter in: (1) forewing veins black and apical limbus black (veins yellow to light brown, apical limbus hyaline in *S. sinensis*) (2) suprahumeral horns short, width between suprahumeral horns apices shorter than body length (as long as body length in *S. sinensis*); (3) posterior pronotal process nearly straightly (concave medially in *S. sinensis*); (4) scutellum longer than wide (wider than long in *S. sinensis*); (5) apex of posterior pronotal process not reaching M_{3+4} veins (exceeding M_{3+4} veins in *S. sinensis*).

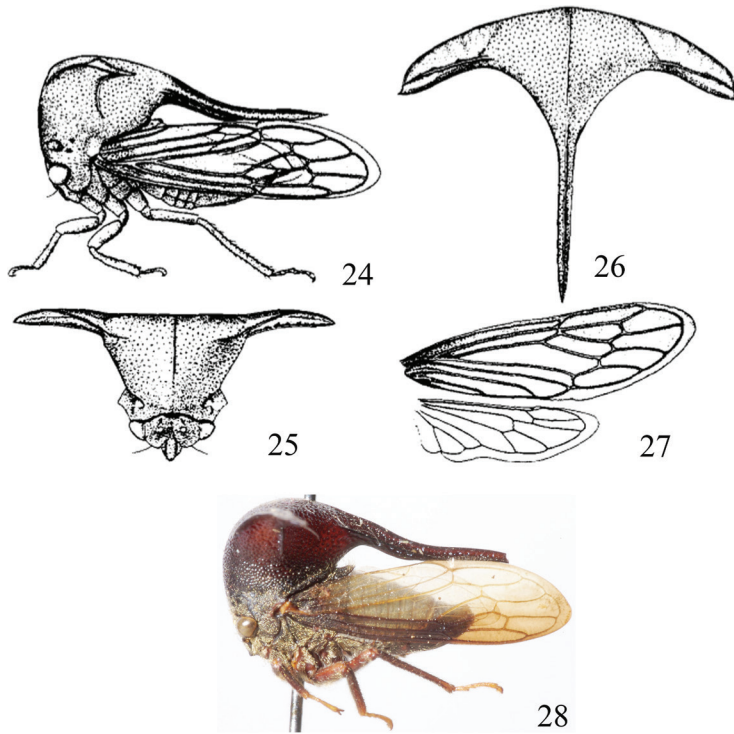
***Sinocentrus sinensis* Yuan, 2002**

Figs 24–28

Sinocentrus sinensis Yuan, 2002: 170, by original designation.

Description. Coloration. General color reddish-brown with golden setae (Fig. 28). Head blackish-brown. Ocelli pale yellow. Eyes yellow-brown. Forewing dark brown; A_1 , A_2 , A_3 , and Cu_1 white hyaline; Sc, R, and M brown; Cu and A pale yellow. Hindwing with veins pale yellow. Thorax dark brown. Legs reddish-brown except with tarsi yellow. Abdomen dark brown.

Head and thorax. Head wider than long. Vertex with dorsal margin arched and ventral margin oblique. Eyes oval. Ocelli hyaline, slightly closer to the inner margin of eyes less than to each other. Frontoclypeus distinct and trilobed, the apex of lateral lobes and the median lobes on the same plane, two-thirds of median lobe extending beyond towards ventral margin of vertex. Pronotum with dense setae and punctures. Humeral angles large, apices blunt. Suprahumeral horns leaflike pyramidal, horizontally extended laterally, width between suprahumeral horns apices nearly as long as body length (Figs 24–25). Nearly median part of the posterior pronotal process concave and touching forewing, apical upward, with four carinas. Scutellum short, wider greater than length, posterior margin round emarginate. Forewing with opaque sclerotization



Figures 24–28. *Sinocentrus sinensis* Yuan, 2002 **24** female habitus, lateral view **25** head and pronotum, anterior view **26** female habitus, dorsal view **27** forewing and hindwing **28** holotype, female, habitus, lateral view, photo by Robert L. Snyder from the treehopper website <http://treehoppers.insectmuseum.org>
 Note: **24–27** from Fauna Sinica. Insecta Vol. 28, 171 pp, figure 66.

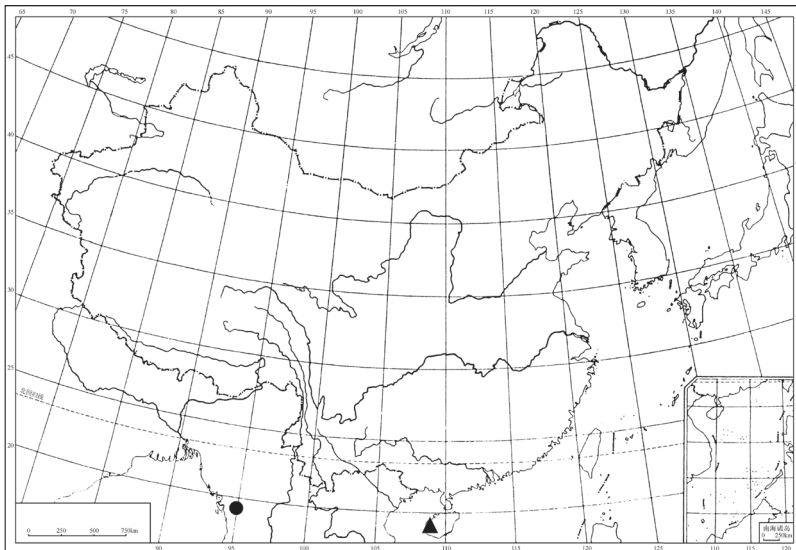


Figure 29. Geographic distributions of *Sinocentrus* species: *S. sinensis* (circle); *S. brevicornis* Li & Chen, sp. nov. (triangle).

at basal one-eighth, Venation similar to that of *S. brevicornis*. Metathoracic trochanter without spines and tibia with 3 rows of cucullate setae.

Male. Unknown.

Distribution. China (Yunnan).

Note. While holotype was not examined, an online image of the holotype (Fig. 28) and detailed Chinese description were available.

