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Seven new freshwater species of *Gammarus* from southern China (Crustacea, Amphipoda, Gammaridae)

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Abstract

Seven new species of the genus *Gammarus* are described and illustrated from southern China. The new species *Gammarus vallecula* Hou & Li, **sp. n.**, *G. qinling* Hou & Li, **sp. n.**, *G. zhigangi* Hou & Li, **sp. n.** and *G. jidutanxian* Hou & Li, **sp. n.** are characterized by inner ramus of uropod III half the length of outer ramus. *Gammarus longdong* Hou & Li, **sp. n.** is characterized by inner ramus of uropod III 0.9 times as long as outer ramus. *Gammarus mosuo* Hou & Li, **sp. n.** is characterized by pereopods V–VII with long setae on anterior margins and both rami of uropod III armed with simple setae. *Gammarus caecigenus* Hou & Li, **sp. n.** can be distinguished from other species by eyes absent. DNA barcodes of the new species are documented as proof of molecular differences between species. A key to the new species and a map of their distributions are provided.

Keywords

Cave, DNA barcoding, morphology, new species, taxonomy

Introduction

The genus *Gammarus* Fabricius, 1775 contains more than 200 freshwater, brackish, and marine species in the Northern Hemisphere (Väinölä et al. 2008), of which 80% species inhabit fresh waters. They are essential components of freshwater ecosystems, often forming bioindicators for water quality assessment (Gerhardt et al. 2011). Previous studies suggested that *Gammarus* originated from the ancient Tethys, then diversified in Eurasia driven by plate tectonic activities between Eurasia and Africa/India (Hou et al. 2011). In China, 76 species of *Gammarus* have been recorded and phylogenetic analysis indicated that Tibetan uplift triggered the separation of north and south lineages (Hou et al. 2007). The new species described in current paper belong to south lineage.

In the last 15 years several collecting trips were carried out in southern China including Qinling, Daba Mountain, and Yunnan-Guizhou Plateau. This effort allowed the collection of many freshwater *Gammarus*, and was followed by the preliminary description of some new species (Hou and Li 2010, Hou et al. 2013, Li et al. 2013). However, detailed morphological examination and molecular studies of this material revealed a further species diversity that was previously underestimated. In the present paper, seven new species of the genus *Gammarus* from southern China are described and illustrated. A distribution map of new species is presented, as is a key to the new species.

Materials and methods

Sampling

The specimens were collected with a fine-meshed hand net. Samples were preserved in 95% ethanol in the field, and then deposited at -20 °C refrigerator for long preservation. Type specimens are lodged in the Institute of Zoology, Chinese Academy of Sciences (**IZCAS**), Beijing.

Morphological observations

The body length was recorded by holding the specimen straight and measuring the distance along the dorsal side of the body from the base of the first antenna to the base of the telson. All dissected appendages were mounted in glycerol on slides. Appendages were drawing using a Leica DM2500 compound microscope equipped with a drawing tube. Terminology and taxonomic descriptions follow Zhao et al. (2017). The nomenclature of setal patterns on the mandibular palp follows Cole (1980). The holotype specimen was used for morphological observation, while one paratype specimen was used for both morphological and molecular parts.

DNA sequencing and COI genetic distance calculations

A partial fragment of the mitochondrial cytochrome *c* oxidase subunit I (COI) was proposed as a crustacean barcode (Costa et al. 2007, Hou et al. 2009). The primers used are LCO1490 (5'-GGTCAACAAATCATAAAGATATTGG-3') and HCO2198 (5'-TAAACTTCAGGGTGACCAAAAAATCA-3') (Folmer et al. 1994). Genomic DNA extraction, amplification, and sequencing procedures were performed as in Hou et al. (2007). All sequences were deposited in GenBank, and the accession numbers are provided in Table 1.

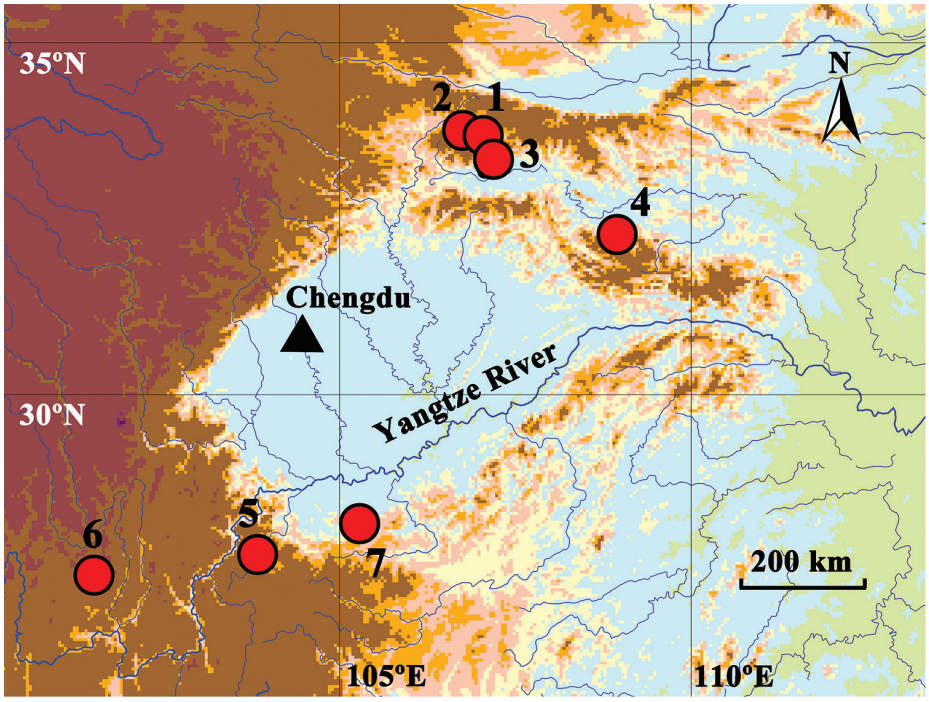

Figure 1. Collection localities of seven *Gammarus* species from southern China. **1** *Gammarus vallecula* Hou & Li, sp. n. **2** *G. qinling* Hou & Li, sp. n. **3** *G. zhigangi* Hou & Li, sp. n. **4** *G. jidutanxian* Hou & Li, sp. n. **5** *G. longdong* Hou & Li, sp. n. **6** *G. mosuo* Hou & Li, sp. n. **7** *G. caecigenus* Hou & Li, sp. n.

Table 1. GenBank accession numbers and uncorrected pairwise distance of the COI partial sequences between species in this text.

	Species	GenBank accession number	1	2	3	4	5	6
1	*Gammarus vallecula* Hou & Li, sp. n.	MG550237						
2	*Gammarus qinling* Hou & Li, sp. n.	MG550238	0.177					
3	*Gammarus zhigangi* Hou & Li, sp. n.	MG550239	0.207	0.209				
4	*Gammarus jidutanxian* Hou & Li, sp. n.	MG550240	0.251	0.270	0.243			
5	*Gammarus longdong* Hou & Li, sp. n.	MG550241	0.213	0.202	0.239	0.255		
6	*Gammarus mosuo* Hou & Li, sp. n.	MG550242	0.214	0.208	0.227	0.244	0.227	
7	*Gammarus caecigenus* Hou & Li, sp. n.	MG550243	0.264	0.274	0.275	0.275	0.288	0.254

Raw sequences were edited and assembled using MacClade 4.0 (Maddison and Maddison 2000), and uncorrected pairwise distances between sequences were calculated using MEGA 7.0.16 (Kumar et al. 2016) and are shown in Table 1.

Taxonomy

Family Gammaridae Leach, 1814

Genus *Gammarus* Fabricius, 1775

Type species. *Gammarus pulex* (Linnaeus, 1758)

***Gammarus vallecula* Hou & Li, sp. n.**
http://zoobank.org/6D34788A-7029-4933-9A27-855786E4F731
Figs 2–7

Material examined. Holotype: male (IZCAS-I-A1411-1), 8.5 mm, Liuba County (106.92°E, 33.61°N), altitude 1001 m, Hanzhong City, Shaanxi Province, China, October 23, 2013, collected by Yunchun Li and Jincheng Liu. Paratype: female (IZCAS-I-A1411-2), 7.8 mm, same data as holotype.

Etymology. The specific name alludes to its typical biotope, living in a valley; adjective.

Diagnosis. Antenna II with setae along peduncle articles and flagellum, calceoli absent; merus to propodus of pereopods III and IV with short straight setae on posterior margins; epimeral plate II with blunt posterodistal corner; epimeral plate III with subacute posterodistal corner; uropod III inner ramus reaching 0.5 times the length of outer ramus, second article of outer ramus subequal to adjacent spines, both rami with a few plumose setae on inner margins.

Description of holotype male (IZCAS-I-A1411-1). 8.5 mm.

Head (Fig. 2A): eyes reniform, inferior antennal sinus deep, lateral cephalic lobe rounded.

Antenna I (Fig. 2B, C): peduncle articles I–III in length ratio 1.0: 0.7: 0.4, with distal setae; flagellum with 26 articles, articles IV–XX with aesthetascs; accessory flagellum with four articles; both primary and accessory flagella with short distal setae.

Antenna II (Fig. 2D): peduncle articles III–V in length ratio 1.0: 2.5: 2.3, peduncle article III with setae on lateral margin, articles IV and V of peduncle with clusters of lateral and medial setae; flagellum with ten articles, each article with long setae; calceoli absent.

Upper lip (Fig. 2E): ventral margin rounded, bearing short minute setae.

Mandible (Fig. 2G, H): left mandible incisor with five teeth; lacinia mobilis with four teeth; spine row with five pairs of plumose setae; articles I–III of palp in length ratio 1.0: 3.1: 1.9, second article of palp with 12 marginal setae, article III with four

A-setae, four B-setae, 16 D-setae, and five E-setae apically; incisor of right mandible with four teeth, lacinia mobilis bifurcate, with small teeth.

Lower lip (Fig. 2F): inner lobes lacking, outer lobes covered with thin setae.

Maxilla I (Fig. 2I, J): asymmetrical, left inner plate with nine plumose setae and two simple setae on medial margin; outer plate with 11 robust serrated apical spines, each spine with small teeth; second article of left palp with seven slender spines apically; second article of right palp with five stout spines, one slender spine and one stiff spine.

Maxilla II (Fig. 2K): inner plate with three simple setae and 11 plumose facial setae in an oblique row; inner and outer plates with long setae apically.

Maxilliped (Fig. 2L): inner plate with three stout apical spines and one subapical spine, 21 plumose setae along lateral margin; outer plate bearing a row of 14 blade spines and three plumose setae apically; article IV of palp hooked, with a group of setae at hinge of unguis.

Pereon. *Gnathopod I* (Fig. 3A, B): coxal plate bearing three setae and two setae on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins, and with three serrated spines accompanied by two setae on posterodistal corner; carpus 1.3 times as long as wide, 0.7 times as long as propodus, ventral margin bearing a cluster of simple setae and three clusters of serrated setae; propodus oval, palm with one medial spine and 12 spines on posterior margin and surface; dactylus with one seta on outer margin.

Gnathopod II (Fig. 3C, D): coxal plate bearing three setae and two setae on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins, and with three serrated spines accompanied by one seta on posterodistal corner; carpus 1.8 times as long as wide, 0.9 times as long as propodus, bearing seven clusters of setae along ventral margin, two clusters of setae on dorsal margin; propodus subrectangular, palm margin with one medial spine and three spines on lateral posterodistal corner; dactylus with one seta on outer margin.

Pereopod III (Fig. 4A, B): coxal plate bearing two setae on anterior margin and three setae on posterior margin; basis elongated, with setae along anterior and posterior margins; merus with long and straight setae on posterior margin and two spines on anterior margin, anterodistal corner with one spine accompanied by setae; carpus with five spines accompanied by setae on posterior margin, anterodistal corner with one spine and one seta; propodus with three spines accompanied by setae on posterior margin and two spines on posterodistal corner; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

Pereopod IV (Fig. 4C, D): coxal plate concave, bearing three setae on anterior margin and seven setae on posterior margin; basis with two setae on anterior margin, with clusters of setae on posterior margin; merus with clusters of long setae on posterior margin and one spine on anterior margin, anterodistal corner with one spine accompanied by setae; carpus with seven spines accompanied by setae on posterior margin, anterodistal corner with two spines accompanied by setae; propodus with two spines accompanied by setae on posterior margin and two spines on posterodistal corner; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

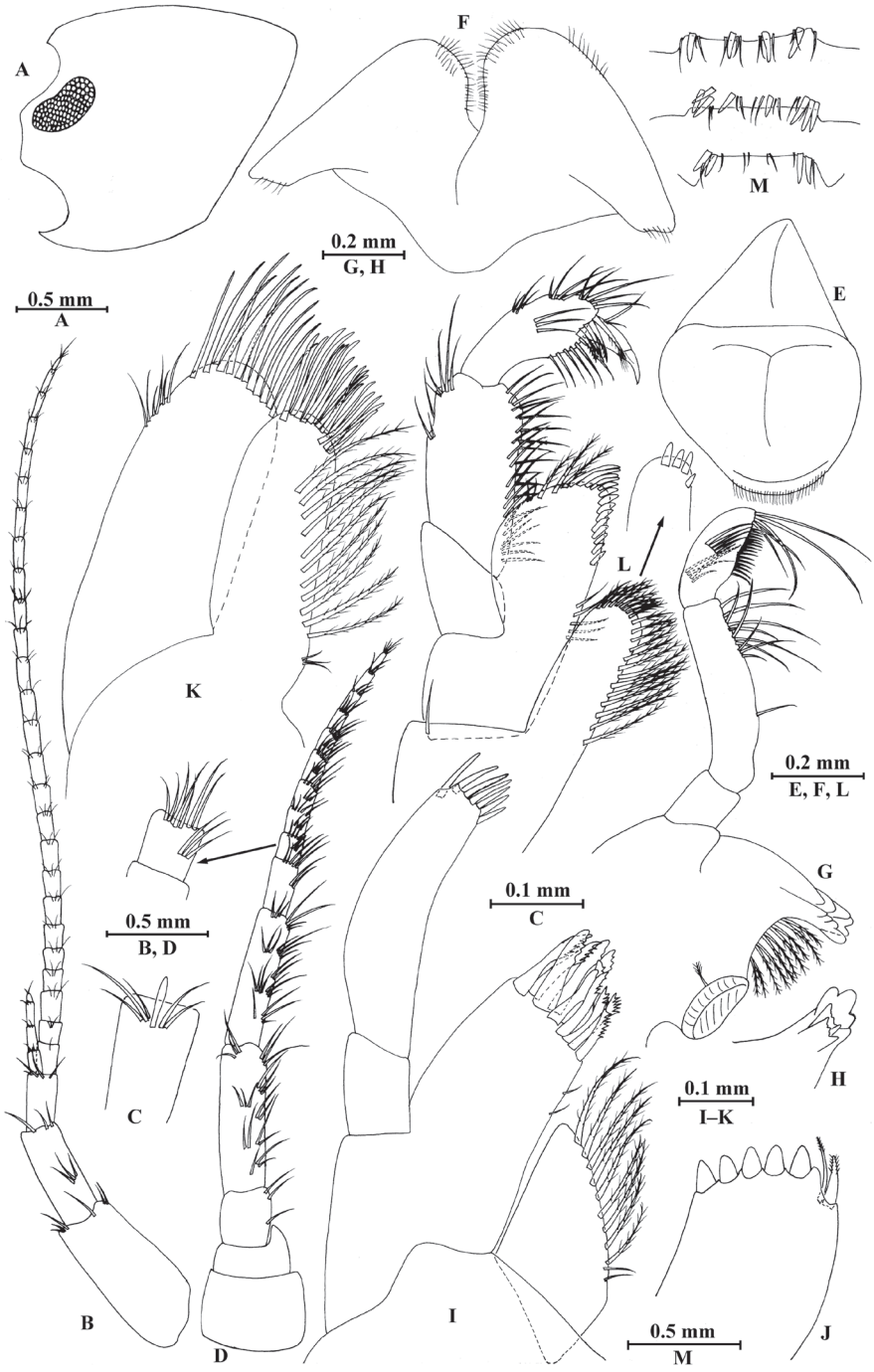

Figure 2. *Gammarus vallecula* Hou & Li, sp. n., male holotype. **A** head **B** antenna I **C** flagellar article of antenna I with aesthetasc **D** antenna II **E** upper lip **F** lower lip **G** left mandible **H** incisor and lacinia mobilis of right mandible **I** left maxilla I **J** distal part of palp article II of right maxilla I **K** maxilla II **L** maxilliped **M** dorsal margins of urosomites I–III.

Figure 3. *Gammarus vallecula* Hou & Li, sp. n., male holotype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C** gnathopod II **D** propodus and dactylus of gnathopod II.

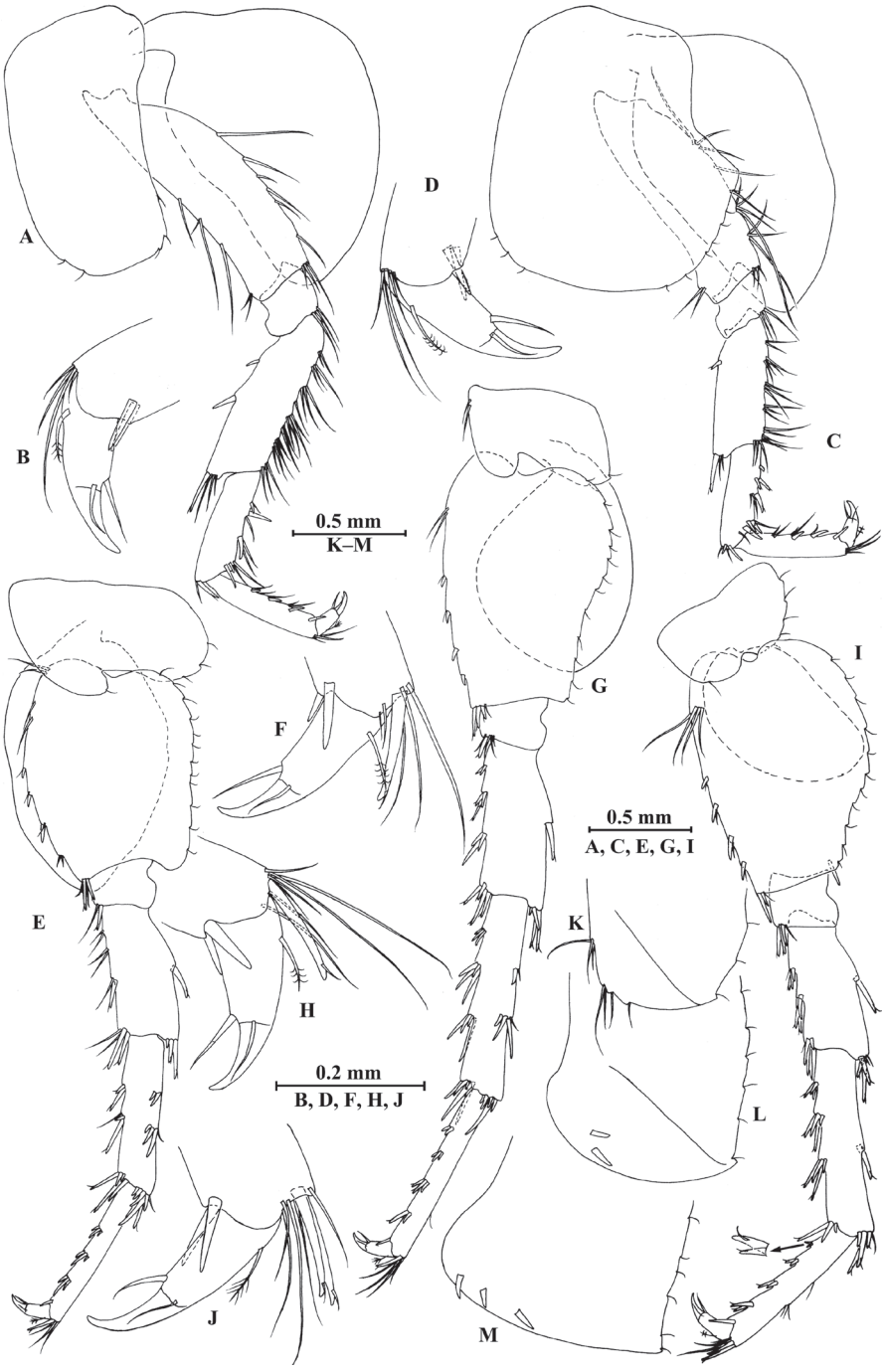

Figure 4. *Gammarus vallecula* Hou & Li, sp. n., male holotype. **A** pereopod III **B** dactylus of pereopod III **C** pereopod IV **D** dactylus of pereopod IV **E** pereopod V **F** dactylus of pereopod V **G** pereopod VI **H** dactylus of pereopod VI **I** pereopod VII **J** dactylus of pereopod VII **K** epimeral plate I **L** epimeral plate II **M** epimeral plate III.

Pereopod V (Fig. 4E, F): coxal plate bearing one seta on anterior margin and three setae on posterior margin; basis expanded, with four long setae and three spines accompanied by fine setae on anterior margin, anterodistal corner with two spines accompanied by two setae, posterior margin with a row of 12 setae; merus with one spine accompanied by setae on anterior margin and one spine on posterior margin, anterodistal corner with two spines accompanied by setae and posterodistal corner with three spines; carpus with two groups of spines on anterior and posterior margins each; propodus with three groups of spines on anterior margin; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Pereopod VI (Fig. 4G, H): coxal plate bearing two long setae and two fine setae on anterior and posterior margins, respectively; basis elongated, with two long setae and four spines accompanied by setae on anterior margin, anterodistal corner with three spines and one fine seta, posterior margin with a row of 12 fine setae; merus with three groups of spines and one spine on anterior and posterior margins, respectively, anterodistal and posterodistal corners with four spines each; carpus with three or two groups of spines on anterior and posterior margins, respectively; propodus with four groups of spines on anterior margin; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Pereopod VII (Fig. 4I, J): coxal plate bearing one seta on anterior margin and five setae on posterior margin; basis with four long setae and four spines accompanied by setae on anterior margin, anterodistal corner with two spines and a fine seta, posterior margin with a row of 11 setae, posterodistal corner with one spine; merus with two groups of spines on anterior margin and one spine on posterior margin, anterodistal and posterodistal corners with four and three spines, respectively; carpus with three groups of spines on anterior margin and one spine on posterior margin, anterodistal and posterodistal corners with three and four spines, respectively; propodus with groups of spines on anterior margin; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Coxal gills: coxal gill of gnathopod II and gills of pereopods III–V longer than bases; gill of pereopod VI a little shorter than basis; gill of pereopod VII smallest, half the length of basis.

Pleon. *Epimeral plates* (Fig. 4K–M): plate I ventrally rounded, bearing seven long setae on anteroventral margin and three tiny setae on posterior margin; plate II with two spines on ventral margin and six tiny setae on posterior margin, posterodistal corner blunt; plate III with three spines on ventral margin and six tiny setae on posterior margin, posterodistal corner subacute.

Pleopods I–III (Fig. 5A–C): similar, peduncle with two retinacula accompanied by two setae; outer ramus slightly longer than inner ramus, both inner and outer rami fringed with plumose setae.

Urosome. *Urosomites* (Fig. 2M): urosomite I with one-one-one-one spines accompanied by setae on dorsal margin; urosomite II with three-one-one-three spines accompanied by setae on dorsal margin; urosomite III with two spines accompanied by two setae on each side and two pairs of setae on dorsal margin.

Figure 5. *Gammarus vallecula* Hou & Li, sp. n., **A–G** male, holotype; **H** female, paratype. **A** pleopod I **B** pleopod II **C** pleopod III **D** uropod I **E** uropod II **F** uropod III **G** telson **H** uropod I.

Uropods I–III (Fig. 5D–F): uropod I peduncle with one basofacial spine, two spines on inner margin and three spines on outer margin, inner and outer distal corners with one and two spines, respectively; inner and outer rami with two and one spines on inner margins, respectively; both rami with five terminal spines. Uropod II peduncle with one and two spines on inner and outer margins respectively, and with one distal spine on each corner; inner ramus with two spines on inner margin; outer ramus with one spine on inner margin; both rami with five terminal spines. Uropod III peduncle with two spines accompanied by one seta on surface and eight distal spines; inner ramus 1.2 times as long as peduncle, reaching 0.5 times the length of outer ramus, with one spine accompanied by three plumose setae on inner margin and two distal spines accompanied by setae; proximal article of outer ramus with three pairs of spines accompanied by simple setae on outer margin, with four plumose setae and one simple seta on inner margin, terminal article with simple setae, subequal to adjacent spines.

Telson (Fig. 5G): deeply cleft, 0.8 times as long as wide; each lobe with one spine accompanied by one seta and clusters of setae on surface, bearing two distal spines accompanied by three setae.

Description of paratype female (IZCAS-I-A1411-2). 7.8 mm.

Pereon. *Gnathopod I* (Fig. 6A, B): coxal plate bearing four and two setae on anterior and posterior margins, respectively; basis with long setae on anterior and posterior margins, posterodistal corner with four serrated spines accompanied by setae; propodus oval, palm with six spines on posterior margin, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Gnathopod II (Fig. 6C, D): coxal plate bearing five and two fine setae on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins; propodus subrectangular, palm margin with three spines on posterodistal corner, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Pereopods III–VII (Fig. 7E–I): similar to those of male.

Oostegite (Fig. 6H–K): oostegite of gnathopod II broad, oostegites of pereopods III and IV elongated, oostegite of pereopod V smallest.

Urosome. *Uropods I–III* (Figs 5H; 7J, K): uropod I peduncle with one basofacial spine, with two and one spines on outer and inner margins, respectively, with two and one spines on outer and inner distal corners, respectively; outer ramus with two spines on inner margin and one spine on outer margin; inner ramus with two spines on inner margin; both rami with five terminal spines. Uropod II short, peduncle bearing two spines on outer and inner margins each, with one spine on outer and inner distal corners each; outer ramus with one spine on outer margin; inner ramus with two spines on inner margin; both rami with five terminal spines. Uropod III peduncle with two spines accompanied by one seta on surface and five distal spines; inner ramus 1.1 times as long as peduncle, reaching 0.6 times the length of outer ramus, with one spine accompanied by three plumose setae and one simple seta on inner margin and two distal spines accompanied by setae; proximal article of outer ramus with five spines accompanied by one plumose seta and simple setae on outer margin, inner margin with three plumose setae and two simple setae, terminal article subequal to adjacent spines.

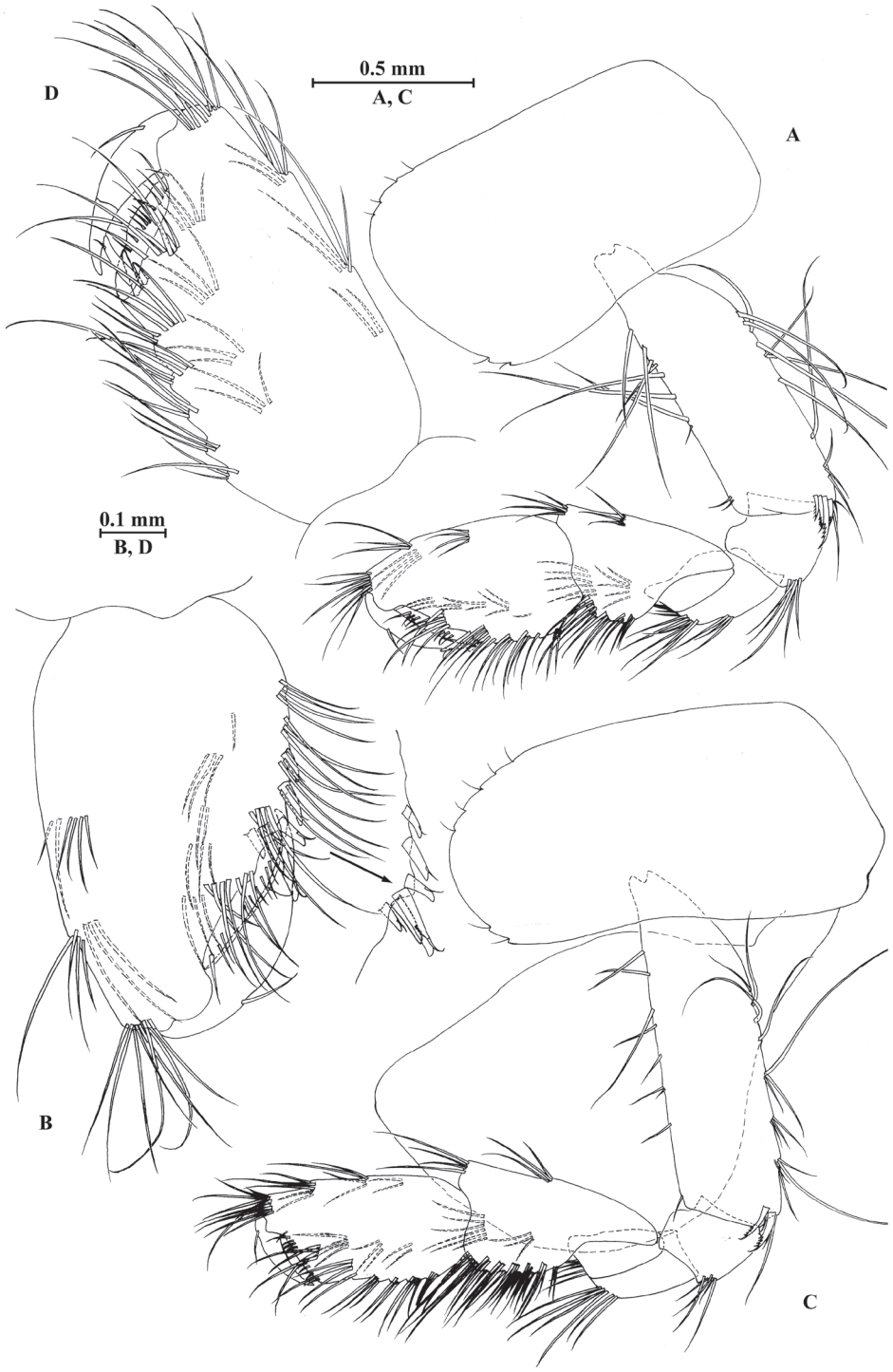

Figure 6. *Gammarus vallecula* Hou & Li, sp. n., female paratype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C** gnathopod II **D** propodus and dactylus of gnathopod II.

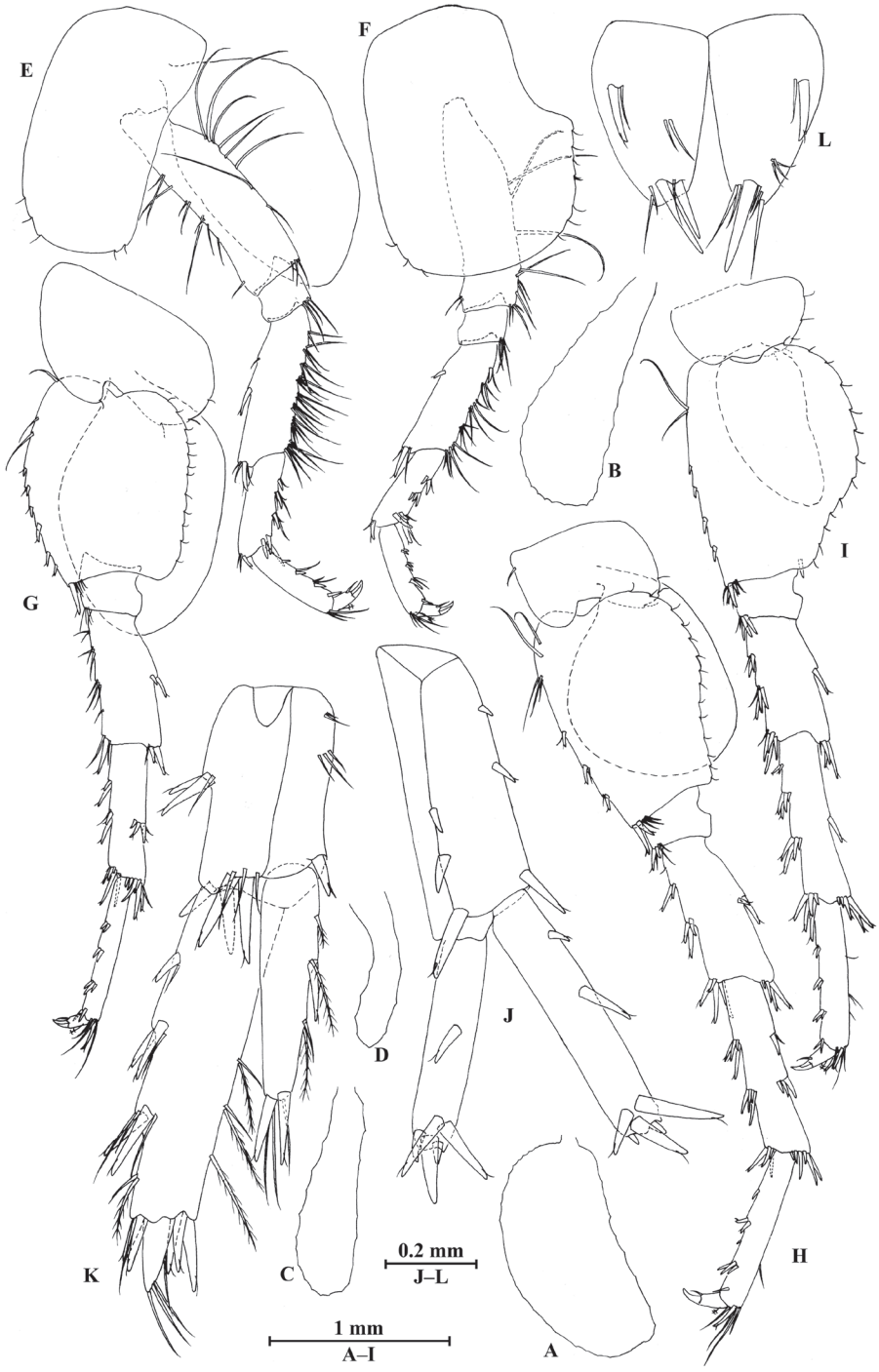

Figure 7. *Gammarus vallecula* Hou & Li, sp. n., female paratype. **A** oostegite of gnathopod II **B** oostegite of pereopod III **C** oostegite of pereopod IV **D** oostegite of pereopod V **E** pereopod III **F** pereopod IV **G** pereopod V **H** pereopod VI **I** pereopod VII **J** uropod II **K** uropod III **L** telson.

Telson (Fig. 7L): cleft, 0.8 times as long as wide; left lobe with one spine accompanied by one seta and a cluster of two setae on surface, bearing two distal spines accompanied by three setae; right lobe with one spine accompanied by one seta and a cluster of three setae on surface, bearing one distal spine accompanied by five setae.

Habitat. This species was collected from a valley of south part of the Qinling. Individuals inhabit a stream, usually under decomposing leaves.

Remarks. The new species of *Gammarus vallecula* Hou & Li, sp. n. is similar to *G. craspedotrichus* Hou & Li, 2002a in antenna II calceoli absent; pereopods III and IV with straight setae on posterior margins; and both rami of uropod III with plumose setae on inner margins. It differs from *G. craspedotrichus* (*G. craspedotrichus* in parentheses) by peduncle of antenna II with setae along ventral margin, setae as long as article's diameter (antenna II with long setae along ventral margin, setae as long as three times of article's diameter); uropod I peduncle with one basofacial spine (without basofacial spine); inner ramus of uropod III 0.5 times the length of outer ramus (as long as first article of outer ramus); terminal article of outer ramus of uropod III subequal to adjacent spines (shorter); and urosomites I–III with four clusters of dorsal spines and setae (with two clusters of dorsal spines and setae).

Gammarus vallecula Hou & Li, sp. n. is also similar to *G. emeiensis* Hou, Li & Koenemann, 2002 in antenna II calceoli absent; epimeral plate II with blunt posterodistal corner and plate III with subacute posterodistal corner; peduncle of uropod I with one basofacial spine; and terminal article of outer ramus of uropod III approx. as long as adjacent spines of first article. It can be distinguished from *G. emeiensis* by the following characters (*G. emeiensis* in parentheses): second article of left palp of maxilla I with seven slender spines apically (seven slender spines and three stiff setae); pereopod III with short setae on posterior margin (with long setae on posterior margin); and inner ramus of uropod III 0.5 times the length of outer ramus (0.74 times the length of first article of outer ramus).

The new species of *Gammarus vallecula* Hou & Li, sp. n. can be distinguished from *G. martensi* Hou & Li, 2004a which was collected on the summit of the Qinling by the following characters (*G. martensi* in parentheses): antenna II flagellum with a few setae, calceoli absent (with flag-like brush of setae, calceoli present); merus and carpus of pereopods V–VII with few marginal setae (with marginal setae); and uropod III inner ramus approx. half of outer ramus, both with a few plumose setae on inner margins (inner ramus 0.75 times as long as outer ramus, both rami densely with plumose setae on inner and outer margins).

Gammarus qinling Hou & Li, sp. n.

http://zoobank.org/DD98C03F-55E1-4A97-9D00-686ECAC39F54
Figs 8–13

Material examined. Holotype: male (IZCAS-I-A1416-1), 8.3 mm, Zibo Mountain National Forest Park (106.82°E, 33.67°N), altitude 1352 m, Liuba County,

Hanzhong City, Shaanxi Province, China, October 24, 2013, collected by Yunchun Li and Jincheng Liu. Paratype: female (IZCAS-I-A1416-2), 9.4 mm, same data as holotype.

Etymology. The specific name is derived from the type locality; noun in apposition.

Diagnosis. Antenna II calceoli present in male; pereopods III and IV with short straight setae on posterior margins of merus and propodus; epimeral plates II and III with blunt posterodistal corners; uropod III inner ramus reaching half the length of outer ramus, terminal article of outer ramus a little longer than adjacent spines, both rami with plumose setae on inner and outer margins.

Description of holotype male (IZCAS-I-A1416-1). 8.3 mm.

Head (Fig. 8A): eyes oval, inferior antennal sinus deep, lateral cephalic lobe rounded.

Antenna I (Fig. 8B, C): peduncle articles I–III in length ratio 1.0: 0.6: 0.4, with lateral and distal setae; flagellum incomplete, articles II–XIX with aesthetascs; accessory flagellum with four articles; both primary and accessory flagella with short distal setae.

Antenna II (Fig. 8D, E): peduncle articles III–V in length ratio 1.0: 2.7: 2.4, article III with distal setae, articles IV and V with clusters of lateral and medial setae; flagellum with 11 articles and one tiny distal article, with setae along dorsal and ventral margins; articles III and IV with calceoli.

Upper lip (Fig. 8F): ventral margin rounded, bearing short minute setae.

Mandible (Fig. 8H, I): left mandible incisor with five teeth; lacinia mobilis with four teeth; spine row with five pairs of plumose setae; articles I–III of palp in length ratio 1.0: 3.7: 3.8, second article of palp with nine marginal setae, article III with three A-setae, three B-setae, 12 D-setae and five E-setae apically; incisor of right mandible with four teeth, lacinia mobilis bifurcate, with small teeth.

Lower lip (Fig. 8G): inner lobes lacking, outer lobes covered with thin setae.

Maxilla I (Fig. 8J, K): asymmetrical, left inner plate with 13 plumose setae on medial margin; outer plate with 11 robust serrated apical spines, each spine with small teeth; second article of left palp with seven slender spines apically; second article of right palp with four stout spines and two slender spines.

Maxilla II (Fig. 8L): inner plate with three fine setae and 12 plumose facial setae in an oblique row; inner and outer plates with long setae apically.

Maxilliped (Fig. 8M): inner plate with three stout apical spines and one subapical spine, 17 plumose setae along lateral margin; outer plate bearing a row of 13 blade spines and three plumose setae apically; article IV of palp hooked, with a group of setae at hinge of unguis.

Pereon. *Gnathopod I* (Fig. 9A, B): coxal plate bearing three setae and one seta on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins; carpus 1.1 times as long as wide, 0.6 times as long as propodus, ventral margin bearing four clusters of setae; propodus oval, palm with one medial spine and ten spines on posterior margin and surface; dactylus with one seta on outer margin.

Gnathopod II (Fig. 9C, D): coxal plate bearing three setae and one seta on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins,

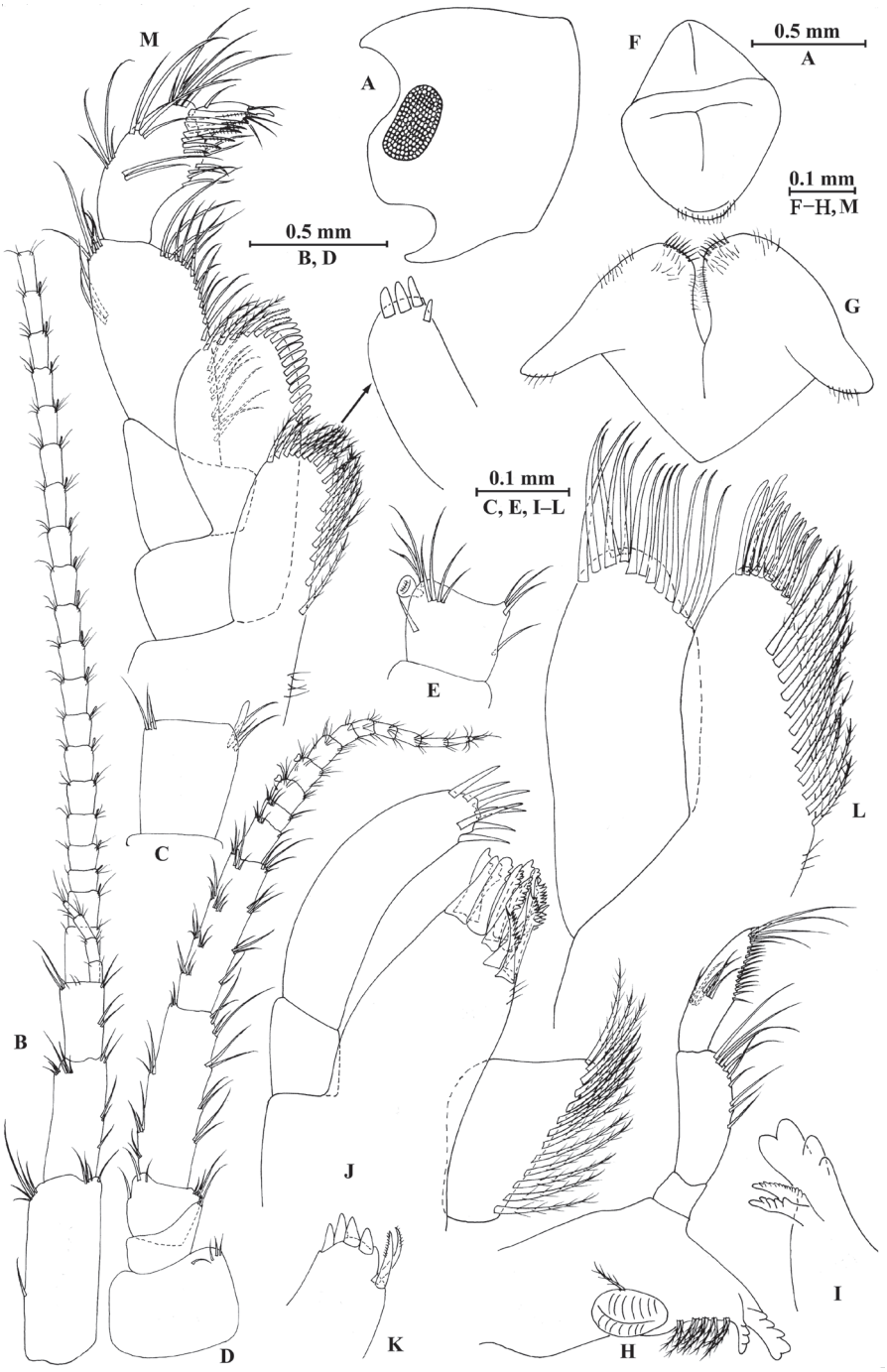

Figure 8. *Gammarus qinling* Hou & Li, sp. n., male holotype. **A** head **B** antenna I **C** flagellar article of antenna I with aesthetasc **D** antenna II **E** calceoli of antenna II **F** upper lip **G** lower lip **H** left mandible **I** incisor and lacinia mobilis of right mandible **J** left maxilla I **K** distal part of palp article II of right maxilla I **L** maxilla II **M** maxilliped.