Discussion

In their phylogeny and genus-level revision of Centrotinae, Wallace and Deitz (2004) were unable to examine specimens of *Sinocentrus* and treated the genus as Centrotinae, *incertae sedis*.

We provide the following additional details on *Sinocentrus*: (1) frontoclypeus distinct (indistinct in Centrotypini); (2) posterior pronotal process elevated far above the scutellum, entirely exposed (straight at base, partially covers the scutellum in Centrotypini); (3) male lateral plate with short dorsoapical lobe extending dorsally, style clasp angled ventrally; style shank with arch at central section (angled dorsally; style shank with significant arch medially in Centrotypini); (4) mesothoracic femur without ablatral and adlatral cucullate setae; metathoracic leg cucullate setae row II irregular. Although the above characteristics can suggest that the genus is related to Leptocentrini, the shape of the female second valvulae closely align *S. brevicornis* with the tribe Centrotypini. Given these mixed affinities, we follow Wallace and Deitz, in treating *Sinocentrus* as Centrotinae, *incertae sedis*. Proper tribal placement may be affirmed by future phylogenetic analyses of combined morphological and molecular data.

Acknowledgments

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Revision of the Australian genus *Logasa* Chandler (Staphylinidae, Pselaphinae, Faronitae) with description of three new species

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Abstract

The Australian genus *Logasa* Chandler, 2001 (type species: *L. novaeanglia* Chandler) is comprised of six species, three of which are described as new: *Logasa newtoni* **sp. nov.**, *Logasa thayerae* **sp. nov.**, and *Logasa comforti* **sp. nov.** Examination of the types of *L. tricolor* (Oke) and *L. ventralis* (Oke) revealed that they do not share some of the diagnostic characters used here to characterize the type, and other species of the genus, but they are retained in *Logasa* until the group is revised. A key to species, illustrations of their habitus, and diagnostic characters are provided.

Keywords

beetle, biodiversity, biogeography, systematics, taxonomy

Introduction

The Australian genus *Logasa* Chandler was described in 2001 based on *Logasa novaeanglia* Chandler. Two other species, *L. tricolor* (Oke, 1928) and *L. ventralis* (Oke, 1928), were originally described in the genus *Sagola* (Oke, 1928), and were transferred to *Logasa* by Chandler (2001). During our revisionary study based on 140 specimens, three new species were recognized. After examination of the types of *L. tricolor* and *L. ventralis*, we found that at the generic level they have different useful diagnostic characters that are based on their foveal system and the form of the male genitalia. This combination of features has not been seen in any of the existing known faronite genera. The Australian faronite fauna has numerous undescribed species (Park and Chandler 2017), which will become the targets of further studies of this very rich fauna. In this study, *L. tricolor* and *L. ventralis* are retained in the genus *Logasa*, but are not further treated here as they may be placed in a new genus once a subsequent revisionary study is conducted with the discovery of additional specimens of these two species.

Materials and methods

One hundred and forty specimens were examined. They are deposited in the following collections:

ANIC	Australian National Insect Collection, Canberra, ACT, Australia;
CBNUIC	Chungbuk National University Insect Collection, Cheongju, South Korea;
FMNH	Field Museum of Natural History, Chicago, IL, USA;
MV	Museum of Victoria, Melbourne, Victoria, Australia;
QM	Queensland Museum, South Brisbane, Queensland, Australia;
UNHC	University of New Hampshire Insect Collection, Durham, NH, USA.

One specimen of each species was mounted on a permanent microscope slide to observe the internal characters and fine external characters that are not apparent when using a dissecting microscope. Permanent microscopic slides were prepared using the techniques described by Hanley and Ashe (2003). Terminology and nomenclature for the descriptions follow Chandler (2001). Paired structures such as fovea are treated as singular. The morphological right and left of parameres refer to orientation on the illustrations. Decimal degrees were used for the format of geographical coordinates. Holotypes are deposited in ANIC, and paratype depositions are indicated parenthetically. Specimen label data for the holotypes is transcribed verbatim. Data for paratypes are standardized for consistency. The map of Australia is based on an image from SimpleMappr (Shorthouse 2010) that was subsequently modified to add locality marks.

Systematics

Family Staphylinidae Latreille, 1802

Subfamily Pselaphinae Latreille, 1802

Supertribe Faronitae Reitter, 1882

Genus *Logasa* Chandler, 2001

<http://zoobank.org/14006A6B-F528-41B1-94FF-03871A4617C5>

Logasa Chandler, 2001: 47.

Type species. *Logasa novaeanglia* Chandler (designated by Chandler 2001: 47).

Diagnosis. Members of this genus are easily separated from other faronite genera by the following combination of characters: head with long frontal sulcus, closed anteriorly (Fig. 2a); elytra rectangular and longer than wide, hind wings fully developed (Fig. 1a–d); mesoventrite with lateral mesosternal fovea, promesocoxal fovea, and lateral mesocoxal fovea (Fig. 2b), and round setal patch at center (Fig.