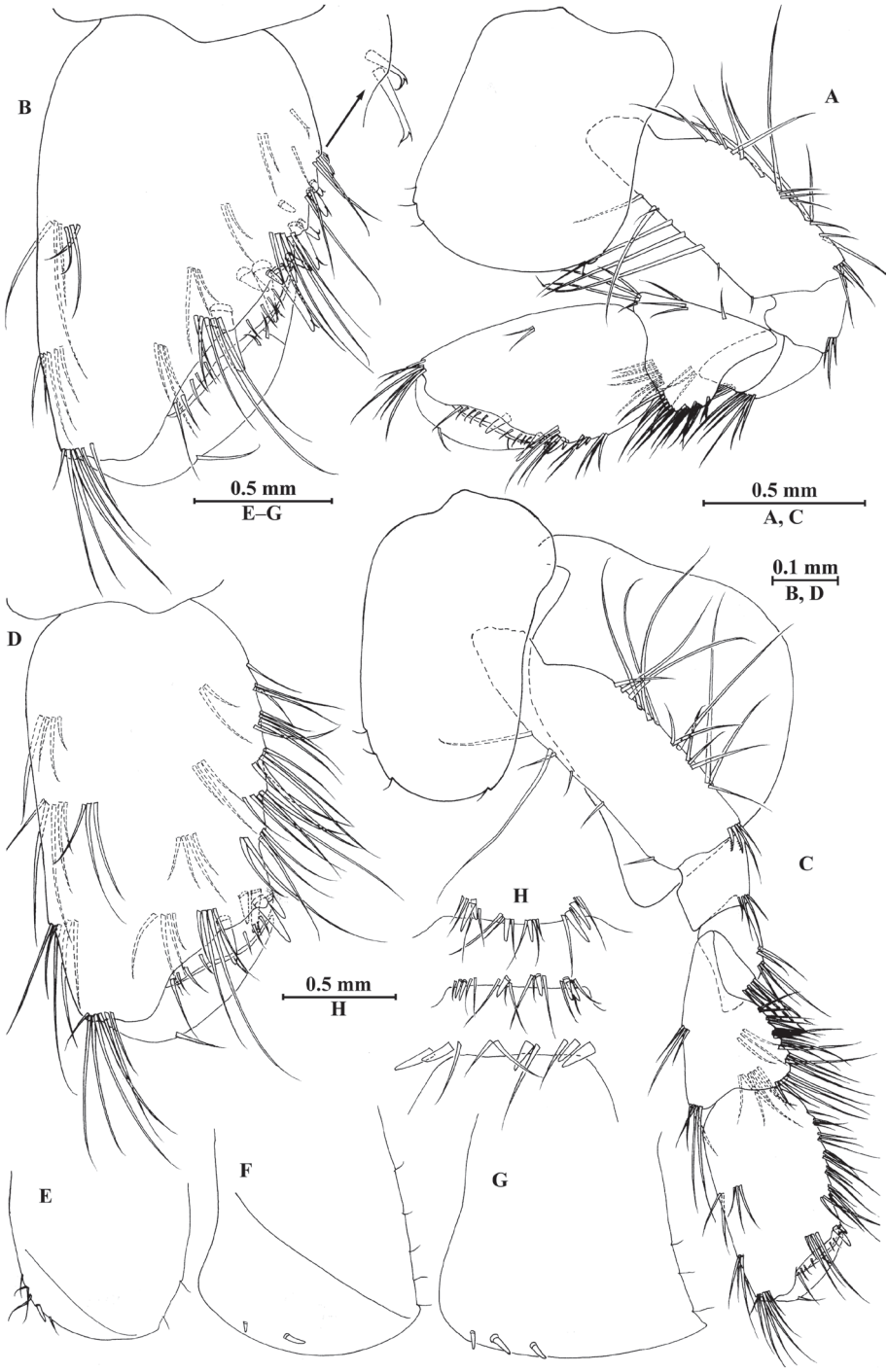

Figure 9. *Gammarus qinling* Hou & Li, sp. n., male holotype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C** gnathopod II **D** propodus and dactylus of gnathopod II **E** epimeral plate I **F** epimeral plate II **G** epimeral plate III **H** dorsal margins of urosomites I–III.

and with two serrated spines accompanied by two setae on posterodistal corner; carpus 1.7 times as long as wide, 0.8 times as long as propodus, bearing six clusters of setae along ventral margin, two clusters of setae on dorsal margin; propodus subrectangular, palm margin with one medial spine and four spines on lateral posterodistal corner; dactylus with one seta on outer margin.

Pereopod III (Fig. 10A, B): coxal plate bearing two setae on anterior margin and one seta on posterior margin; basis elongated, with setae along anterior and posterior margins; merus with straight setae on posterior margin and two spines on anterior margin, anterodistal corner with one spine accompanied by setae; carpus with three spines accompanied by long setae on posterior margin; propodus with five spines accompanied by short setae on posterior margin and two spines on posterodistal corner; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

Pereopod IV (Fig. 10C, D): coxal plate concave, bearing two setae on anterior margin and five setae on posterior margin; basis with setae along anterior and posterior margins; merus with clusters of short straight setae on posterior margin and one spine on anterior margin, anterodistal and posterodistal corners with one spine accompanied by setae each; carpus with three pairs of spines accompanied by setae on posterior margin, anterodistal corner with one spine accompanied by one seta; propodus with three pairs of spines accompanied by setae on posterior margin and two spines on posterodistal corner; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

Pereopod V (Fig. 10E, F): coxal plate bearing two setae on posterior margin; basis sub-oval, with three simple setae and five spines accompanied by fine setae on anterior margin, anterodistal corner with two spines, posterior margin with a row of ten setae; merus with three spines accompanied by setae on anterior margin and two spines on posterior margin, anterodistal and posterodistal corners with three spines accompanied by one seta each; carpus with two pairs of spines on anterior and posterior margins each; propodus with three groups of spines on anterior margin; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Pereopod VI (Fig. 10G, H): coxal plate bearing one seta on anterior and posterior margins each; basis expanded, with three simple setae and four spines accompanied by setae on anterior margin, anterodistal corner with two spines and two fine setae, posterior margin with a row of 11 fine setae; merus with two groups of spines on anterior margin and a pair of spines on posterior margin, anterodistal and posterodistal corners with four spines each; carpus with groups of spines on anterior and posterior margins, anterodistal corner with five spines accompanied by one fine seta and posterodistal corner with five spines; propodus with groups of spines on anterior margin; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Pereopod VII (Fig. 10I, J): coxal plate bearing three setae on posterior margin; basis with two simple setae and five spines accompanied by setae on anterior margin, anterodistal corner with three spines and two fine setae, posterior margin with a row of 12 setae; merus with two groups of spines on anterior margin and a pair of spines on posterior margin, anterodistal and posterodistal corners with four spines each; carpus with two groups of spines on anterior margin and three spines on posterior margin,

anterodistal corner with three spines accompanied by two fine setae and posterodistal corner with five spines accompanied by one seta; propodus with three groups of spines on anterior margin; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Coxal gills: coxal gill of gnathopod II and gills of pereopods IV and V a little longer than bases; gill of pereopod III approx. as long as basis; gill of pereopod VI a little shorter than basis; gill of pereopod VII smallest, more than half the length of basis.

Pleon. *Epimeral plates* (Fig. 9E–G): plate I ventrally rounded, bearing five setae and one spine on anteroventral margin and two tiny setae on posterior margin; plate II with two spines on ventral margin and five tiny setae on posterior margin, posterodistal corner blunt; plate III with three spines on ventral margin and three tiny setae on posterior margin, posterodistal corner subacute.

Pleopods I–III (Fig. 11A–C): similar, peduncle with two retinacula accompanied by one or two plumose setae; outer ramus slightly shorter than inner ramus, both inner and outer rami fringed with plumose setae.

Urosome. *Urosomites* (Fig. 9H). urosomite I with two-one-one-two spines accompanied by setae on dorsal margin; urosomite II with two-one-one-two spines accompanied by setae on dorsal margin; urosomite III with two spines accompanied by one seta on each side and one spine accompanied by three setae on dorsal margin.

Uropods I–III (Fig. 11D–F): uropod I peduncle with one basofacial spine, one spine on inner margin and one spine on outer margin, inner and outer distal corners with one and two spines, respectively; inner ramus with one spine on inner margin; outer ramus with one spine on inner and outer margins each; both rami with five terminal spines. Uropod II peduncle with one spine on inner and outer margins each, and with one distal spine on each corner; both rami with one spine on inner margins and five terminal spines. Uropod III peduncle with one spine accompanied by one seta on surface and five distal spines; inner ramus 0.9 times as long as peduncle, reaching 0.5 times the length of outer ramus, with one spine accompanied by four plumose setae and one simple seta on inner margin, two plumose setae and one simple seta on outer margin, and two distal spines accompanied by setae; proximal article of outer ramus with three pairs of spines accompanied by five plumose setae and simple setae on outer margin, with ten plumose setae on inner margin, terminal article with simple setae, a little longer than adjacent spines.

Telson (Fig. 11G): deeply cleft, approx. as long as wide; left lobe with two single setae and a cluster of three setae on surface; right lobe with one spine and two clusters of setae on surface; each lobe bearing two distal spines accompanied by setae.

Description of paratype female (IZCAS-I-A1416-2), 9.4 mm.

Pereon. *Gnathopod I* (Fig. 12A, B): coxal plate bearing two and one setae on anterior and posterior margins, respectively; basis with long setae on anterior and posterior margins; propodus oval, palm with six spines on posterior margin, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Gnathopod II (Fig. 12C, D): coxal plate bearing three and one setae on anterior and posterior margins, respectively; basis with long setae on anterior and posterior margins; propodus subrectangular, palm margin with three stout spines and two stiff

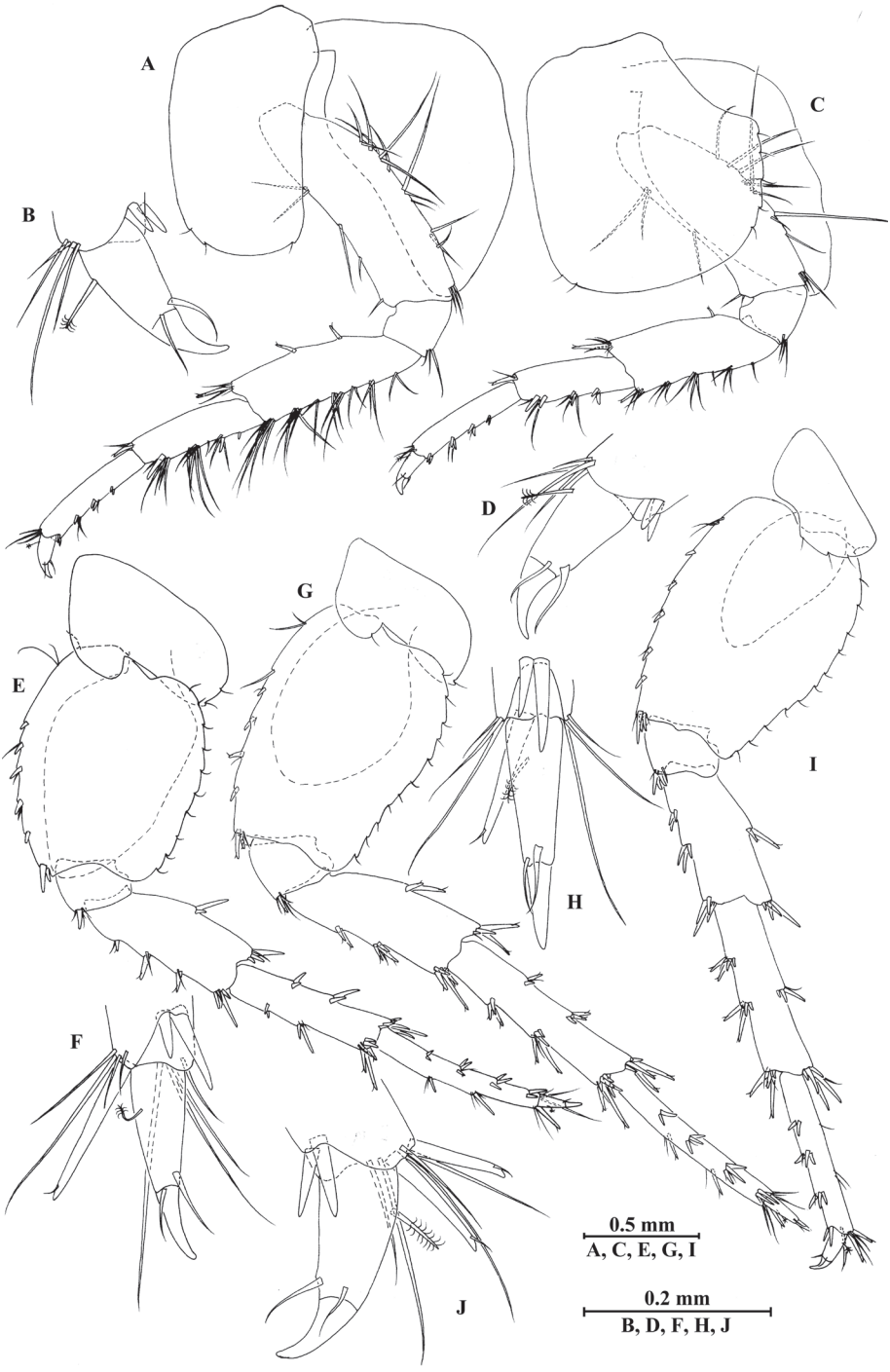

Figure 10. *Gammarus qinling* Hou & Li, sp. n., male holotype. **A** pereopod III **B** dactylus of pereopod III **C** pereopod IV **D** dactylus of pereopod IV **E** pereopod V **F** dactylus of pereopod V **G** pereopod VI **H** dactylus of pereopod VI **I** pereopod VII **J** dactylus of pereopod VII.

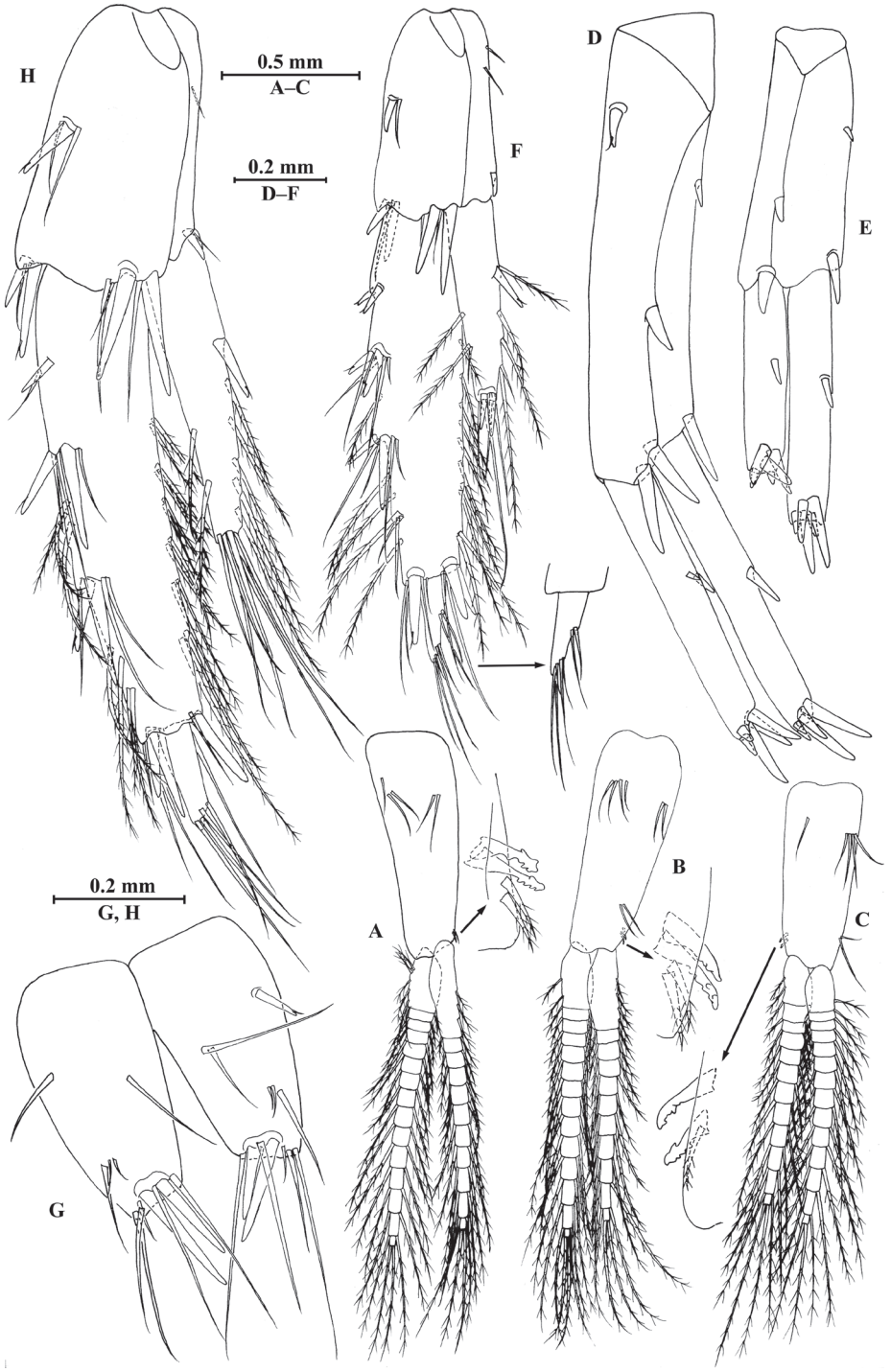

Figure 11. *Gammarus qinling* Hou & Li, sp. n., **A–G** male, holotype; **H** female, paratype. **A** pleopod I **B** pleopod II **C** pleopod III **D** uropod I **E** uropod II **F** uropod III **G** telson **H** uropod III.

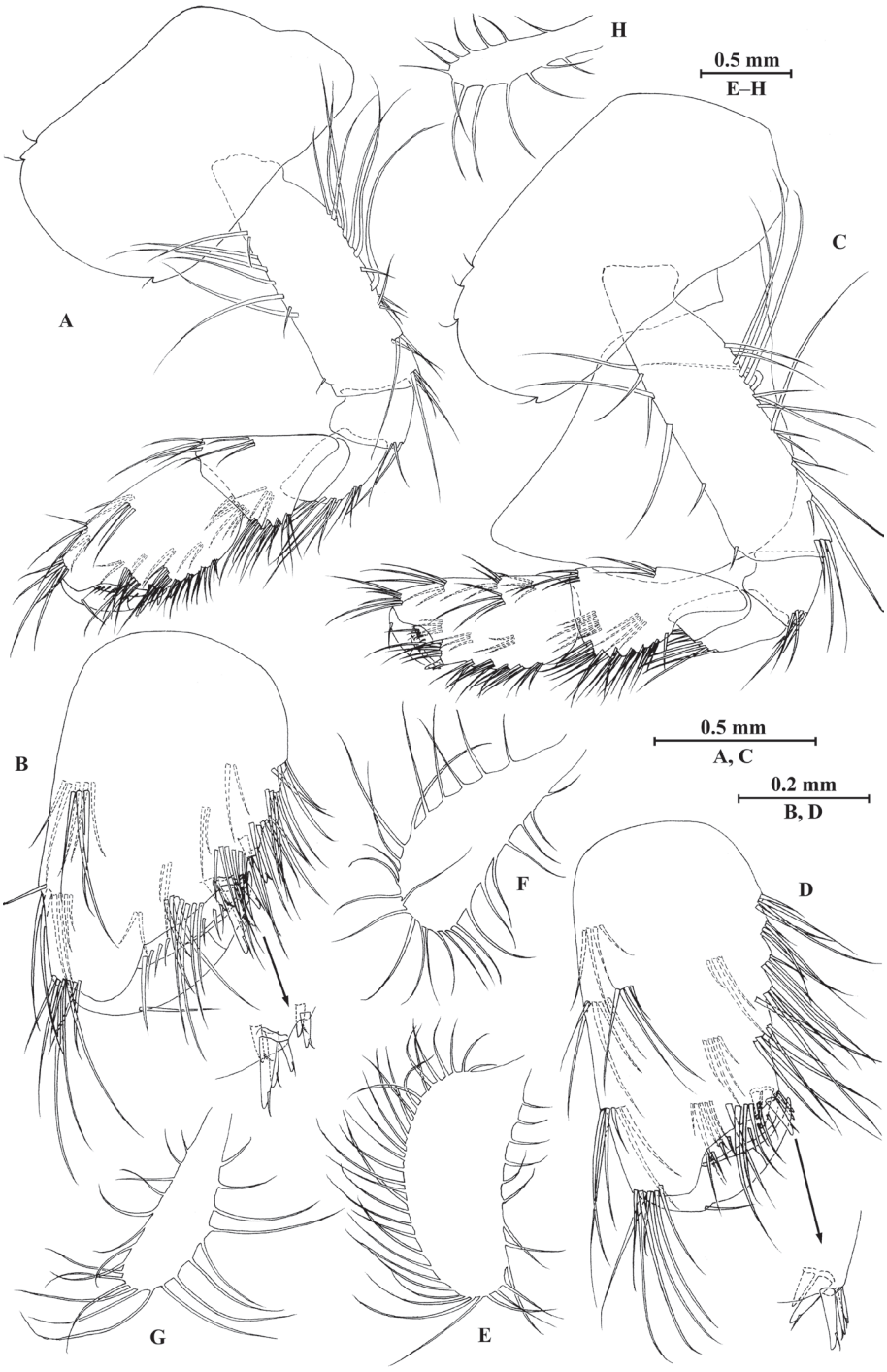

Figure 12. *Gammarus qinling* Hou & Li, sp. n., female paratype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C** gnathopod II **D** propodus and dactylus of gnathopod II **E** oostegite of gnathopod II **F** oostegite of pereopod III **G** oostegite of pereopod IV **H** oostegite of pereopod V.

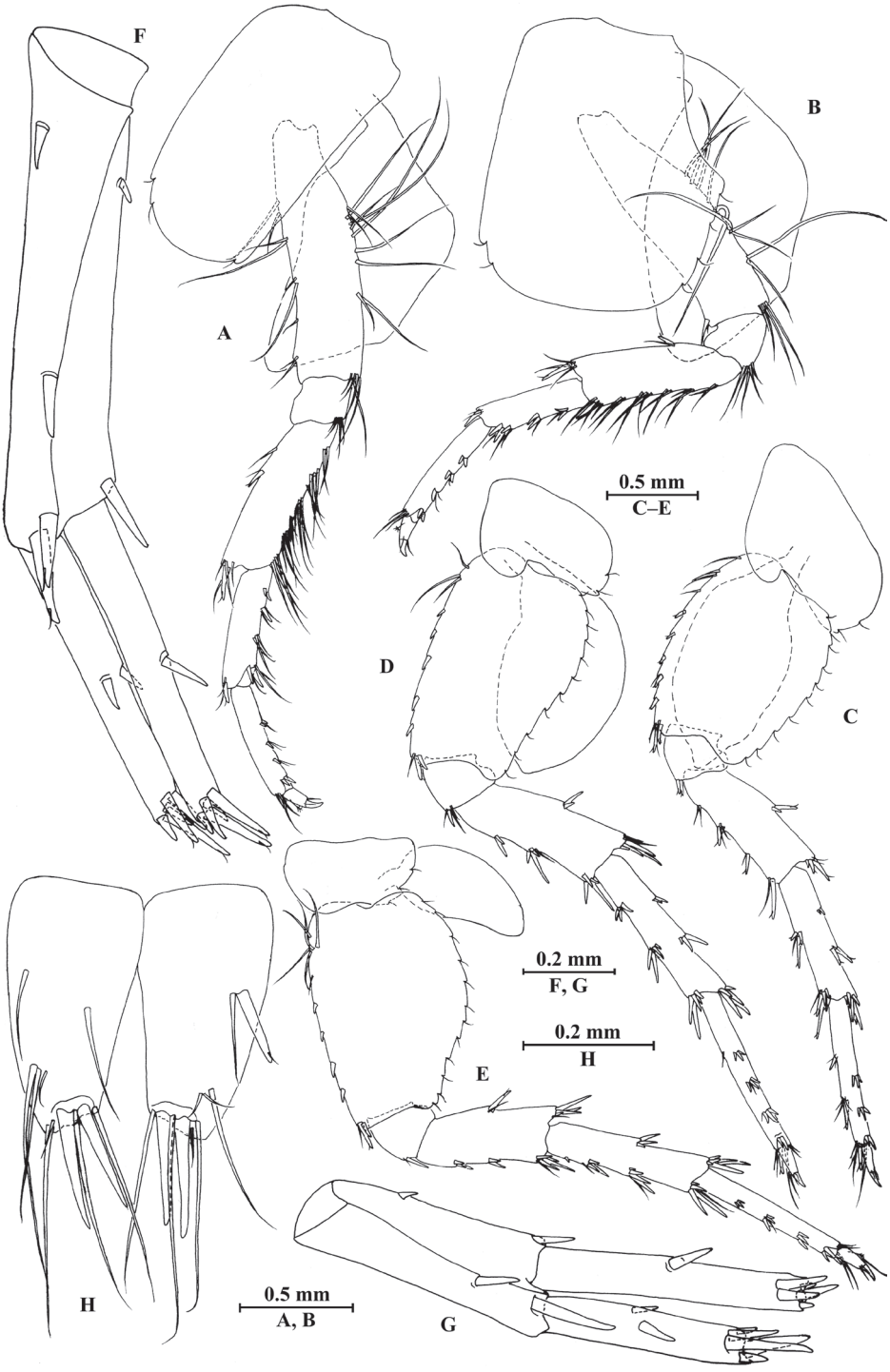

Figure 13. *Gammarus qinling* Hou & Li, sp. n., female paratype. **A** pereopod III **B** pereopod IV **C** pereopod V **D** pereopod VI **E** pereopod VII **F** uropod I **G** uropod II **H** telson.

spines on posterodistal corner, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Pereopods III and IV (Fig. 13A, B): carpus with more setae on posterior margins than those of male.

Pereopods V–VII (Fig. 13C–E): similar to those of male.

Oostegite (Fig. 12E–H): oostegite of gnathopod II broad, with marginal setae, oostegites of pereopods III and IV elongate, oostegite of pereopod V smallest.

Urosome. *Uropods I–III* (Figs 11H; 13F, G): Uropods I and II similar to those of male. Uropod III peduncle with one spine accompanied by two setae on surface and five distal spines; inner ramus 1.2 times as long as peduncle, reaching 0.5 times the length of outer ramus, with one spine accompanied by five plumose setae on inner margin and two plumose setae on outer margin; proximal article of outer ramus with three clusters of spines accompanied by plumose setae and simple setae on outer margin, with six pairs of plumose setae on inner margin, terminal article a little longer than adjacent spines.

Telson (Fig. 13H): cleft, approx. as long as wide; left lobe with two single setae and a cluster of three setae on surface; right lobe with one spine accompanied by one seta and a cluster of three setae on surface; each lobe bearing two distal spines accompanied by setae.

Habitat. Specimens were collected from a spring of Wulong Cave in Zibo Mountain National Forest Park, which is famous for the specific topography of sinkholes. Zibo Mountain is located in the south of Qinling.

Remarks. This new species of *Gammarus qinling* Hou & Li, sp. n. is most similar to *G. vallecula* Hou & Li, sp. n. in pereopods III and IV with short setae on posterior margins; pereopods V–VII with spines along anterior and posterior margins, but few setae; and epimeral plates II and III posterior margins blunt. *Gammarus qinling* Hou & Li, sp. n. can be distinguished from *G. vallecula* Hou & Li, sp. n. by the following characters (*G. vallecula* in parentheses): antenna II calceoli absent (present); uropod III inner ramus approx. half the length of outer ramus, both rami armed with plumose setae (uropod III approx. half the length of outer ramus, both rami with a few plumose setae on inner margins, outer margins with no plumose setae).

This new species of *Gammarus qinling* Hou & Li, sp. n. can be distinguished from the closely related species *G. murarius* Hou & Li, 2004a (*G. murarius* in parentheses) by the following characters: merus and carpus of pereopod III with straight setae on posterior margins (with long curled setae); epimeral plate I bearing five setae and one spine on anteroventral margin (only with four setae); and inner ramus of uropod III 0.5 times the length of outer ramus (0.65 times the length of first article of outer ramus).

Gammarus zhigangi Hou & Li, sp. n.

http://zoobank.org/8303CC73-FE70-41D1-95E5-D8F23B2DF809
Figs 14–20

Material examined. Holotype: male (IZCAS-I-A1424-1), 9.1 mm, Tiantai Mountain National Forest Park (107.05°E, 33.25°N), altitude 865 m, Hanzhong City, Shaanxi

Province, China, October 25, 2013, collected by Zhigang Chen. Paratype: female (IZ-CAS-I-A1424-2), 10.9 mm, same data as holotype.

Etymology. The new species is named after Mr. Zhigang Chen who extensively collected gammarids from China; noun (name) in genitive case.

Diagnosis. Antenna II calceoli present in male; merus of pereopod III with long, straight setae on posterior margin; inner ramus of uropod III reaching 0.6 times the length of outer ramus, outer ramus with no plumose setae on outer margin but with a row of plumose setae on inner margin.

Description of holotype male (IZCAS-I-A1424-1). 9.1 mm.

Head (Fig. 14A): eyes reniform, inferior antennal sinus deep, lateral cephalic lobe rounded.

Antenna I (Fig. 14B, C): peduncle articles I–III in length ratio 1.0: 0.6: 0.3, with distal setae; flagellum with 24 articles, articles V–XXII with aesthetascs; accessory flagellum with three articles; both primary and accessory flagella with short distal setae.

Antenna II (Fig. 14D, E): peduncle articles III–V in length ratio 1.0: 2.8: 2.7, article IV of peduncle with lateral setae and article V of peduncle with clusters of lateral and medial setae; flagellum with ten articles, with setae along ventral margin; articles III–VI with calceoli.

Upper lip (Fig. 14F): ventral margin rounded, bearing short minute setae.

Mandible (Fig. 14H, I): left mandible incisor with five teeth; lacinia mobilis with four teeth; spine row with five pairs of plumose setae; articles I–III of palp in length ratio 1.0: 3.1: 2.7, second article of palp with 12 marginal setae, article III with four A-setae, two B-setae, a row of D-setae, and five E-setae apically; incisor of right mandible with four teeth, lacinia mobilis bifurcate, with small teeth.

Lower lip (Fig. 14G): inner lobes lacking, outer lobes covered with thin setae.

Maxilla I (Fig. 14J, K): asymmetrical, left inner plate with 15 plumose setae on medial margin; outer plate with 11 robust serrated apical spines, each spine with small teeth; second article of left palp with six slender spines and one seta apically; second article of right palp with five stout spines, one stiff seta and one slender spine.

Maxilla II (Fig. 14L): inner plate with 15 plumose facial setae in an oblique row; inner and outer plates with long setae apically.

Maxilliped (Fig. 14M): inner plate with three stout apical spines and one subapical spine, 15 plumose setae along lateral margin; outer plate bearing a row of 11 blade spines and three plumose setae apically; article IV of palp hooked, with three setae at hinge of unguis.

Pereon. *Gnathopod I* (Fig. 15A, B): coxal plate bearing three setae and one seta on anterior and posterior margins, respectively; basis with long setae on anterior and posterior margins; carpus 1.3 times as long as wide, 0.7 times as long as propodus, ventral margin bearing three clusters of setae; propodus oval, palm with one medial spine and 13 spines on posterior margin and surface; dactylus with one seta on outer margin.

Gnathopod II (Fig. 15C, D): coxal plate bearing four setae and one seta on anterior and posterior margins, respectively; basis with long setae on anterior and posterior margins; carpus 1.7 times as long as wide, 0.8 times as long as propodus, bearing six

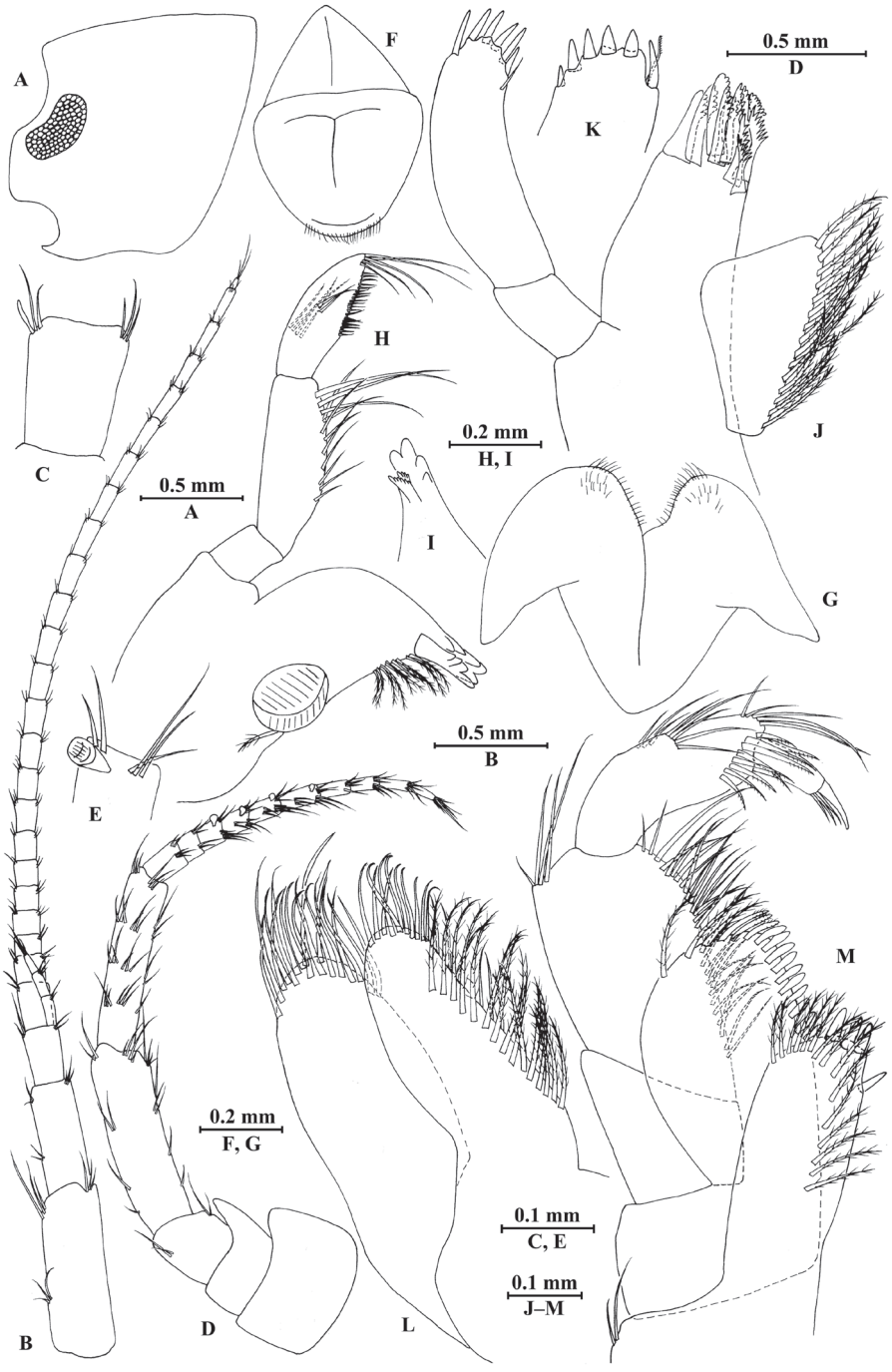

Figure 14. *Gammarus zhigangi* Hou & Li, sp. n., male holotype. **A** head **B** antenna I **C** flagellar article of antenna I with aesthetasc **D** antenna II **E** calceoli of antenna II **F** upper lip **G** lower lip **H** left mandible **I** incisor and lacinia mobilis of right mandible **J** left maxilla I **K** distal part of palp article II of right maxilla I **L** maxilla II **M** maxilliped.

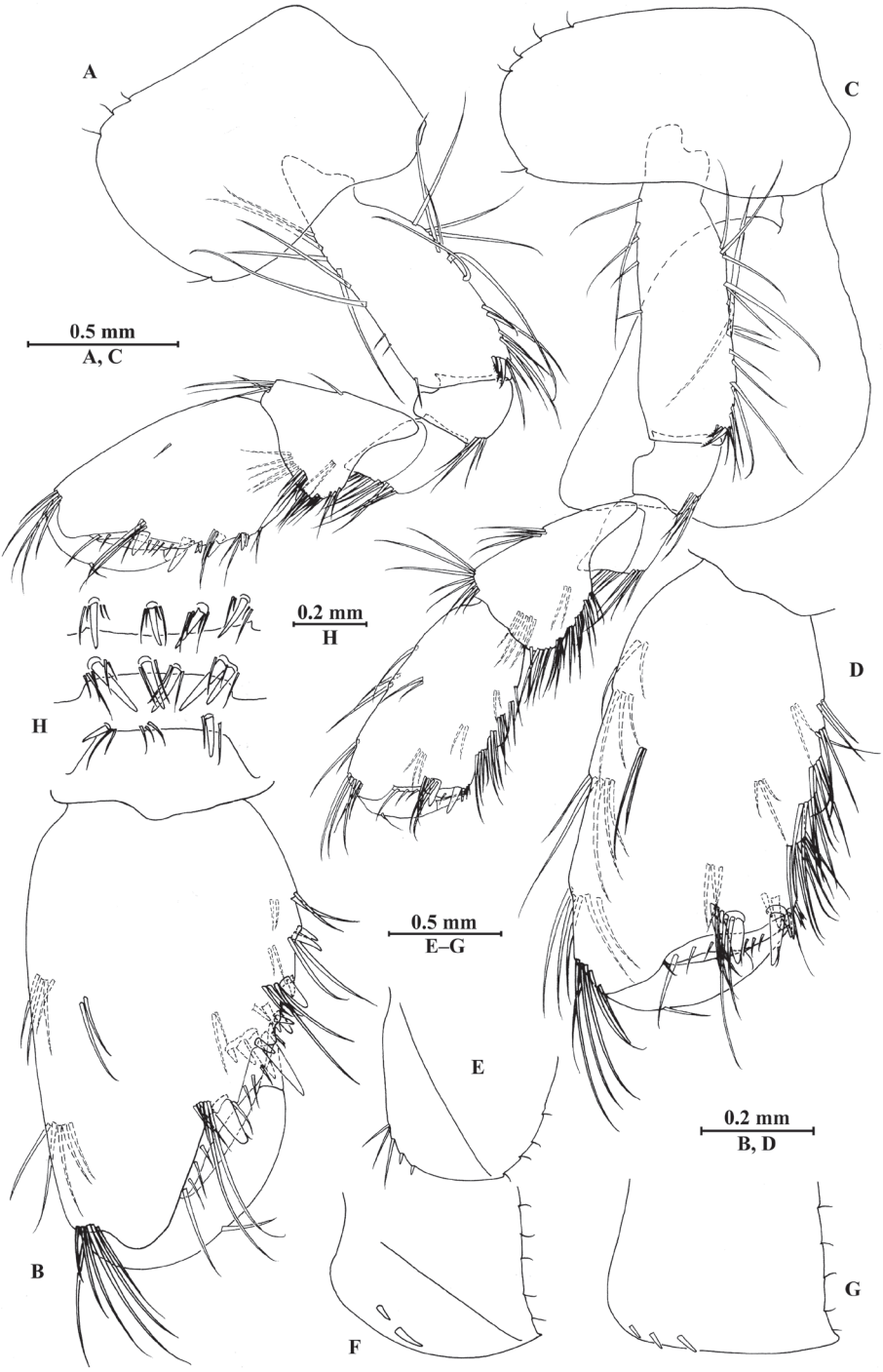

Figure 15. *Gammarus zhigangi* Hou & Li, sp. n., male holotype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C** gnathopod II **D** propodus and dactylus of gnathopod II **E** epimeral plate I **F** epimeral plate II **G** epimeral plate III **H** dorsal margins of urosomites I–III.

clusters of setae along ventral margin, two clusters of setae on dorsal margin; propodus subrectangular, palm margin with one medial spine and five spines on lateral posterodistal corner; dactylus with one seta on outer margin.