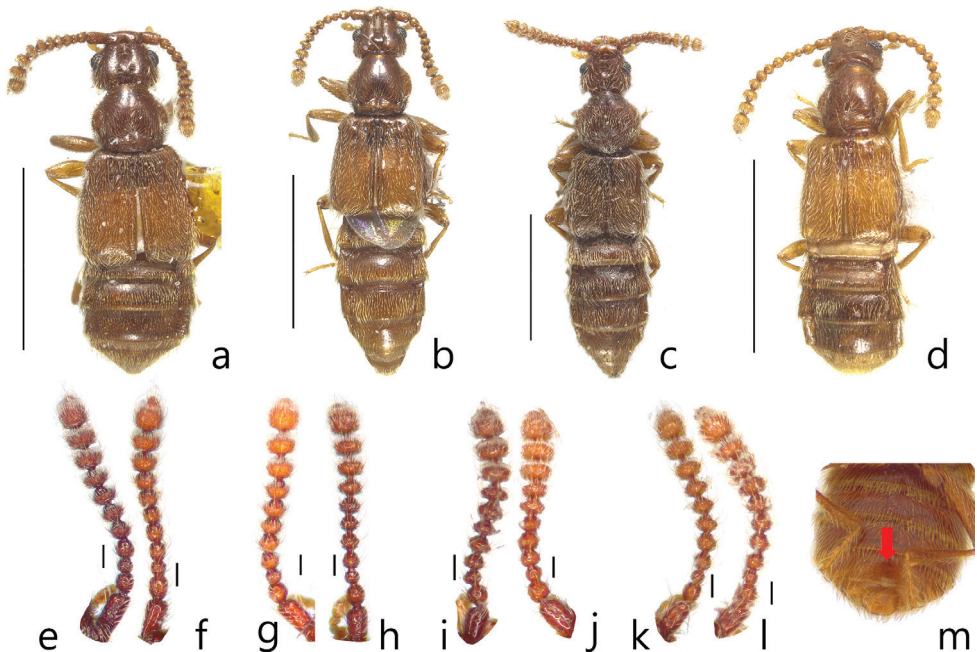


Figure 1. Habitus figures, dorsal view **a** *Logasa novaeanglia* Chandler **b** *L. newtoni* sp. nov. **c** *L. thayerae* sp. nov. **d** *L. comforti* sp. nov. Antennae *L. novaeanglia* Chandler: **e** male **f** female *L. newtoni* sp. nov.: **g** male **h** female *L. thayerae* sp. nov.: **i** male **j** female *L. comforti* sp. nov.: **k** male **l** female. Male abdominal venter of *L. comforti* sp. nov. **m** setose depression (arrow). Scale bars: 1 mm (**a–d**), 0.1 mm (**e–l**).

2b; arrow); metaventricle with metasternal fovea and median metasternal fovea (Fig. 2b); male abdominal ventrite VIII with setose depression (Fig. 1m) located at middle; abdominal ventrites without basolateral fovea; length of abdominal ventrites and tergites VI–VII longer than others (Fig. 1a–d); female abdominal ventrite IX with two pairs of long setae (Fig. 2c); parameres of male genitalia asymmetric and shorter than apical lobe (Fig. 3a–d); phallobase of median lobe rounded and asymmetric (Fig. 3a–d).

Distribution. Southeast Australia (New South Wales, Victoria, Tasmania).

Comments. All specimens, both male and female, of the genus *Logasa* have fully-developed hind wings, and many specimens were collected by flight intercept traps. Members of this genus are usually found in temperate or rainforest habitats in southeastern Australia. Male specimens have a setose depression located at the middle of abdominal ventrite VIII as a secondary sexual character, but this is not easily observed on some specimens. Abdominal ventrite IX is important for recognizing the sex of specimens: in males ventrite IX is usually fragile and partially concealed by ventrite VIII; in females it is more robust, triangular and bears a pair of long setae (Park and Carlton 2014).

Key to species of the genus *Logasa* Chandler

The key is mainly based on male genitalia because most species are indistinguishable based on external morphology.

- 1 Antennomeres II and IV subquadrate (Fig. 1i–j); right paramere of male genitalia divided into two lobes (Fig. 3c, long arrow); found in Tasmania and Victoria (Fig. 4: triangle).....***Logasa thayerae* sp. nov.**
- Antennomeres II and IV longer than wide (Fig. 1e–h, k–l); right paramere of male genitalia not divided (Fig. 3a–b, d) **2**
- 2 Apical portion of median lobe of male genitalia not branched (Fig. 3b); left paramere of male genitalia curved to left (Fig. 3b, short arrow); found in New South Wales and Victoria (Fig. 4: circle) ***L. newtoni* sp. nov.**
- Apical portion of median lobe of male genitalia branched (Fig. 3a, d); left paramere of male genitalia less curved (Fig. 3a, d) **3**
- 3 Apical lobe of male genitalia forked into two lobes, major lobe longer than three branches (Fig. 3a); right paramere of male genitalia twice as wide as left (Fig. 3a); found in New South Wales (Fig. 4: square).....***L. novaeanglia* Chandler**
- Apical lobe of male genitalia with three branches extending from right side (Fig. 3d); right paramere of male genitalia slightly broader than left or as wide as left (Fig. 3d); found in Tasmania and Victoria (Fig. 4: diamond).....***L. comforti* sp. nov.**

***Logasa novaeanglia* Chandler, 2001**

<http://zoobank.org/CC8FB01A-83D3-4674-8D98-BF2E4441FAE7>

Logasa novaeanglia Chandler, 2001: 49.

Type material examined. Paratypes ($N = 16$; 5 males, 11 females). **Australia: New South Wales (NSW):** 1♂ (aedeagus dissected and placed in micro-vial, UNHC), New England National Park, Wright's Lookout Trail, 1300 m, 27 II–6 III 1980, *Nothofagus moorei* rainforest, A. Newton, M. Thayer, window trap; 1♂ (UNHC), 1320 m, 15–27 II 1993, D. S. Chandler, FIT, cool temperate rainforest; 1♀ (UNHC), 2–17 IV 1993, D. S. Chandler, FIT, cool temperate rainforest; 1♀ (UNHC), 28 II–14 III 1993, D. S. Chandler, FIT, cool temperate rainforest; 1♀ (UNHC), 1330 m, 17 V 1993, D.S. Chandler, *Nothofagus moorei* leaf litter; 2♂♂ 2♀♀ (1♂ 2♀♀ in UNHC, 1♂ in QM), Styx River State Forest, Cedar Pit Floral Reserve, 42 km south east Wollomombi, 935 m, 25 II–15 III 1993, D.S. Chandler, FIT, old temperate rainforest; 1♂ (UNHC), 16 III–4 IV 1994, D.S. Chandler, FIT, old temperate rainforest; 1♀ (UNHC), 3–15 II 1993, K. MacGregor, FIT, old temperate rainforest; 1♀ (ANIC), 20 IV–12 V 1993, D.S. Chandler, FIT, old temperate rainforest; 1♂ (UNHC), 40 km south east Wollomombi, 990 m, 16 III–4 IV 1993, D.S. Chandler, FIT, old wet sclerophyll; 1♀ (ANIC), 2–14 XII 1993, K. MacGregor, FIT, old wet sclerophyll; 1♀ (ANIC), 6 XI–1 XII 1993, K. MacGregor, FIT, old wet sclerophyll; 1♀ (ANIC), 25 II–15 III 1993, D.S. Chandler, FIT, old wet sclerophyll; 1♀ (ANIC), 15 X–5 XI 1993, K. MacGregor, FIT, old wet sclerophyll.

Additional materials ($N = 26$; 10 males, 16 females). **Australia: NSW:** 6♂♂ 14♀♀ (2♂ aedeagus dissected and mounted in Euparal on clear plastic card, FMNH), New England National Park, Robinson's Knob Road, 1 km east Park Gate, 1320 m, 30.30S, 152.24E, 29 XII 1986–14 I 1987, *Nothofagus moorei* forest, A. Newton & M. Thayer 781, FMHD#86-689, FIT & window; 1♂ (FMNH), 1305 m; 30.30S, 152.24E, 29 XII 1986, *Nothofagus moorei* forest, A. Newton & M. Thayer 780, FMHD#86-688, berlese, leaf & log litter, forest floor; 3♂♂ 2♀♀ (CBNUIC), 29 XII 1986–14 I 1987, *Nothofagus moorei* forest, A. Newton & M. Thayer 780, FMHD#86-686, flight intercept (window) trap.

Diagnosis. This species can be distinguished from the other species of the genus *Logasa* by the following combination of characters: antennomeres II and IV rectangular and longer than wide (Fig. 1e–f), apical lobe of male genitalia forked into two lobes, major lobe longer with three branches, parameres with over ten setae, and right lobe shorter and wider (Fig. 3a).

Description. Length 2.1–2.5 mm. Body yellowish to reddish-brown (Fig. 1a). *Head.* Head triangular with frontal fovea and vertexal foveae. Antennomeres with tubercles and long setae (Fig. 1e–f). Antennomere I elongate, II rectangular, III subquadrate and smallest, IV rectangular, V rhombic, VI–X gradually transverse (Fig. 1e–f). *Tho-*

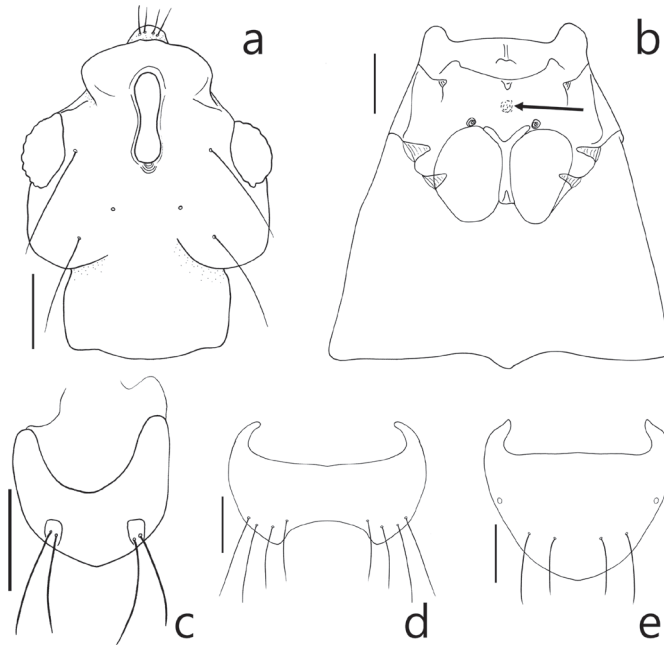


Figure 2. *Logasa newtoni* sp. nov. **a** head, dorsal view **b** meso- and metaventrite, ventral view **c** female abdominal ventrite IX, ventral view **d** male abdominal ventrite VIII, ventral view **e** male abdominal tergite VIII, dorsal view. Scale bar: 0.1mm.

rax. Pronotum with deep sulcus and pair of lateral antebasal foveae. Each elytron with basal elytral foveae and discal elytral foveae. *Abdomen*. Tergite IV with pair of transverse patches of microtrichia (Fig. 1a). *Aedeagus*. Apical lobe of male genitalia forked into two lobes, major lobe longer with three branches, minor lobe short and simple (Fig. 3a). Phallobase of median lobe asymmetric and rounded (Fig. 3a). Parameres asymmetric with over ten setae, left paramere longer and narrower than right (Fig. 3a).

Distribution. New South Wales (Fig. 4: square).

Habitat. Specimens of this species were collected using flight intercept traps, window traps, or by sifting leaf and log litter in wet sclerophyll forests.

***Logasa newtoni* Kang, Chandler & Park, sp. nov.**

<http://zoobank.org/66785C9A-2DA5-4593-A9EA-BB78B2DA22AA>

Type material. *Holotype*. **Australia: NSW:** ♂ (ANIC), “AUSTRALIA: NSW., / Brown Mtn. Floral / Res., 0.5 km SSW / Cochrane Dam, 940 m” “II – 8/ 22 – 1993 / A Newton & M Thayer / cool temp. rainfor / window trap”. *Paratypes* ($N = 83$; 25 males, 58 females). **Australia: NSW:** 1♂2♀♀ (FMNH), Brown Mountain Flora Reserve, 0.5 km SSW Cochrane Dam, 950 m, 36.35S, 149.27E, 20 XII 1986, warm-temperate rainforest, A. Newton & M. Thayer 767, FMHD #86-650, berlese, leaf &