Pereopod III (Fig. 16A, B): coxal plate bearing three setae on anterior margin and one seta on posterior margin; basis elongated, with short setae along anterior margin and long setae along posterior margin; merus with long straight setae on posterior margin and two single spines on anterior margin, anterodistal corner with one spine accompanied by two setae; carpus with straight setae on posterior margin; propodus with three spines accompanied by setae on posterior margin and two spines on posterodistal corner; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

Pereopod IV (Fig. 16C, D): coxal plate concave, bearing three setae on anterior margin and six setae on posterior margin; basis with two short setae on anterodistal corner and long setae along posterior margin; merus with clusters of setae on posterior margin and one spine on anterior margin, anterodistal corner with one spine accompanied by two setae; carpus with three pairs of spines accompanied by setae on posterior margin, anterodistal corner with one spine accompanied by three setae; propodus with three single spines accompanied by setae on posterior margin and two spines on posterodistal corner; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

Pereopod V (Fig. 16E, F): coxal plate bearing one seta on anterior margin and two setae on posterior margin; basis with two pairs of setae and six spines accompanied by fine setae on anterior margin, anterodistal corner with one spine accompanied by setae, posterior margin with a row of 11 setae; merus with one spine accompanied by setae on anterior margin and a pair of spines on posterior margin, anterodistal and posterodistal corners with two spines accompanied by setae each; carpus and propodus with groups of spines on anterior margin; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Pereopod VI (Figs 16G, H): coxal plate bearing one seta on anterior margin and two setae on posterior margin; basis with four simple setae and five spines accompanied by setae on anterior margin, anterodistal corner with three spines and two fine setae, posterior margin with a row of ten fine setae; merus with three pairs of spines on anterior margin and one spine on posterior margin, anterodistal and posterodistal corners with four spines each; carpus with two groups of spines accompanied by setae on anterior and posterior margins each, anterodistal corner with five spines accompanied by one fine seta and posterodistal corner with five spines; propodus with four groups of spines on anterior margin; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Pereopod VII (Fig. 16I, J): coxal plate bearing two setae on posterior margin; basis with four long simple setae and four spines on anterior margin, anterodistal corner with two spines and two fine setae, posterior margin with a row of 11 setae; merus with two groups of spines on anterior margin and a pair of spines on posterior margin, anterodistal corner with four spines accompanied by two setae and posterodistal

corner with three spines accompanied by one seta; carpus with three groups of spines on anterior margin and two groups of spines on posterior margin, anterodistal corner with three spines accompanied by one seta and posterodistal corner with three spines; propodus with three groups of spines on anterior margin; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Coxal gills: coxal gill of gnathopod II and gills of pereopods III to V a little longer than bases; gill of pereopod VI a little shorter than basis; gill of pereopod VII smallest, approx. half the length of basis.

Pleon. *Epimeral plates* (Fig. 15E–G): plate I ventrally rounded, bearing three setae and two spines on anteroventral margin and four tiny setae on posterior margin; plate II with two spines on ventral margin and five tiny setae on posterior margin, posterodistal corner subacute; plate III with three spines on ventral margin and five tiny setae on posterior margin, posterodistal corner subacute.

Pleopods I–III (Fig. 17A–C): similar, peduncle with two retinacula accompanied by one plumose seta; outer ramus slightly shorter than inner ramus, both inner and outer rami fringed with plumose setae.

Urosome. *Urosomites* (Fig. 15H): urosomite I with one-one-one-one spines accompanied by setae on dorsal margin; urosomite II with one-one-one-two spines accompanied by setae on dorsal margin; urosomite III with one spine accompanied by two setae on each side and three setae on dorsal margin.

Uropods I–III (Fig. 17D–F): uropod I peduncle with one basofacial spine, two spines on inner and outer margins each, inner and outer distal corners with one and two spines, respectively; inner ramus with two spines on inner margin; outer ramus with one spine on inner and outer margins each; both rami with five terminal spines. Uropod II peduncle with one spine on inner and outer margins each, and with one distal spine on each corner; inner ramus with two spines on inner margin and one spine on outer margin; outer ramus with one spine on inner and outer margins each; both rami with five terminal spines. Uropod III peduncle with one spine accompanied by one seta on surface and six distal spines; inner ramus 1.4 times as long as peduncle, reaching 0.6 times the length of outer ramus, with two spines accompanied by eight plumose setae and two simple setae on inner margin, five plumose setae on outer margin, and two distal spines accompanied by setae; proximal article of outer ramus with six spines accompanied by simple setae on outer margin, with 13 plumose setae on inner margin, terminal article with simple setae, a little longer than adjacent spines.

Telson (Fig. 17G): deeply cleft, approx. as long as wide; each lobe with clusters of setae on surface, bearing two distal spines accompanied by setae.

Description of paratype female (IZCAS-I-A1424-2). 10.9 mm.

Pereon. *Gnathopod I* (Fig. 18A, B): coxal plate bearing three and one setae on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins; propodus oval, palm with seven spines on posterior margin, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Gnathopod II (Fig. 18C, D): coxal plate bearing five and one setae on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins;

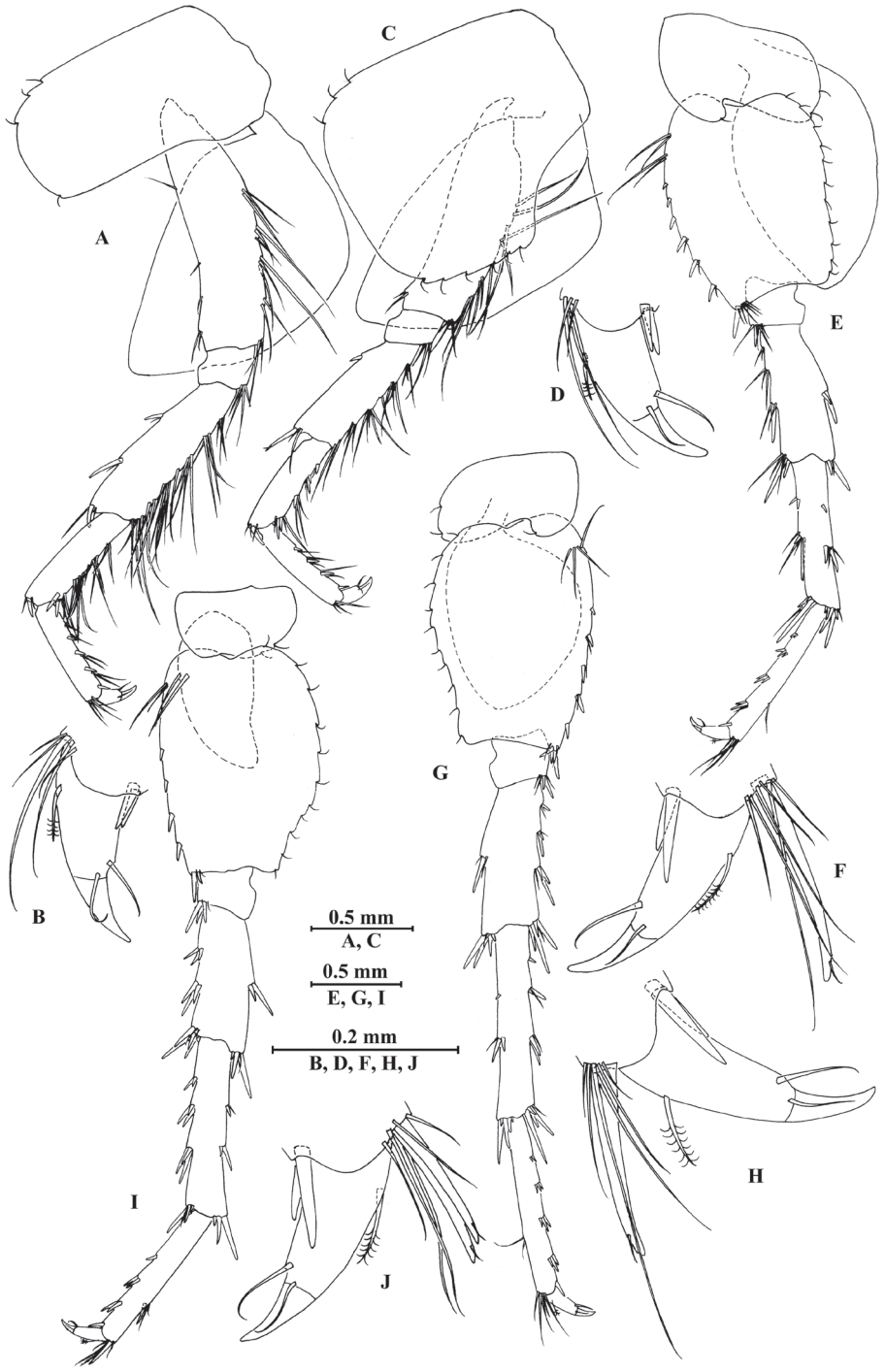

Figure 16. *Gammarus zhigangi* Hou & Li, sp. n., male holotype. **A** pereopod III **B** dactylus of pereopod III **C** pereopod IV **D** dactylus of pereopod IV **E** pereopod V **F** dactylus of pereopod V **G** pereopod VI **H** dactylus of pereopod VI **I** pereopod VII **J** dactylus of pereopod VII.

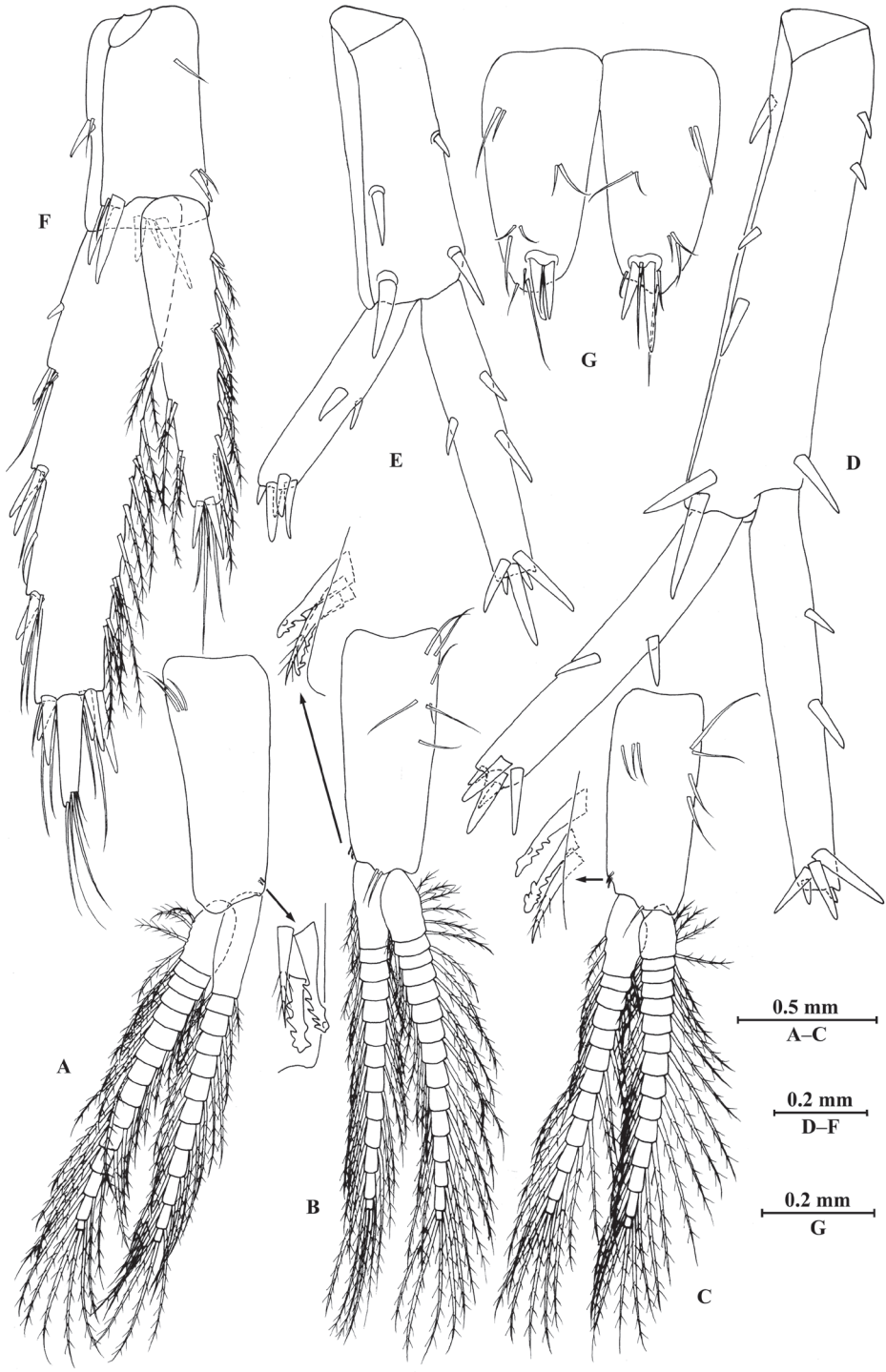

Figure 17. *Gammarus zhigangi* Hou & Li, sp. n., male holotype. **A** pleopod I **B** pleopod II **C** pleopod III **D** uropod I **E** uropod II **F** uropod III **G** telson.

Figure 18. *Gammarus zhigangi* Hou & Li, sp. n., female paratype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C** gnathopod II **D** propodus and dactylus of gnathopod II.

propodus subrectangular, palm margin with two stout spines and three stiff spines on posterodistal corner, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Pereopods III and IV (Fig. 19A, B): with more setae on posterior margins than those of male.

Pereopods V–VII (Fig. 19C–E): similar to those of male, but with more setae on anterior margins of pereopods V–VI.

Oostegite (Fig. 20A–D): oostegite of gnathopod II broad, with marginal setae, oostegites of pereopods III and IV elongated, oostegite of pereopod V smallest.

Urosome. *Uropods I–III* (Fig. 20E–G): uropods I and II similar to those of male. Uropod III peduncle with one spine accompanied by one seta on surface and five distal spines; inner ramus 1.3 times as long as peduncle, reaching 0.6 times the length of outer ramus, with one spine accompanied by five plumose setae and one simple seta on inner margin and five plumose setae on outer margin; proximal article of outer ramus with three pairs of spines accompanied by simple setae on outer margin, with one spine accompanied by four plumose setae and three simple setae on inner margin, terminal article a little longer than adjacent spines.

Telson (Fig. 19F): cleft, approx. as long as wide; each lobe with one spine accompanied by two setae and two clusters of three setae on surface, bearing two distal spines accompanied by setae.

Habitat. Specimens were collected from a geyser in Tiantai Mountain National Forest Park. The geyser is influenced by the formation of cavities in the deep strata. When the groundwater is filled with cavities, the geyser will erupt from the rock cracks. The intermittent geyser is considered as person's breathing, therefore it is known as a breathing spring. This park is located in the middle of the southern slope of Qinling with lush forests; the topography is full of deep valleys and steep mountains.

Remarks. The new species of *Gammarus zhigangi* Hou & Li, sp. n. is most similar to *Gammarus qinling* Hou & Li, sp. n. in antenna II calceoli present; merus of pereopod III with straight setae on posterior margin; and epimeral plates II and III blunt on posterodistal corners. *Gammarus zhigangi* Hou & Li, sp. n. differs from *Gammarus qinling* Hou & Li, sp. n. (*Gammarus qinling* in parentheses) by pereopod V of male and female with more setae on anterior margin of merus; and uropod III inner ramus 0.6 times the length of outer ramus (0.5 times), outer margin of outer ramus with no plumose setae (with plumose setae).

The new species of *Gammarus zhigangi* Hou & Li, sp. n. is similar to *G. preciosus* Wang, Hou & Li, 2009 in antenna II calceoli present; uropod III without plumose setae on outer margin of outer ramus, and terminal article longer than adjacent spines; and telson long than wide. *Gammarus zhigangi* Hou & Li, sp. n. can be distinguished from *G. preciosus* Wang, Hou & Li, 2009 (*G. preciosus* in parentheses) in epimeral plate I with three setae and two spines on anteroventral margin (with eight long setae on anteroventral margin); epimeral plate III with five setae on posterior margin (with 11 setae on posterior margin); and uropod III inner ramus 0.6 times the length of outer ramus (inner ramus 0.4 times the length of outer ramus).

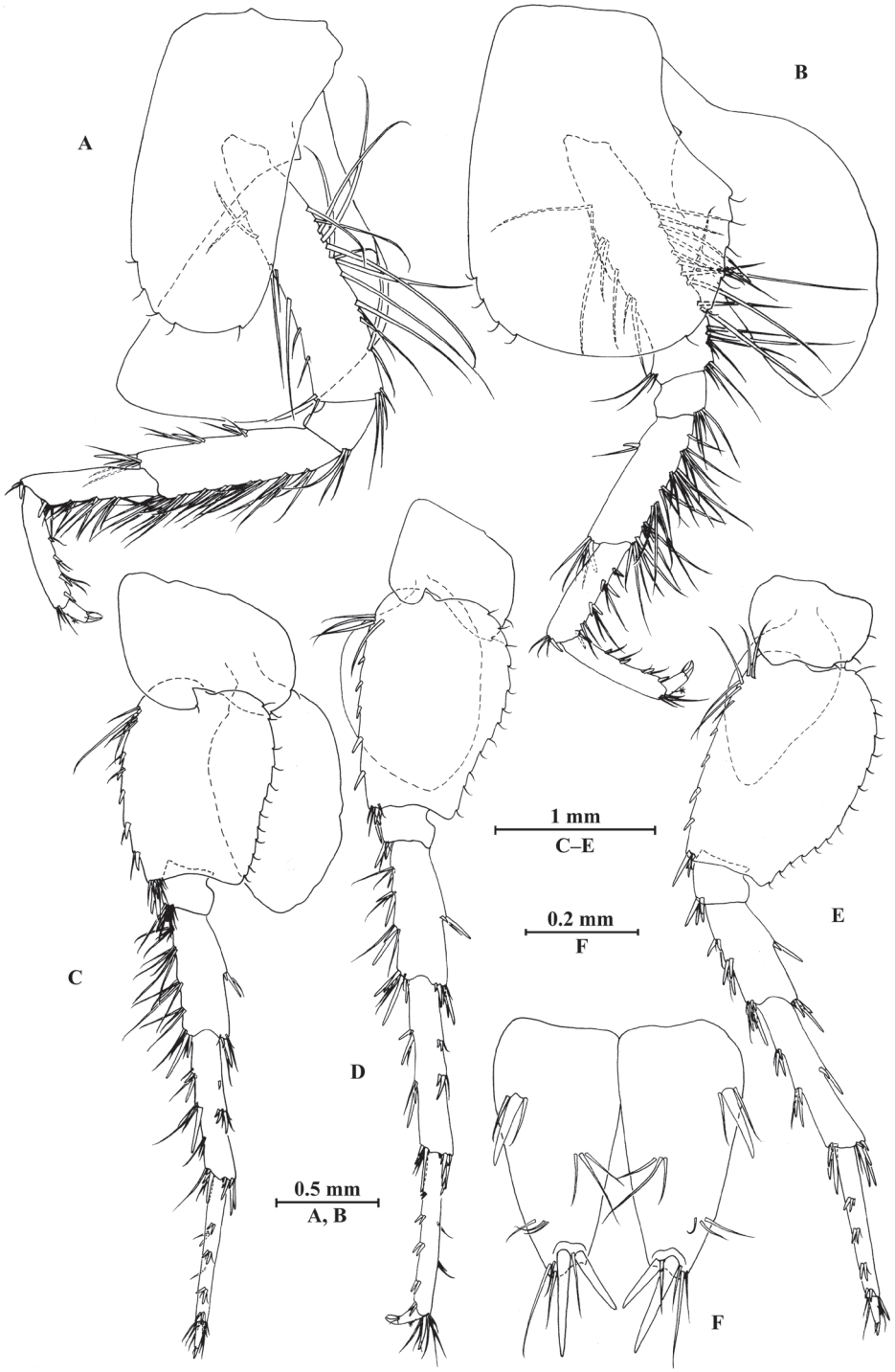

Figure 19. *Gammarus zhigangi* Hou & Li, sp. n., female paratype. **A** pereopod III **B** pereopod IV **C** pereopod V **D** pereopod VI **E** pereopod VII **F** telson.