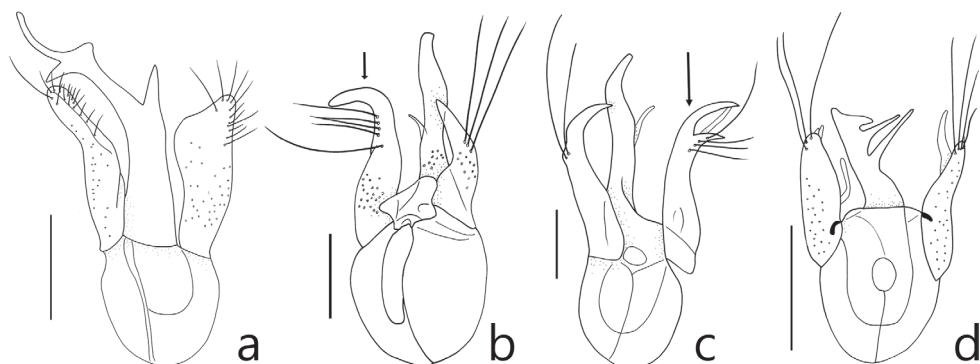


Figure 3. Aedeagi, dorsal view **a** *Logasa novaeanglia* Chandler **b** *L. newtoni* sp. nov. **c** *L. thayerae* sp. nov. **d** *L. comforti* sp. nov. Scale bar: 0.1 mm.

log litter, forest floor; 6♂♂ 41♀♀ (3♂♂ aedeagus dissected and mounted in Euparal on clear plastic card, 1♀ slide mounted, FMNH), 20 XII 1986–15 II 1987, warm-temperate rainforest, A. Newton & M. Thayer 767, FMHD#86-648, FIT & window; 13♂♂ 12♀♀ (1♂ aedeagus dissected and mounted in Euparal on clear plastic card, 1♂ slide mounted, 1♂ 2♀♀, CBNUIC; 10♂♂ 10♀♀, UNHC), 940 m, 8–22 II 1993, A. Newton & M. Thayer, cool temperate rainforest, window trap; 3♀♀ (UNHC), Brown Mountain, 853 m, 30 III 1967, rainforest, RWT, RJB, ANIC Berlesate No. 20 leafmould; 1♂ (aedeagus dissected and placed in micro-vial, left paramere damaged, ANIC), ca. 914 m, 9 XII 1967, rainforest, Taylor & Brooks, ANIC Berlesate No. 42 leafmould; 1♂ (aedeagus dissected and placed in micro-vial, left paramere damaged, ANIC), Rutherford Creek, 9 I 1968, rainforest, M. Upton, ANIC Berlesate No. 55 leafmould; 1♂ (ANIC), nr Nimmitabel, Rutherford Creek, 910 m, 26 V 1970, RWT & R. Bartell, rainforest, ANIC Berl. #287; **Victoria (VIC):** 1♂ (aedeagus dissected and mounted in Euparal on clear plastic card, MV), Road C187, 15 km west Dartmoor, 1 VIII 2012, ground moss, blackwood stringybark forest.

Diagnosis. This species can be distinguished from the other *Logasa* species by the following combination of characters: antennomeres II and IV rectangular and longer than wide (Fig. 1g–h), apical lobe of male genitalia not divided, left paramere of male genitalia curved to left (Fig. 3b).

Description. Length 1.6–2.5 mm. Body yellowish to reddish-brown (Fig. 1b). *Head.* Head triangular with frontal fovea and vertexal foveae. Antennomeres with tubercles and long setae (Fig. 1g–h). Antennomere I elongate, II rectangular, III subquadrate and smallest, IV rectangular, V–VII rhombic, VIII–X gradually transverse (Fig. 1g–h). *Thorax.* Pronotum with deep sulcus and pair of lateral antebasal foveae. Each elytron with basal elytral foveae and discal elytral foveae. *Abdomen.* Tergite IV with pair of transverse patches of microtrichia (Fig. 1b). *Aedeagus.* Apical lobe of male genitalia not branched (Fig. 3b). Phallobase of median lobe asymmetrical and rounded (Fig. 3b). Parameres of male genitalia asymmetrical, left longer than right and curved to left (Fig. 3b).

Distribution. New South Wales, Victoria (Fig. 4: circle).

Etymology. This species is named for one of the co-collectors of the holotype and world-renowned beetle specialist, Alfred F. Newton.

Habitat. Most specimens of this species were collected using flight intercept traps, window traps, or by sifting leaf and log litter in temperate forest or rainforest habitats.

***Logasa thayerae* Kang, Chandler & Park, sp. nov.**

<http://zoobank.org/E70F5324-AF5F-4A20-9B1D-DC613B4A08FB>

Type material. Holotype. **Australia: VIC:** ♂ (MV), aedeagus dissected in micro-vial, “AUSTRL.: VIC.: Otway N.P., / Malts Rest, 260 m / 38.45S 143.33E / 25.I–8.II.1987 / wet scleroph. - *Noth. cunn.*” “A. Newton & M. Thayer 807 / FMHD #87-206 / flight intercept / (window) trap”. **Paratypes** (*N* = 6; 2 males, 4 females). **Australia: VIC:** 1♂ 2♀♀ (1♂ aedeagus dissected and whole body placed in micro-vial, 1♀ slide mounted, UNHC), 10 km east of Maryville, 27 XI 1986, D. Burckhardt; 1♀ (UNHC), Belgrave, V.F.E. Wilson, I 1922, fallen leaves (MV); **Australia: Tasmania (TAS):** 1♂ (aedeagus dissected and whole body placed in micro-vial, MV), Zeehan, 16 IV 1895; 1♀ (MV), Mt. Wellington, I 1948, C. Oke.

Diagnosis. This species can be distinguished from the other *Logasa* species by the following combination of characters: antennomeres II and IV subquadrate (Fig. 1i–j), apical lobe of male genitalia not divided, left paramere of male genitalia curved to right, and right paramere divided into two lobes apically and curved to right (Fig. 3c).

Description. Length 2.0–2.3 mm. Body yellowish to reddish-brown with long setae (Fig. 1c). **Head.** Head triangular with frontal fovea and vertexal foveae. Antennomeres with tubercles and long setae (Fig. 1i–j). Antennomere I elongate, II–IV subquadrate, III smallest, V–VI rhombic, VII–X gradually transverse (Fig. 1i–j). **Thorax.** Pronotum with the deep sulcus and pair of lateral antebasal foveae. Each elytron with basal elytral foveae and discal elytral foveae. **Abdomen.** Tergite IV with patches of microtrichia (Fig. 1c). **Aedeagus.** Apical lobe of male genitalia not branched (Fig. 3c). Phallobase of median lobe asymmetrical and rounded (Fig. 3c). Left parameres of male genitalia curved to right (Fig. 3c). Right paramere divided into two lobes apically and curved to right (Fig. 3c).

Distribution. Tasmania, Victoria (Fig. 4: triangle).

Etymology. This species is named for one of the co-collectors of the holotype and world-renowned beetle specialist, Margaret K. Thayer.

Habitat. Most specimens of this species were collected using flight intercept (window) traps in wet sclerophyll forests.

***Logasa comforthi* Kang, Chandler & Park, sp. nov.**

<http://zoobank.org/5268E63A-440F-4E4B-B861-078605AA90E3>

Type material. Holotype. **Australia: TAS:** ♂ (ANIC), “43.25S 146.10E TAS / Melaleuca near / Bathurst Harbour / 15 Apr.–29 May 1991 / M. Comfort F.I.T.#1”, “F.I.T. /

ANIC 1185 / closed forest". **Paratypes** ($N = 6$; 3 males, 3 females). **Australia: TAS:** 1♂ 1♀ (ANIC), Melaleuca near Bathurst Harbour, 43.25S, 146.10E, 15 IV–29 V 1991, M. Comfort, FIT#1, ANIC 1185, closed forest; 1♀ (ANIC), 29 V–29 VIII 1991, M. Comfort, FIT#1, ANIC 1190, closed forest; 1♂ (aedeagus dissected and mounted in Euparal on clear plastic card, ANIC), 29 VIII–28 XI 1991, I. Naumann & G. Clarke, FIT#1, closed forest, ANIC 1202; 1♀ (ANIC), 15 III–15 IV 1991, E. Edwards, J. Berry, FIT#1, ANIC 1179, closed forest; **VIC:** 1♂ (aedeagus dissected in micro-vial, MV), Ballarat, C. Oke.

Diagnosis. This species can be distinguished from the other *Logasa* species by the following combination of characters: antennomeres II and IV rectangular and longer than wide (Fig. 1k–l), apical lobe of male genitalia with three branches bearing to right, left paramere broader than right (Fig. 3d).

Description. Length 1.6–1.9 mm. Body yellowish to reddish-brown (Fig. 1d). **Head.** Head triangular with frontal fovea and vertexal foveae. Antennomeres with tubercles and long setae (Fig. 1k–l). Antennomere I elongate, II rectangular, III subquadrate, IV rectangular, V–VI rhombic, VII–X gradually transverse (Fig. 1k–l). **Thorax.** Pronotum with deep and distinct pit in the middle and lateral antebasal foveae. Each elytron with basal elytral foveae and discal elytral foveae. **Abdomen.** Tergite IV with patches of microtrichia (Fig. 1d). **Aedeagus.** Apical lobe of male genitalia with three branches bearing to right (Fig. 3d). Phallobase of aedeagus asymmetric and rounded (Fig. 3d). Left paramere broader than right (Fig. 3d).

Distribution. Tasmania, Victoria (Fig. 4: diamond).

Etymology. This species is named for the collector of the holotype, C. Comfort.

Habitat. Most specimens of this species were collected using flight intercept traps in forests.

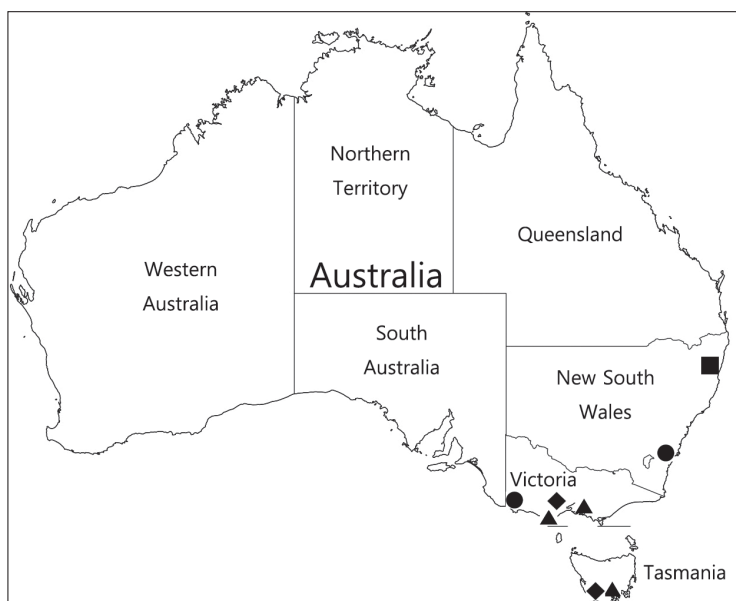


Figure 4. Collection localities of *Logasa novaeanglia* Chandler: square *L. newtoni* sp. nov.: circle *L. thayerae* sp. nov.: triangle *L. comforti* sp. nov.: diamond.

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Taxonomy of *Cyrtomorphus* Lacordaire (Coleoptera, Erotylidae, Tritomini) from China

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Abstract

In this paper, a key to separate the Chinese species of genus *Cyrtomorphus* Lacordaire is provided for the first time. A new species, *Cyrtomorphus rufobrunneus* **sp. nov.**, is described and illustrated, and one species, *Cyrtomorphus connexus* Gorham, 1896 is newly recorded to China.

Keywords

Cucujoidea, description, key, new species.

Introduction

The genus *Cyrtomorphus* was established by Lacordaire (1842) for *Cyrtomorphus pantherinus* Lacordaire, 1842, which is mainly distributed in the Oriental region. This genus can be distinguished from other genera in the tribe Tritomini Curtis, 1834 by the following characters: body oval or broadly ovate, distinctly convex on the dorsum, antennomere XI small, compound eye small and finely faceted, lateral walls of oral cavity forming flattened plates; males of some species with a row protuberance on inner surface of middle tibia.