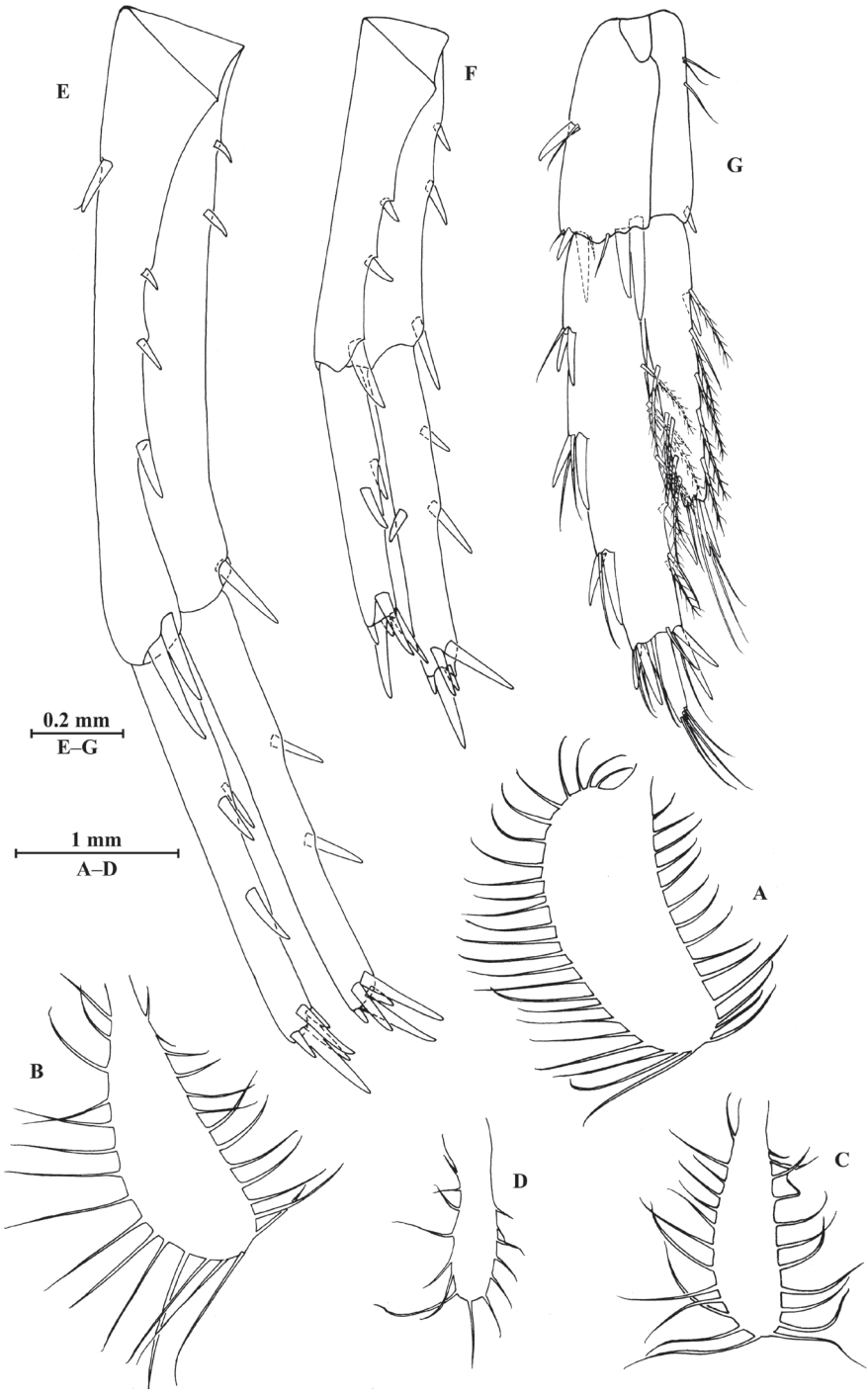

Figure 20. *Gammarus zhigangi* Hou & Li, sp. n., female paratype. **A** oostegite of gnathopod II **B** oostegite of pereopod III **C** oostegite of pereopod IV **D** oostegite of pereopod V **E** uropod I **F** uropod II **G** uropod III.

This new species can be distinguished from *G. murarius* Hou & Li, 2004 (*G. murarius* in parentheses) by the following characters: merus and carpus of pereopod III with straight setae on posterior margins (with long curled setae); epimeral plate I bearing three setae and two spines on anteroventral margin (only with four setae); and uropod III without plumose setae on outer margin of outer ramus (with plumose).

***Gammarus jidutanxian* Hou & Li, sp. n.**
http://zoobank.org/3CB909C4-CF89-4BB6-B94B-580A94E6147C
Figs 21–26

Material examined. Holotype: male (IZCAS-I-A1439-1), 8.2 mm, Langao County (108.91°E, 32.29°N), altitude 529 m, Ankang City, Shaanxi Province, China, October 28, 2013, collected by Yunchun Li and Jincheng Liu. Paratype: female (IZCAS-I-A1439-2), 9.8 mm, same data as holotype. Paratype: male (IZCAS-I-A1804), 8.5 mm, Huiwan Town (109.84°E, 32.15°N), Zhuxi County, Shiyan City, Hubei Province, August 28, 2015, collected by Chunjiang Sang.

Etymology. The species name is a Chinese phrase, "*jidutanxian*", meaning "adventure exploration", in honour of Mr. Chunjiang Sang extensively exploring karst biota in southern China; noun in apposition.

Diagnosis. Antenna II peduncle with long setae, calceoli absent; epimeral plate III with subacute posterodistal corner; uropod III inner ramus reaching 0.6 times the length of outer ramus, outer ramus with no plumose setae on outer margin, terminal article of outer ramus shorter than adjacent spines; each lobe of telson with plumose setae on surface.

Description of holotype male (IZCAS-I-A1439-1). 8.2 mm.

Head (Fig. 21A): eyes oval, inferior antennal sinus deep, lateral cephalic lobe rounded.

Antenna I (Fig. 21B, C): peduncle articles I–III in length ratio 1.0: 0.7: 0.4, with distal setae; flagellum with 30 articles, articles VII–XXV with aesthetascs; accessory flagellum with four articles; both primary and accessory flagella with short distal setae.

Antenna II (Fig. 21D): peduncle articles III–V in length ratio 1.0: 2.7: 2.3, articles IV–V with long setae along anterior and posterior margins; flagellum with 11 articles, each article with long setae; calceoli absent.

Upper lip (Fig. 21E): ventral margin rounded, bearing short minute setae.

Mandible (Fig. 21G, H): left mandible incisor with five teeth; lacinia mobilis with four teeth; spine row with five pairs of plumose setae; articles I–III of palp in length ratio 1.0: 3.9: 2.5, second article with nine marginal setae, article III with four A-setae, eight B-setae, a row of D-setae, and five E-setae apically; incisor of right mandible with four teeth, lacinia mobilis bifurcate, with small teeth.

Lower lip (Fig. 21F): inner lobes lacking, outer lobes covered with thin setae.

Maxilla I (Figs 21I, J): asymmetrical, left inner plate with 13 plumose setae on medial margin; outer plate with 11 robust serrated apical spines, each spine with small

teeth; second article of left palp with seven slender spines apically; second article of right palp with four stout spines, one stiff seta and one slender spine.

Maxilla II (Fig. 21K): inner plate with 12 plumose setae in an oblique row; inner and outer plates with long setae apically.

Maxilliped (Fig. 21L): inner plate with three stout apical spines and one subapical spine, 15 plumose setae along lateral margin; outer plate bearing a row of 14 blade spines and four plumose setae apically; article IV of palp hooked, with three setae at hinge of unguis.

Pereon. *Gnathopod I* (Fig. 22A, B): coxal plate bearing four setae and two setae on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins; carpus 1.4 times as long as wide, 0.8 times as long as propodus, posterior margin bearing four clusters of short setae; propodus oval, palm with one medial spine and 11 spines and clusters of simple setae on posterior margin and surface; dactylus with one seta on outer margin.

Gnathopod II (Fig. 22C, D): coxal plate bearing four setae and one seta on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins; carpus 2.0 times as long as wide, approx. as long as propodus, bearing seven clusters of long setae along ventral margin, three clusters of setae on dorsal margin; propodus subrectangular, palm margin with one medial spine and four spines on posterodistal corner; dactylus with one seta on outer margin.

Pereopod III (Fig. 23A, B): coxal plate bearing three setae on anterior margin and one seta on posterior margin; basis elongated, with setae along anterior and posterior margins; merus with long straight setae on posterior margin and two spines accompanied by two setae on anterior margin, anterodistal corner with one spine accompanied by three setae; carpus with four clusters of spines accompanied by straight setae on posterior margin; propodus with three clusters of spines accompanied by setae on posterior margin and two spines on posterodistal corner; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

Pereopod IV (Fig. 23C, D): coxal plate concave, bearing four setae on anterior margin and six setae on posterior margin; basis with long setae along anterior and posterior margins; merus with clusters of setae on posterior margin and one spine accompanied by one seta on anterior margin, anterodistal corner with one spine accompanied by four setae; carpus and propodus with three groups of spines accompanied by setae on posterior margins; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

Pereopod V (Fig. 23E, F): coxal plate bearing one seta on anterior margin and two setae on posterior margin; basis with five setae and seven spines accompanied by fine setae on anterior margin, anterodistal corner with two spines accompanied by setae, posterior margin with a row of 14 setae; merus with two spines accompanied by setae on anterior margin and one spine accompanied by seta on posterior margin, anterodistal and posterodistal corners with one and two spines accompanied by setae respectively; carpus and propodus with groups of spines on anterior margins; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

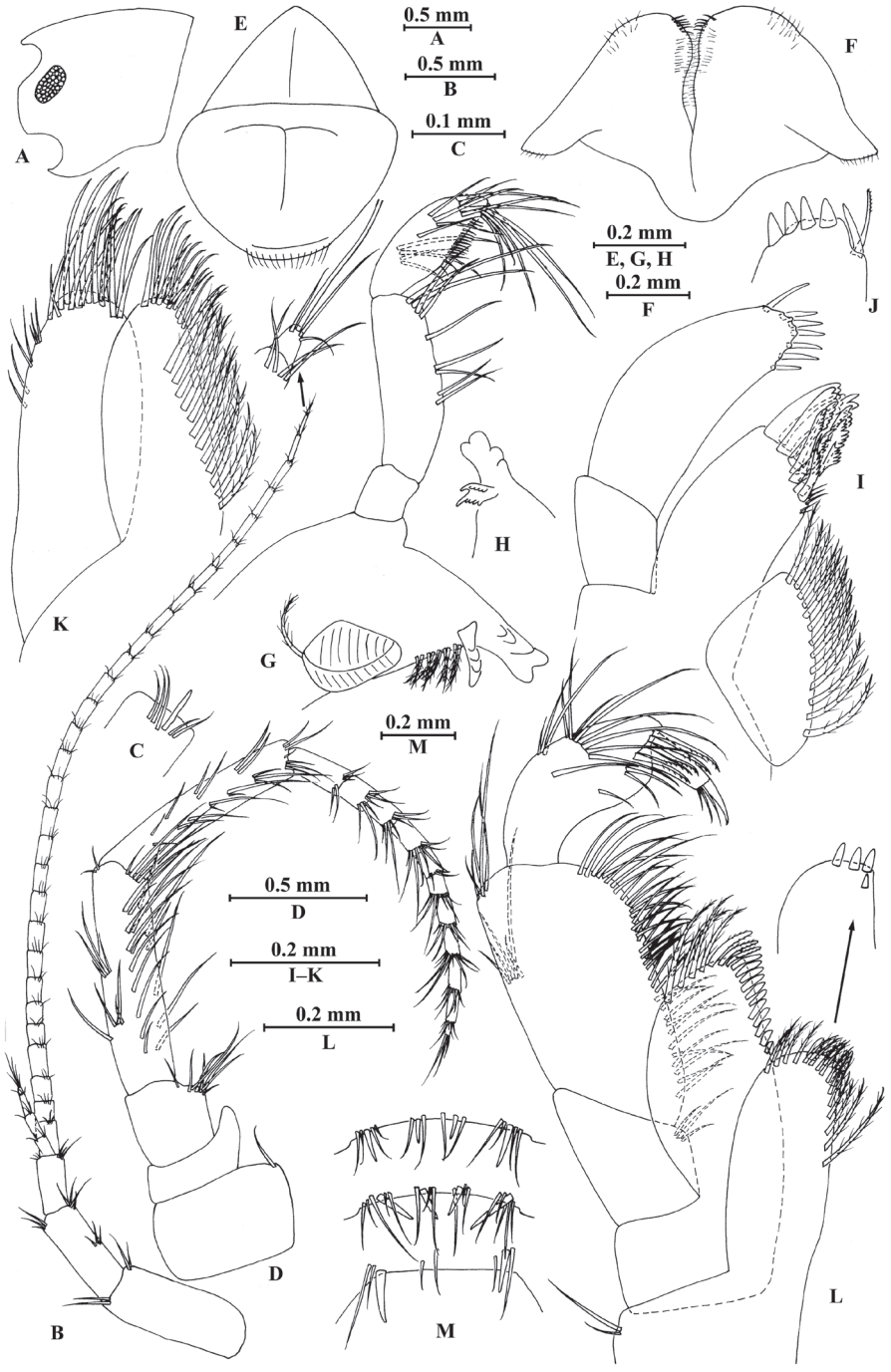

Figure 21. *Gammarus jidutanxian* Hou & Li, sp. n., male holotype. **A** head **B** antenna I **C** flagellar article of antenna I with aesthetasc **D** antenna II **E** upper lip **F** lower lip **G** left mandible **H** incisor and lacinia mobilis of right mandible **I** left maxilla I **J** distal part of palp article II of right maxilla I **K** maxilla II **L** maxilliped **M** dorsal margins of urosomites I–III.

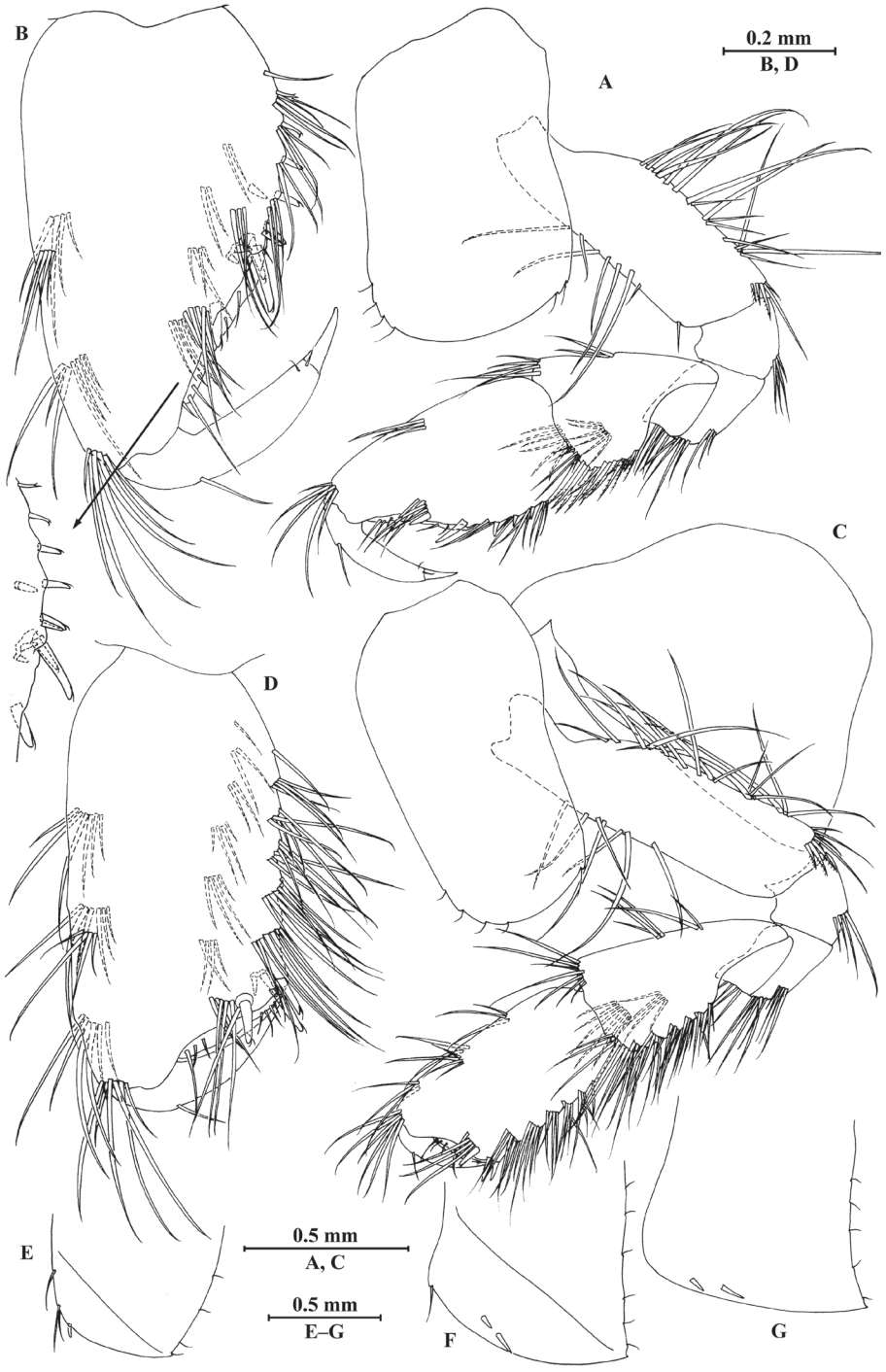

Figure 22. *Gammarus jidutanxian* Hou & Li, sp. n., male holotype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C** gnathopod II **D** propodus and dactylus of gnathopod II **E** epimeral plate I **F** epimeral plate II **G** epimeral plate III.

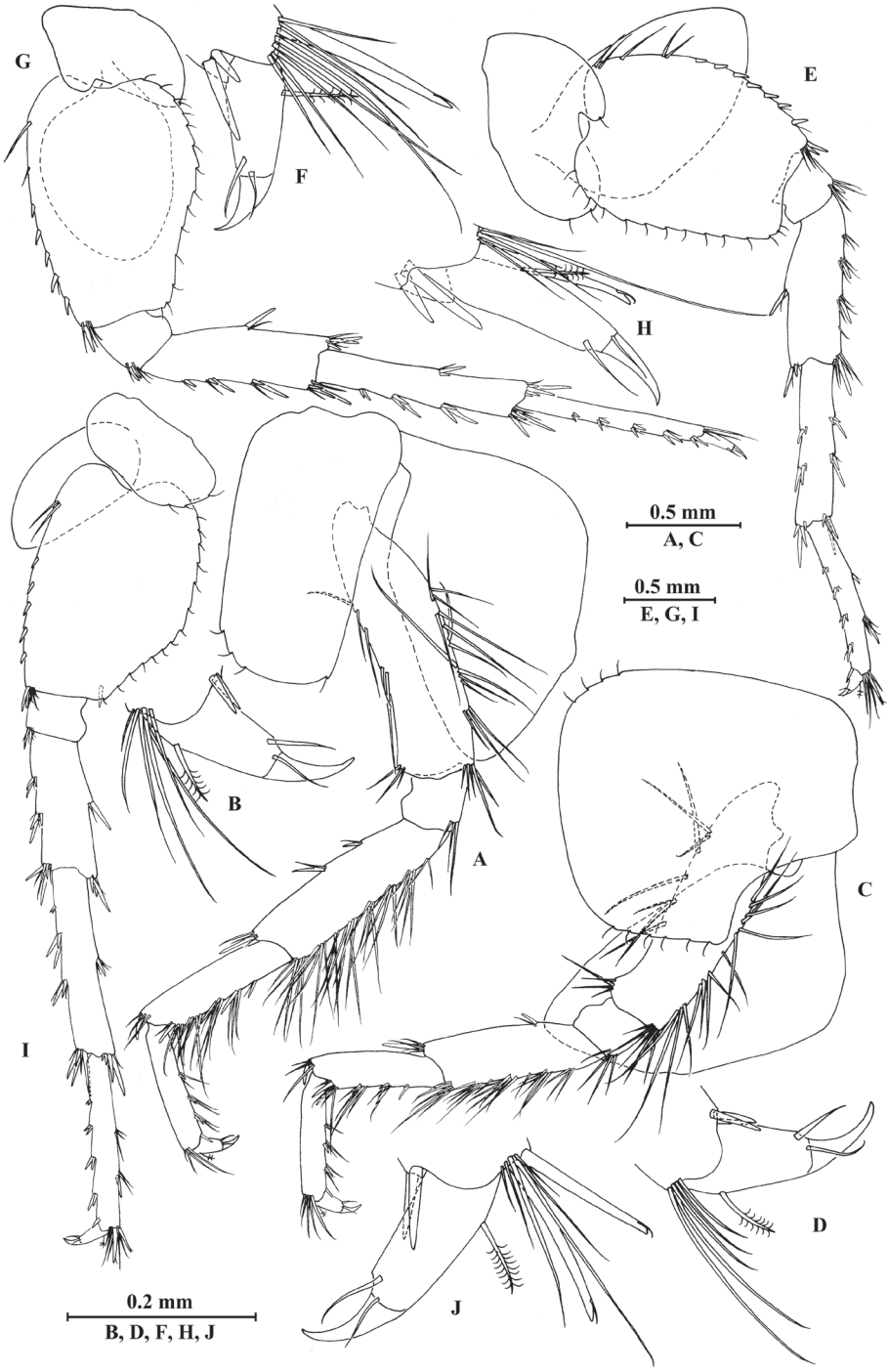

Figure 23. *Gammarus jidutanxian* Hou & Li, sp. n., male holotype. **A** pereopod III **B** dactylus of pereopod III **C** pereopod IV **D** dactylus of pereopod IV **E** pereopod V **F** dactylus of pereopod V **G** pereopod VI **H** dactylus of pereopod VI **I** pereopod VII **J** dactylus of pereopod VII.

Pereopod VI (Fig. 23G, H): coxal plate bearing one seta on posterior margin; basis with two setae and five spines accompanied by one seta on anterior margin, anterodistal corner with one spine and three fine setae, posterior margin with a row of 14 fine setae; merus to propodus with groups of spines accompanied by short setae on anterior margins; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Pereopod VII (Fig. 23I, J): coxal plate bearing three setae on posterior margin; basis with two simple setae and five spines on anterior margin, anterodistal corner with two spines accompanied by fine setae, posterior margin with a row of 15 setae, and with one spine on inner surface; merus to propodus with groups of spines accompanied by short setae on anterior margins; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Coxal gills: coxal gills of gnathopod II and pereopod III a little shorter than bases; gill of pereopod IV longer than basis; gills of pereopods V and VI shorter than bases; gill of pereopod VII smallest, less than half the length of basis.

Pleon. *Epimeral plates* (Fig. 22E–G): plate I ventrally rounded, bearing three setae and one spine on anteroventral margin and four setae on posterior margin; plate II with one seta and two spines on ventral margin and six setae on posterior margin, posterodistal corner blunt; plate III with two spines on ventral margin and five setae on posterior margin, posterodistal corner subacute.

Pleopods I–III (Fig. 24A–C): similar, peduncle with two retinacula accompanied by one seta; outer ramus as long as inner ramus, both rami fringed with plumose setae.

Urosome. *Urosomites* (Fig. 21M): urosomites I and II with one-one-one-one spines accompanied by setae on dorsal margins; urosomite III with one spine accompanied by two setae on each side and two setae on dorsal margin.

Uropods I–III (Figs 24D–F): uropod I peduncle with one basofacial spine, three and two spines on inner and outer margins, respectively, inner and outer distal corners with one and two spines, respectively; inner ramus with two spines on inner margin; outer ramus with two spines on inner and outer margins each; both rami with five terminal spines. Uropod II peduncle with two spines on inner margin and one spine on outer margin, and with one distal spine on each corner; inner ramus with two spines on inner margin; outer ramus with two spines on outer margin; both rami with five terminal spines. Uropod III peduncle with three setae on surface and six distal spines; inner ramus 1.2 times as long as peduncle, reaching 0.6 times the length of outer ramus, with two spines accompanied by seven plumose setae on inner margin, five plumose setae on outer margin, and two distal spines accompanied by setae; proximal article of outer ramus with three pairs of spines accompanied by simple setae on outer margin, with ten plumose setae on inner margin, terminal article with simple setae, shorter than adjacent spines.

Telson (Fig. 24G): deeply cleft, approx. as long as wide; each lobe with three simple setae and two plumose setae on surface, bearing two distal spines accompanied by setae.

Description of paratype female (IZCAS-I-A1439-2). 9.8 mm.

Pereon. *Gnathopod I* (Fig. 25A, B): coxal plate bearing four and two setae on anterior and posterior margins, respectively; basis with setae on anterior and posterior

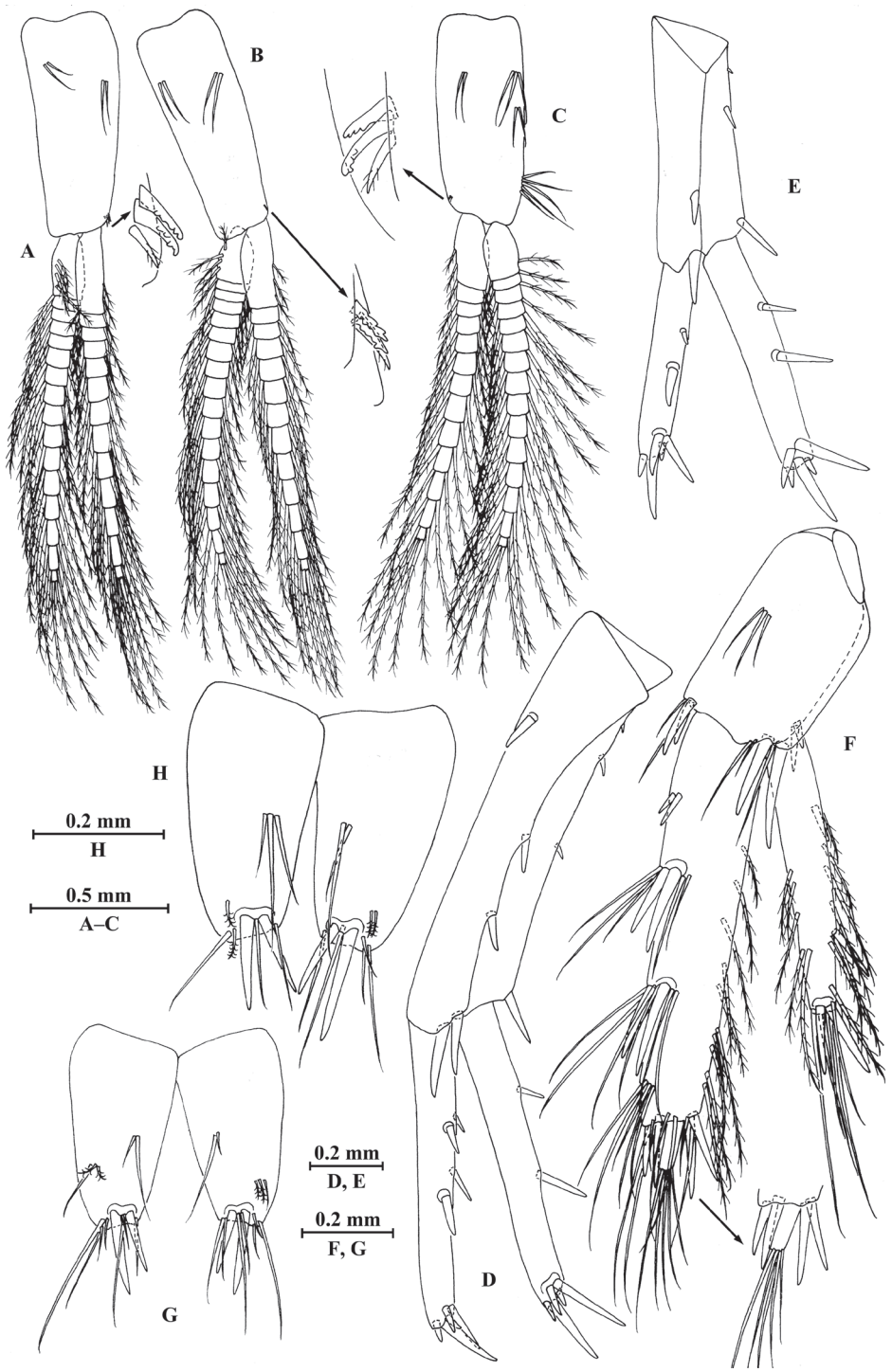

Figure 24. *Gammarus jidutanxian* Hou & Li, sp. n., **A–G** male, holotype; **H** female, paratype. **A** pleopod I **B** pleopod II **C** pleopod III **D** uropod I **E** uropod II **F** uropod III **G** telson **H** telson.

Figure 25. *Gammarus jidutanxian* Hou & Li, sp. n., female paratype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C** gnathopod II **D** propodus and dactylus of gnathopod II **E** oostegite of gnathopod II **F** oostegite of pereopod III **G** oostegite of pereopod IV **H** oostegite of pereopod V.

margins; propodus oval, palm with seven spines on posterior margin, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Gnathopod II (Fig. 25C, D): coxal plate bearing four and one seta on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins; propodus subrectangular, palm margin with four spines on posterodistal corner, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Pereopods III and IV (Fig. 26A, B): with fewer setae on posterior margins than those of male.

Pereopods V–VII (Fig. 26C–E): similar to those of male.

Oostegite (Fig. 25E–G): oostegite of gnathopod II broad, oostegites of pereopods III and IV elongated, oostegite of pereopod V smallest.

Urosome. *Uropods I–III* (Fig. 26F–H): uropod I peduncle with one basofacial spine, with one and three spines on inner and outer margins, respectively, with one and two spines on inner and outer corners; inner ramus with two spines on inner margin; outer ramus with one and two spines on inner and outer margins, respectively; both rami with five terminal spines. Uropod II peduncle with one spine on inner and outer margins each, with one distal spine on each corner; inner ramus with two spines on inner margin; outer ramus with two spines on outer margin; both rami with five terminal spines. Uropod III peduncle with setae on surface and six distal spines; inner ramus 1.4 times as long as peduncle, reaching 0.8 times the length of outer ramus, with one spine accompanied by four plumose setae and one simple seta on inner margin and two plumose setae accompanied by one simple setae on outer margin; proximal article of outer ramus with a single spine and two pairs of spines accompanied by simple setae on outer margin, with five plumose setae and four simple setae on inner margin, terminal article shorter than adjacent spines.

Telson (Fig. 24H): cleft, approx. as long as wide; each lobe with three or two simple setae and two plumose setae on surface, bearing two distal spines accompanied by setae.

Habitat. This species was collected along the shore of a brook, usually in gravel and decomposing leaves. The type locality is located in a valley of north part of Daba Mountain.

Remarks. The new species of *Gammarus jidutanxian* Hou & Li, sp. n. is most similar to *G. craspedotrichus* Hou & Li, 2002 in antenna II with long setae along peduncular articles and calceoli absent; and outer margin of outer ramus in uropod III with simple setae. It differs from *G. craspedotrichus* (*G. craspedotrichus* in parentheses) in peduncle of uropod I with one basofacial spine (without basofacial spine); inner ramus reaching 0.6 times of outer ramus in uropod III (inner ramus approx. as long as outer ramus); and urosomites with four groups of spines and setae (with two clusters of spines and setae).

The new species of *Gammarus jidutanxian* Hou & Li, sp. n. is most similar to *G. vallecula* Hou & Li, sp. n. in antenna II with long setae on peduncle margin and calceoli absent; pereopods III and IV with straight setae on posterior margin; and urosomites with four groups of spines and setae on dorsal margin. *Gammarus jidutanxian* Hou & Li, sp. n. can be distinguished from *G. vallecula* Hou & Li, sp. n. (*G. vallecula*

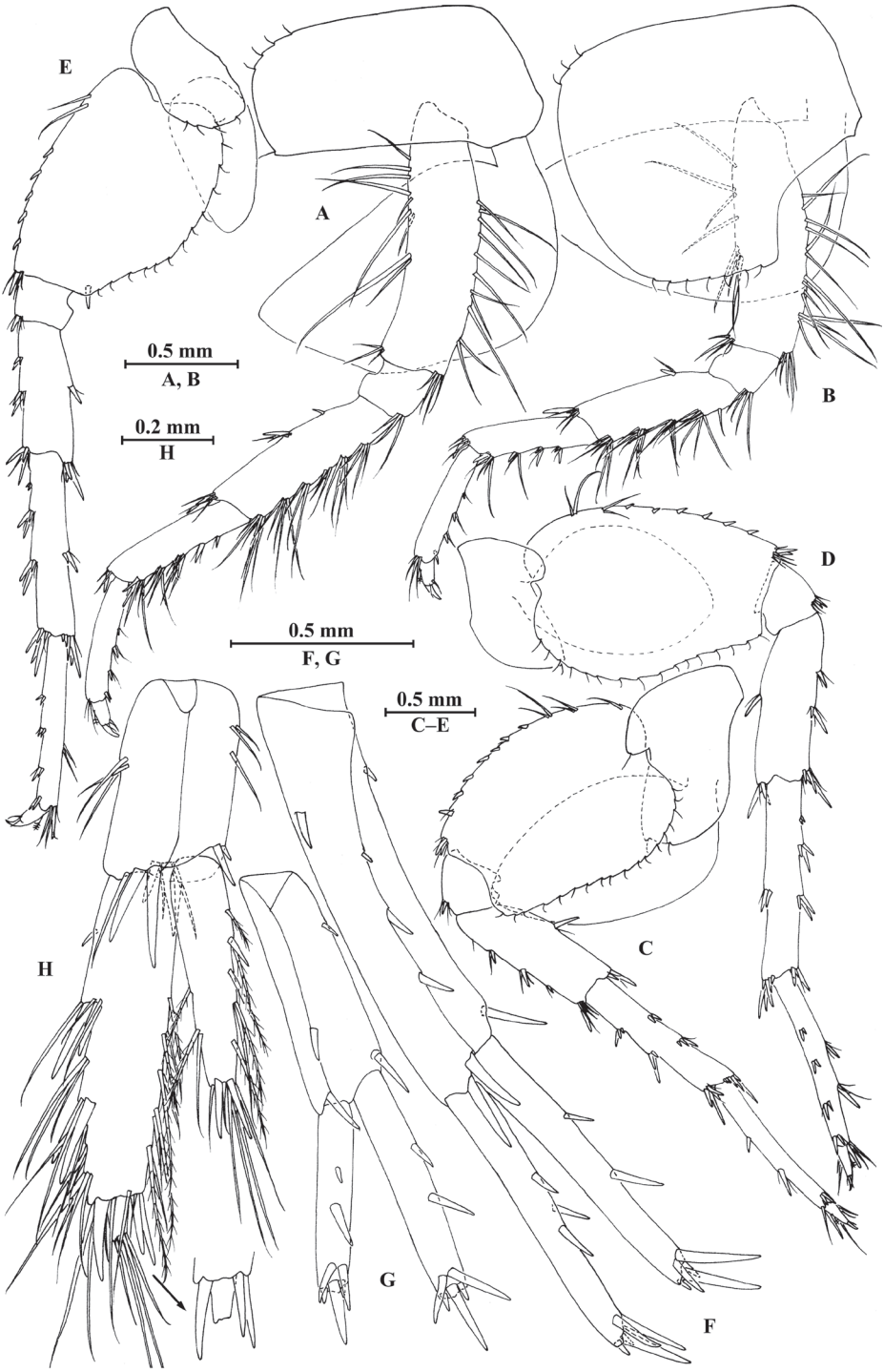

Figure 26. *Gammarus jidutanxian* Hou & Li, sp. n., female paratype. **A** pereopod III **B** pereopod IV **C** pereopod V **D** pereopod VI **E** pereopod VII **F** uropod I **G** uropod II **H** uropod III.

in parentheses) in uropod III inner ramus reaching 0.6 times the length of outer ramus, terminal article shorter than adjacent spines (inner ramus approx. half the length of outer ramus, terminal article subequal or longer than adjacent spines); and telson as long as wide, with no spines on surface (telson 0.8 times as long as wide, each lobe with one spine accompanied by setae on surface).

Gammarus jidutanxian Hou & Li, sp. n. differs from *Gammarus accretus* Hou & Li, 2002a (*G. accretus* in parentheses) by urosomites I and II with one-one-one-one spines accompanied by setae on dorsal margins (with only one group of setae); uropod I peduncle with one basofacial spine (without basofacial spine); and inner ramus of uropod III 0.6 times the length of outer ramus (approx. the same length).

Gammarus longdong Hou & Li, sp. n.

http://zoobank.org/0FF3D2CA-932A-4ABE-B222-22AE4922DC1B
Figs 27–32

Material examined. Holotype: male (IZCAS-I-A1566-1), 10.1 mm, Qinglong Cave (103.75°E, 27.69°N), altitude 1289 m, Mohan Town, Daguan County, Zhaotong City, Yunnan Province, China, March 18, 2014, collected by Yunchun Li and Jincheng Liu. Paratype: female (IZCAS-I-A1566-2), 7.3 mm, same data as holotype.

Etymology. The species name is taken from the Chinese word, "*longdong*" meaning "Dragon Cave", referring to a cave filled with water; noun in apposition.

Diagnosis. Peduncle of antenna II with long setae, calceoli absent; merus and carpus of pereopod III with clusters of long setae on posterior margins; epimeral plates II and III with subacute posterodistal corners; uropod I peduncle with no basofacial spine; inner ramus of uropod III reaching 0.9 times the length of outer ramus, terminal article vestigial.

Description of holotype male (IZCAS-I-A1566-1). 10.1 mm.

Head (Fig. 27A): eyes reniform, inferior antennal sinus deep.

Antenna I (Fig. 27B, C): peduncle articles I–III in length ratio 1.0: 0.8: 0.4, with distal setae; flagellum with 31 articles, articles V–XXX with aesthetascs; accessory flagellum with four articles; both primary and accessory flagella with short distal setae.

Antenna II (Fig. 27D): peduncle articles III–V in length ratio 1.0: 2.9: 2.7, articles IV–V of peduncle with lateral and medial setae; flagellum with 11 articles, each article with long setae; calceoli absent.

Upper lip (Fig. 27E): ventral margin rounded, bearing short minute setae.

Mandible (Fig. 27G, H): left mandible incisor with five teeth; lacinia mobilis with four teeth; spine row with six pairs of plumose setae; articles I–III of palp in length ratio 1.0: 2.7: 2.0, second article with 15 marginal setae, article III with four A-setae, four B-setae, a row of D-setae, and five E-setae apically; incisor of right mandible with four teeth, lacinia mobilis bifurcate, with small teeth.

Lower lip (Fig. 27F): inner lobes lacking, outer lobes covered with thin setae.

Maxilla I (Fig. 27I, J): asymmetrical, left inner plate with 15 plumose setae on medial margin; outer plate with 11 robust serrated apical spines; second article of left palp

with nine slender spines apically; second article of right palp with four stout spines, one stiff seta and one slender spine.

Maxilla II (Fig. 27K): inner plate with 12 plumose setae in an oblique row; inner and outer plates with long setae apically.

Maxilliped (Fig. 27L): inner plate with three stout apical spines, one subapical spine, and 20 plumose setae; outer plate bearing a row of 17 blade spines and three plumose setae apically; article IV of palp hooked, with a group of setae at hinge of unguis.

Pereon. *Gnathopod I* (Fig. 28A, B): coxal plate bearing two setae and four setae on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins; merus bearing setae on posterodistal corner; carpus 1.7 times as long as wide, 0.75 times as long as propodus, bearing four clusters of setae along ventral margin and two clusters of setae on dorsal margin; propodus oval, palm with one medial spine and 12 spines on posterior margin and surface; dactylus with one seta on outer margin.

Gnathopod II (Fig. 28C, D): coxal plate bearing two setae and three setae on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins; merus bearing setae on posterodistal corner; carpus 1.9 times as long as wide, 0.8 times as long as propodus, bearing six clusters of setae along ventral margin and two clusters of setae on dorsal margin; propodus subrectangular, palm margin with one medial spine and four spines on posterodistal corner; dactylus with one seta on outer margin.

Pereopod III (Fig. 29A, B): coxal plate bearing three setae and two setae on anterior and posterior margins, respectively; basis elongated, with setae along anterior and posterior margins; merus with clusters of long setae on posterior margin and one spine on anterior margin, anterodistal corner with one spine accompanied by setae; carpus with two groups of long setae on posterior margin, anterodistal corner with one spine accompanied by setae and posterodistal corner with two spines accompanied by setae; propodus with three spines accompanied by setae on posterior margin and two spines on posterodistal corner; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

Pereopod IV (Fig. 29C, D): coxal plate concave, bearing two fine setae on anterior margin and five setae on posterior margin; basis with setae along anterior and posterior margins; merus with four clusters of setae on posterior margin and one spine accompanied by one seta on anterior margin, anterodistal corner with one spine accompanied by setae; carpus and propodus with three or four spines accompanied by setae on posterior margins; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

Pereopod V (Fig. 29E, F): coxal plate bearing one seta on anterior and posterior margins, respectively; basis expanded, with two setae and six spines on anterior margin, anterodistal corner with two spines accompanied by setae, posterior margin with a row of 13 setae; merus with two clusters of short setae on anterior margin and one spine accompanied by one seta on posterior margin, anterodistal corner with one spine accompanied by setae and posterodistal corner with two spines accompanied by setae; carpus and propodus with groups of spines accompanied by fine setae on anterior margins; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

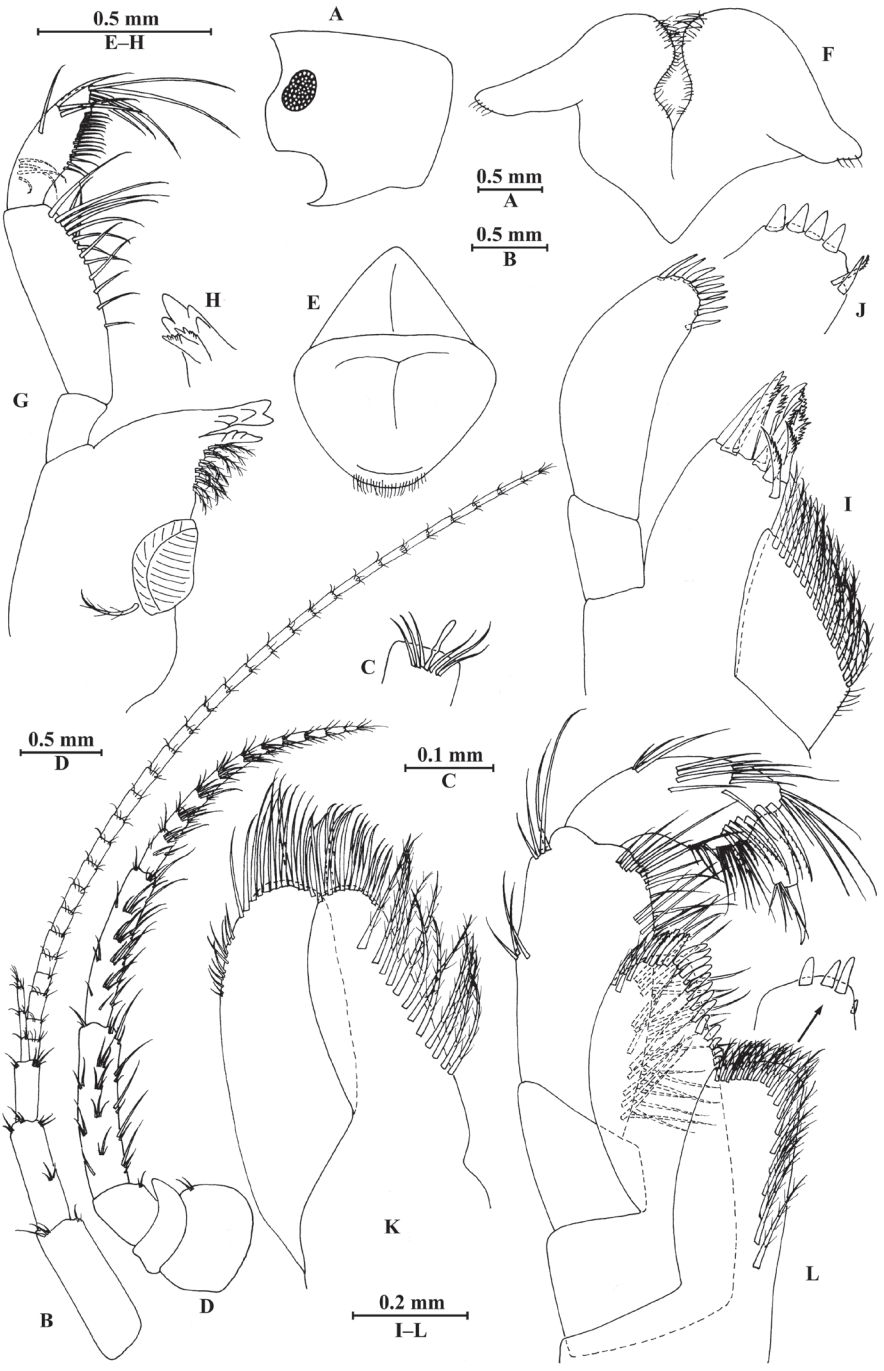

Figure 27. *Gammarus longdong* Hou & Li, sp. n., male holotype. **A** head **B** antenna I **C** flagellar article of antenna I with aesthetasc **D** antenna II **E** upper lip **F** lower lip **G** left mandible **H** incisor and lacinia mobilis of right mandible **I** left maxilla I **J** distal part of palp article II of right maxilla I **K** maxilla II **L** maxilliped.