The genus *Cyrtomorphus* (Coleoptera, Erotylidae, Tritomini) included 35 species worldwide (Boyle 1956; Delkeskamp 1981; Chûjô and Chûjô 1990; Alvarenga 1994; Wegrzynowicz 2007) with five species known from China. *Cyrtomorphus yunnanus* Mader was described from Yunnan (Mader 1937). *Cyrtomorphus duodecimmaculatus* Araki was described from Taiwan (Araki 1941). Later, *Cyrtomorphus chinensis* Mader and *Cyrtomorphus duxoides* Mader were described from Fujian (Mader 1955). *Cyrtomorphus liui* Chûjô was described from Taiwan (Chûjô 1967).

Before the present study, all taxonomic research on *Cyrtomorphus* in China was at least 50 years ago. But recently, specimens of *Cyrtomorphus* were collected and deposited in Museum of Hebei University (MHU). One new species was found among 52 specimens, *Cyrtomorphus rufobrunneus* sp. nov., from Guizhou Province, and is described and illustrated. A second species, *Cyrtomorphus connexus* Gorham, 1896, is recorded from China for the first time. Additionally, a key to the seven species from China is included.

Materials and methods

The abdominal segments and the genitalia were detached from the body after softening in hot water. Male or female genitalia were put in 5% NaOH boiling solution for 5 minutes and then cleaned with distilled water. Morphological characters were observed using a Nikon SMZ800N stereomicroscope. Photographs were taken with Cannon Eos 5D Mark III camera and Canon EF 100mm f/2.8L Macro IS USM lens and modified with Adobe Photoshop CC 2016. The species distribution was inferred from examined materials and published records. The specimens studied were deposited in MHU.

Taxonomy

Key to the species of *Cyrtomorphus* from China

- | | | |
|---|--|-----------------------------------|
| 1 | Pronotum coloration uniformly black..... | <i>C. yunnanus</i> Mader |
| – | Pronotum coloration not monochrome, with color pattern | 2 |
| 2 | Pronotum, except for the outer margin, brownish black..... | |
| | | <i>C. rufobrunneus</i> sp. nov. |
| – | Pronotum with two or more patches..... | 3 |
| 3 | Four black spots on pronotum..... | <i>C. connexus</i> Gorham |
| – | Two black flecks in the pronotum..... | 4 |
| 4 | Elytron with four black marks..... | 5 |
| – | Elytron with five black marks..... | 6 |
| 5 | Pronotum with two spots on basal margin | <i>C. chinensis</i> Mader |
| – | Pronotum with two spots on frontal margin | <i>C. duxoides</i> Mader |
| 6 | Elytron suture with two united patches..... | <i>C. liui</i> Chûjô |
| – | Elytron suture without united patches | <i>C. duodecimmaculatus</i> Araki |

***Cyrtomorphus rufobrunneus* Jia & Li sp. nov.**

<http://zoobank.org/4AF1346E-6111-4E4E-B180-954869AE2800>

Figures 1–14

Type material. Holotype. CHINA: ♂; fully matured beetle (MHUB01223). Guizhou, Libo County, Maolan National Nature Reserve, 25.3112N, 108.0761E, alt: 755m, 20 July 2015, Caixia Yuan leg.

Paratypes. CHINA: 2 ♂♂, 2 ♀♀, (MHUB01224–MHUB01227), same data as for holotype.

Diagnosis. Body oval convex, widest at base of elytra. General color red-brown, legs and antennae black, antennomere I and II paler, pronotum except the outer margin brownish black, each elytron with a brownish-black band. Clypeus with the anterior border emarginated, clypeofrontal sulcus completed. Antennomere III about 1.5 times as long as IV; relative lengths of antennomeres II–XI: 40: 100: 62: 55: 55: 52: 50: 125: 105: 70. Terminal segment of maxillary palpus asymmetrical triangular, nearly half as long as wide. Pronotum with anterior border directly opposite head, slightly projecting forwards in the middle. Pro-, meso-, and metacoxal lines present.

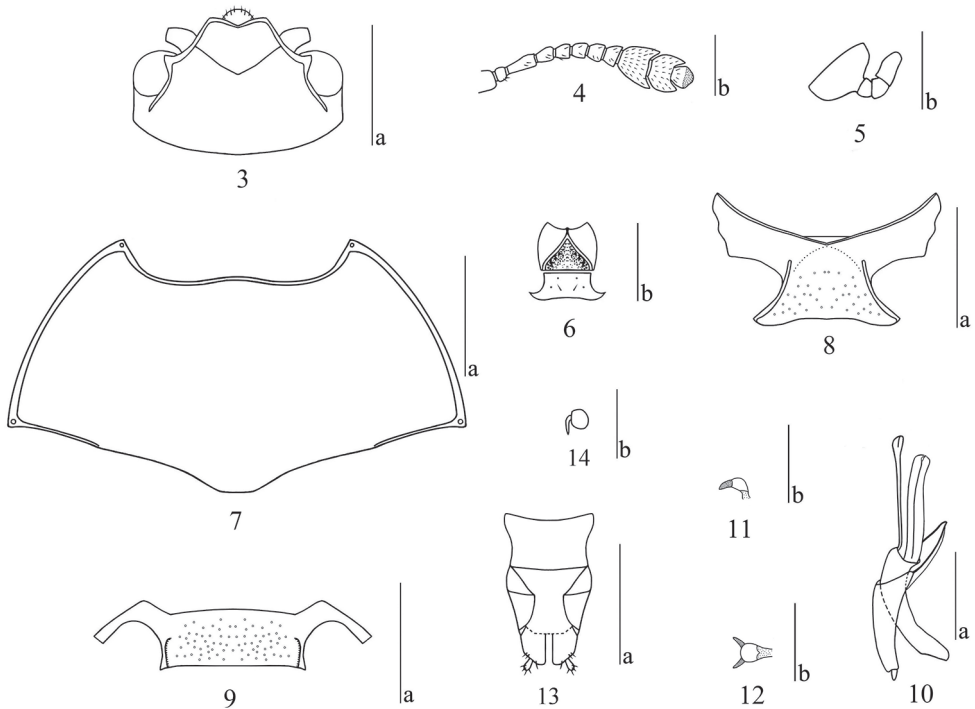
Description. Length: 7.0–9.5 mm, width: 4.5–6.0 mm. Body oval, almost hemispherical, convex, shiny and smooth, widest at base of elytra, general color red-brown, legs and antennae black (antennomeres I–II paler). Pronotum except the outer margin brownish black. Markings on pronotum can differ depending on age; some with a broad, lateral, brownish-black band that almost reaches front and basal margin. Scutellum red-brown, both sides darker. One brownish black band on each elytron, with the color becoming paler from base to apex (Figs 1, 2).

Head (Fig. 3) small; strongly and sparsely punctured on vertex, vertex puncture size approximately 2 times facet diameter, separated by 2–3 diameters. Clypeus strongly and closely punctured, clypeal puncture size same as facet, nearly coalescing; anterior border obviously emarginated; clypeofrontal sulcus completed. Eyes small, moderately prominent and finely faceted; interocular distance 0.70 times width of head. Antennae (Fig. 4) short, extending to basal three-fourths of pronotum, with short, pale-yellow setae; antennomere II round; antennomere III nearly 1.6 times as long as IV; antennomeres IV to VIII subequal, antennomeres VII and VIII slightly wider than VI; antennomere IX bowl-shaped; antennomere X broadly crescent-shaped; antennomere XI small, almost scallop-shaped, half surrounded by antennomere X; relative lengths of antennomeres II–XI: 40: 100: 62: 55: 55: 52: 50: 125: 105: 70. The terminal segment of maxillary palp (Fig. 5) subtriangular, asymmetrical in lateral view, length about 0.5 times as long as width. Mentum (Fig. 6) with pentagonal plate, both sides margined, with middle area depressed; submentum finely and sparsely punctured, with a few setae.

Pronotum (Fig. 7) transverse, widest at basal (pronotum length/width ratio 0.52); lateral border slightly curved, margined; anterior border opposite head, with slightly forward projection in the middle, with fine margin; basal border weakly sinuate, with margins on both sides. Punctures on pronotum similar to vertex, puncture size 2 times facet, separated by 2–3 diameters on both sides, decreasing in size and density toward



Figures 1,2. Dorsal habitus of *Cyrtomorphus rufobrunneus* sp. nov. **1** holotype **2** paratype (MHUB01224). Scale bars: 1.00 mm.



Figures 3–14. *Cyrtomorphus rufobrunneus* sp. nov. **3** head **4** antenna **5** maxillary palpus **6** mentum **7** pronotum **8** prosternum **9** mesoventricle **10** male genitalia in lateral view **11**, **12** lateral and dorsal views of anterior end of male flagellum **13** female genitalia in ventral view **14** female spermatheca. Scale bars: 1 mm (a), 0.5 mm (b).

median area, disc puncture size same as facet, separated by 3–4 diameters. Anterior angle and posterior angle projecting, each with a pore.

Scutellum heart-shaped, with fine punctures.

Elytra widest at base, EL/EW ratio 1.1, gradually narrowing to apex. Each elytron with six or seven indistinct striae; intervals finely punctured.

Prosternum (Fig. 8) with textured surface laterally; fine and sparse punctures medially, with golden setae. Prosternal process broad, produced to an indistinct point anteriorly, and emarginated at posterior border; prosternal lines straight, converging and extending to the front edge of coxae.

Mesoventrite (Fig. 9) broad, each side with a shallow depression, sternum with coarse punctures, size 2 times facet.

Metaventricle coarsely and sparsely punctured in the middle, without punctures on each side of base, with a longitudinal depression on posterior 5/6; coxal lines extending to basal one-third of metaventricle.

Abdomen with coarse and dense punctures laterally, puncture size 2.5 times facet; punctures smaller medially, 0.5 times facet, with short golden setae; long coxal lines on first ventrite nearly attaining posterior border.

Male genitalia (Fig. 10) with median lobe weakly curved, narrowing from one-half to two-thirds, then gradually widening to 5/6; from here narrowing to a blunt point; median strut as long as median lobe; flagellum short, length = 0.85× median lobe length; sclerite at anterior end of flagellum as in Figures 11, 12.

Female genitalia (Fig. 13) with narrow styli at apex of coxite, covered with setae at apex. Female spermatheca (Fig. 14) almost round.

Middle tibia of male without a row of protuberances on the inner surface.

Distribution. China: Guizhou.

Remarks. *Cyrtomorphus rufobrunneus* sp. nov. is similar to *Cyrtomorphus duodecimaculata* Araki, 1941 in its form and body color. The new species can be distinguished by each elytron bearing a brownish-black band, the pronotum having a projecting posterior angle, the prosternal lines straight, and males without a row of protuberances on the inner surface of middle tibia. In contrast, *Cyrtomorphus duodecimaculata* has five black marks on each elytron, the pronotum has obtuse posterior angles, the prosternal lines curved, males have a row protuberances on the inner surface of the middle tibia.

Etymology. The species is named for the red-brown body color.

Cyrtomorphus connexus Gorham, 1896

Cyrtomorphus connexus Gorham, 1896: 286.

Material examined. CHINA: 3♂♂, 4 ♀♀, Yunnan, Mengla County, Mohan Town, 21.0624N, 102.3077E, 3–4 July 2006, Guodong Ren, Wenjun Hou & Yalin Li (MHU) leg.

Distribution. New for China (Yunnan), Burma.



Figures 15, 16. Dorsal habitus of *Cyrtomorphus connexus* Gorham, 1896 **15** elytra with black spot enclosed **16** elytra with open black spot. Scale bars: 1 mm.

Comparative notes. The original description was based on the unique type specimen from Karen Hills, Burma (Gorham 1896). Considerable interspecific variability of *C. connexus* was observed in external characters such as body size, coloration, punctuation, and stripes of the head, pronotum, and elytra (Figs 15, 16). It is recorded here from Yunnan Province for the first time. Some specimens are similar to the type specimen, while others differ slightly with the black spot on elytra enclosed (Fig. 16). Arrow (1925) also pointed out that the black markings may be less united.

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