Figure 28. *Gammarus longdong* Hou & Li, sp. n., male holotype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C** gnathopod II **D** propodus and dactylus of gnathopod II **E** dorsal margins of urosomites I–III.

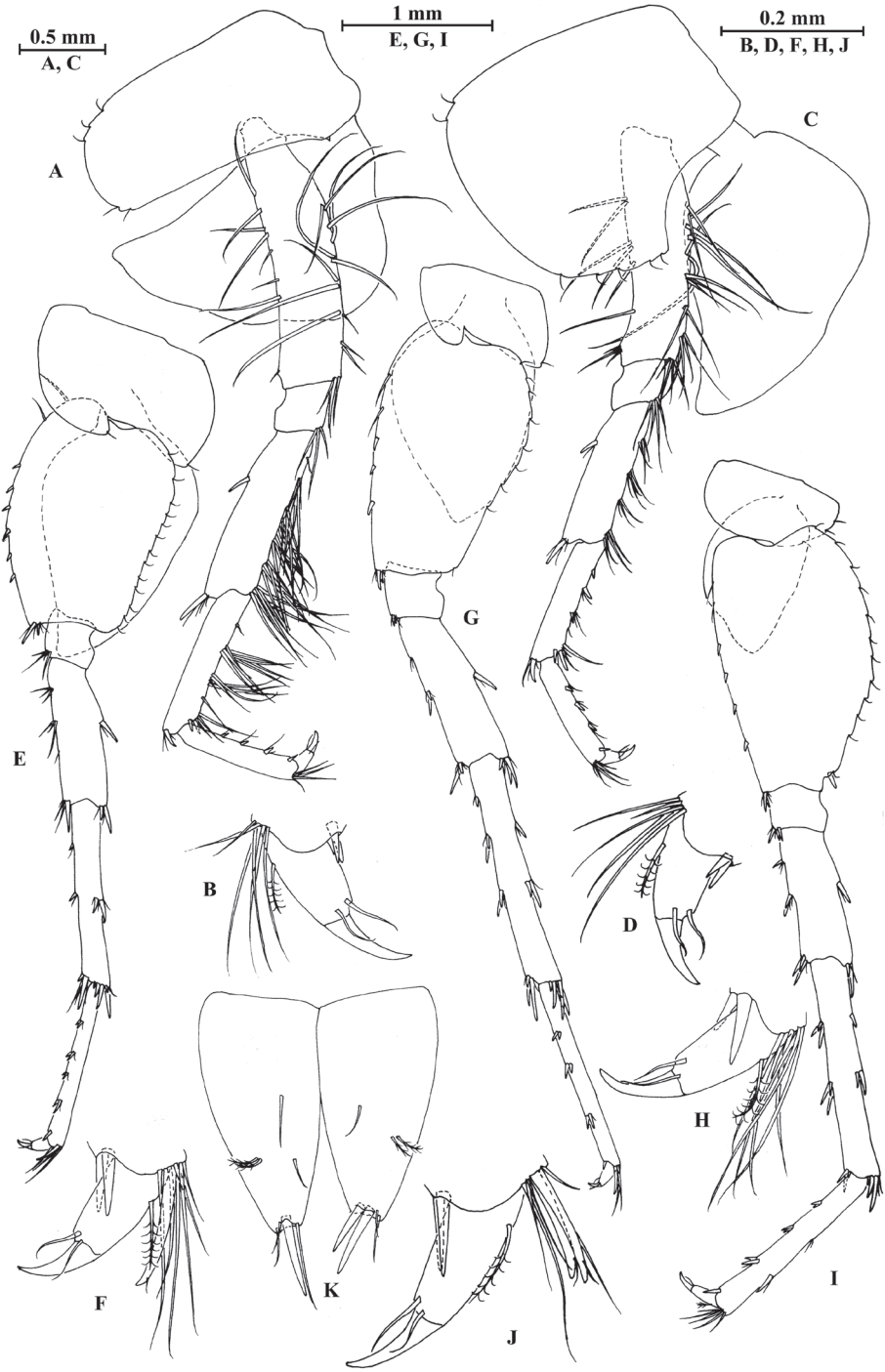

Figure 29. *Gammarus longdong* Hou & Li, sp. n., male holotype. **A** pereopod III **B** dactylus of pereopod III **C** pereopod IV **D** dactylus of pereopod IV **E** pereopod V **F** dactylus of pereopod V **G** pereopod VI **H** dactylus of pereopod VI **I** pereopod VII **J** dactylus of pereopod VII **K** telson.

Pereopod VI (Fig. 29G, H): coxal plate bearing one seta on posterior margin; basis elongated, with two setae and three spines on anterior margin, anterodistal corner with two spines accompanied by setae, posterior margin with a row of nine setae; merus with two spines accompanied by setae on anterior margin and one spine accompanied by one seta on posterior margin, anterodistal and posterodistal corners with two and three spines accompanied by setae respectively; carpus and propodus with three groups of spines accompanied by setae on anterior margins; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Pereopod VII (Figs 29I, J): coxal plate with three setae on posterior margin; basis with two setae and four spines on anterior margin, anterodistal corner with two spines accompanied by setae, posterior margin with a row of 12 setae and one spine; merus with two groups of spines accompanied by setae on anterior margin and one spine accompanied by one seta on posterior margin, anterodistal and posterodistal corners with three and two spines accompanied by one seta, respectively; carpus and propodus with two or three groups of spines on anterior margins; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Coxal gills: coxal gill of gnathopod II a little shorter than basis; gills of pereopods IV and V longer than bases; gills of pereopods III and VI more than half the length of bases; gill of pereopod VII smallest, less than half of the basis.

Pleon. *Epimeral plates* (Fig. 30A–C): plate I ventrally rounded, bearing eight long setae on anteroventral margin and five setae on posterior margin; plate II with one seta and one spine on ventral margin and seven setae on posterior margin, posterodistal corner subacute; plate III with one seta and two spines on ventral margin and six setae on posterior margin, posterodistal corner subacute.

Pleopods I–III (Fig. 30D–F): similar, peduncle with two or three retinacula accompanied by one or two setae; outer ramus slightly shorter than inner ramus, both rami fringed with plumose setae.

Urosome. *Urosomites* (Fig. 28E): urosomite I with one-one-one-one spines accompanied by setae on dorsal margin; urosomite II with one-one-one spines accompanied by setae on dorsal margin; urosomite III with one spine accompanied by two setae on each side.

Uropods I–III (Fig. 30G–I): uropod I peduncle with no basofacial spine and outer margin with one spine, inner and outer distal corners with one and two spines respectively; inner ramus with two spines on inner margin; outer ramus with two spines on inner and outer margins each; both rami with five terminal spines. Uropod II short, peduncle bearing one distal spine on each corner; inner ramus with two spines on inner margin; outer ramus with one spine and two spines on inner and outer margins, respectively; both rami with five terminal spines. Uropod III peduncle with three setae on surface and six distal spines; inner ramus 2.2 times as long as peduncle, reaching 0.9 times the length of outer ramus, with one spine accompanied by ten plumose setae and three simple setae on inner margin, with six plumose setae on outer margin and one spine accompanied by long setae distally; proximal article of outer ramus with three clusters of spines accompanied by simple setae on outer margin, with eight plumose setae on inner margin, and four distal spines, terminal article vestigial, with simple setae.

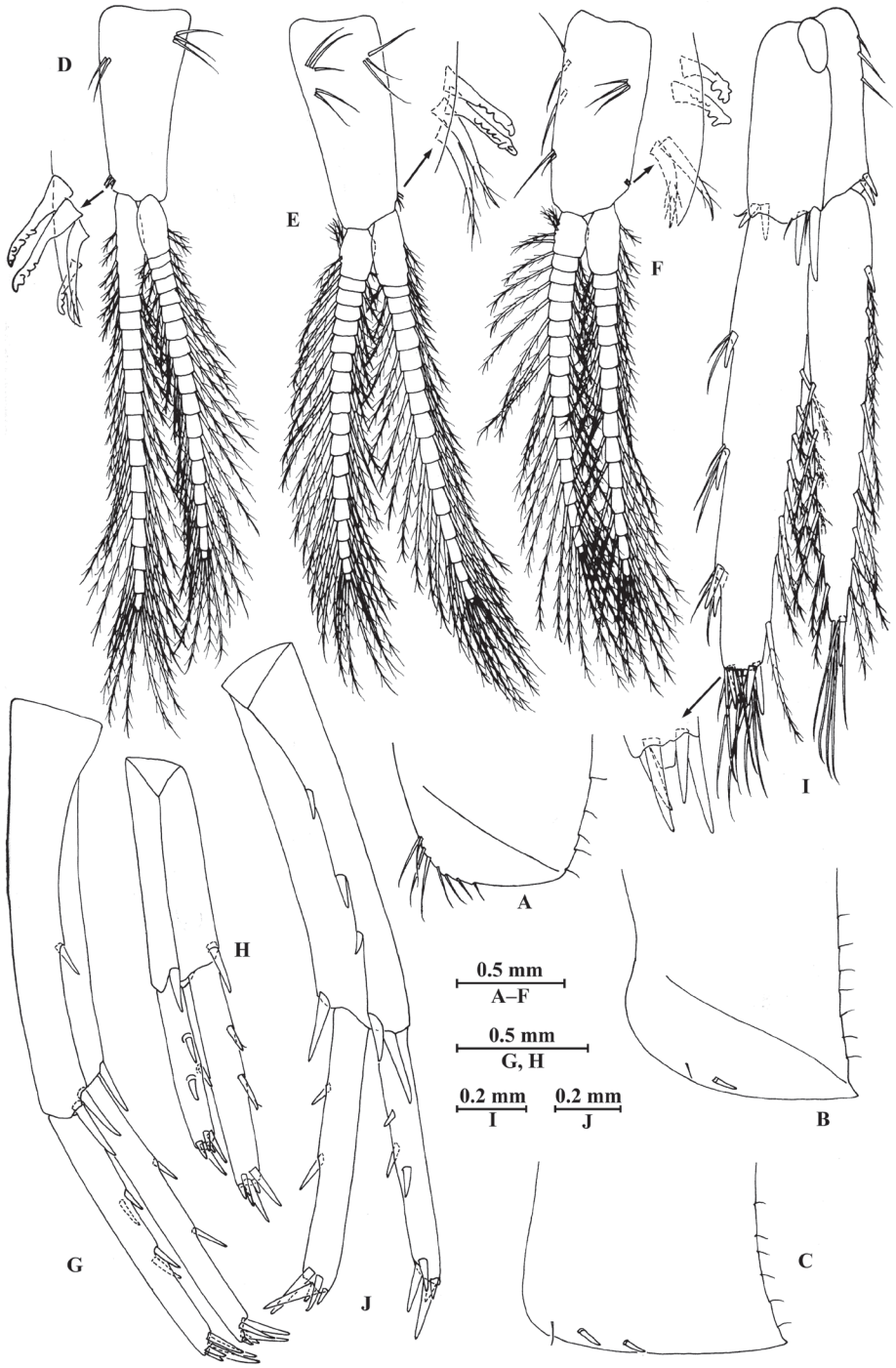

Figure 30. *Gammarus longdong* Hou & Li, sp. n., **A–I** male, holotype; **J** female, paratype. **A** epimeral plate I **B** epimeral plate II **C** epimeral plate III **D** pleopod I **E** pleopod II **F** pleopod III **G** uropod I **H** uropod II **I** uropod III **J** uropod I (right).

Telson (Fig. 29K): deeply cleft, approx. as long as wide, left lobe with two simple setae and two plumose setae on surface and with one distal spine accompanied by three setae; right lobe with one simple seta and two plumose setae on surface and with two distal spines accompanied by two setae.

Description of paratype female (IZCAS-I-A1566-2). 7.3 mm.

Pereon. *Gnathopod I* (Fig. 31A, B): coxal plate bearing two setae on anterior margin and three setae on posterior margin; basis with long setae on anterior and posterior margins; propodus oval, palm with ten spines on posterior margin, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Gnathopod II (Fig. 31C, D): coxal plate bearing three setae on anterior and posterior margins each; basis with setae on anterior and posterior margins; propodus subrectangular, palm margin with four spines on posterodistal corner, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Pereopod III (Fig. 32A): merus and carpus with shorter setae on posterior margins than that of male.

Pereopods IV–VII (Fig. 32B–E): similar to those of male.

Oostegite (Fig. 32I–L): oostegite of gnathopod II broad, with marginal setae, oostegites of pereopods III and IV elongated, oostegite of pereopod V smallest.

Urosome. *Uropods I–III* (Figs 30J; 32F, G): uropod I peduncle with no basofacial spine and outer margin with three spines, inner and outer distal corners with one and two spines respectively; inner ramus with two spines on inner margin; outer ramus with two spines on inner margin and one spine on outer margin; both rami with five terminal spines. Uropod II short, peduncle bearing one spine on inner margin, each corner with one distal spine; outer ramus with one spine on outer and inner margins each; inner ramus with two spines on inner margin; both rami with five terminal spines. Uropod III peduncle with three setae on surface and five distal spines accompanied by setae; inner ramus 1.5 times as long as peduncle, reaching 0.9 times the length of proximal article of outer ramus, with one spine and plumose setae on inner margin, two plumose setae and one simple seta on outer margin; proximal article of outer ramus with three pairs of spines accompanied by simple setae on outer margin and five plumose setae on inner margin, terminal article much shorter than adjacent spines.

Telson (Fig. 32H): cleft, 0.9 times as long as wide, each lobe with simple setae on surface and with one distal spine accompanied by setae.

Habitat. The species was collected in Qinglong Cave Park. The park has a limestone karst mountain landscape. There is an underground river winding through the cave before flowing into a pool. Individuals are found along the bank of river, with no vegetation.

Remarks. The new species of *Gammarus longdong* Hou & Li, sp. n. is similar to *G. craspedotrichus* Hou & Li, 2002 in antenna II with long setae along peduncle margin, calceoli absent; pereopod III merus and carpus with long setae on posterior margins; and uropod I with no basofacial spine. *Gammarus longdong* Hou & Li, sp. n. can be distinguished from *G. craspedotrichus* Hou & Li, 2002 by the following characters (*G. craspedotrichus* in parentheses): urosomites I and II with four groups of spines and setae

Figure 31. *Gammarus longdong* Hou & Li, sp. n., female paratype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C** gnathopod II **D** propodus and dactylus of gnathopod II.

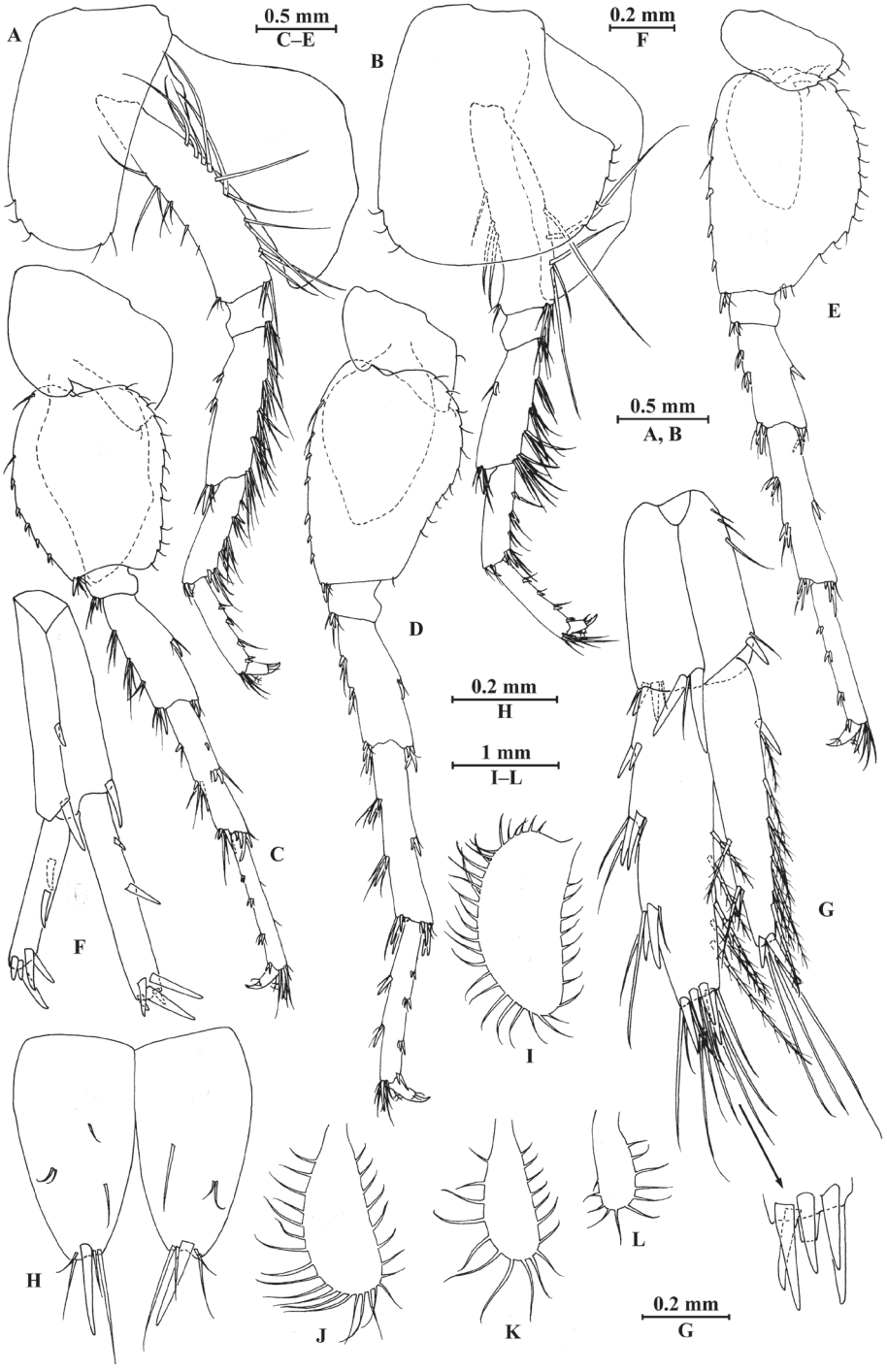

Figure 32. *Gammarus longdong* Hou & Li, sp. n., female paratype. **A** pereopod III **B** pereopod IV **C** pereopod V **D** pereopod VI **E** pereopod VII **F** uropod II **G** uropod III **H** telson **I** oostegite of gnathopod II **J** oostegite of pereopod III **K** oostegite of pereopod IV **L** oostegite of pereopod V.

(with two clusters of spines and setae); and uropod III terminal article vestigial (short but distinct).

The new species of *Gammarus longdong* Hou & Li, sp. n. is similar to *jidutanxian* Hou & Li, sp. n. in antenna II peduncle with long setae, calceoli absent; and uropod III outer ramus with no plumose setae on outer margin. It can be distinguished from *G. jidutanxian* Hou & Li, sp. n. (*G. jidutanxian* in parentheses) in uropod I without basofacial spine (with one basofacial spine); and uropod III inner ramus reaching 0.9 times the length of outer ramus (inner ramus 0.6 times the length of outer ramus).

The new species is similar to *G. egregius* Hou, Li & Li, 2013 in accessory flagellum of antenna I with four articles; antenna II calceoli absent; and uropod I peduncle without basofacial spine. The new species can be distinguished from *G. egregius* Hou, Li & Li, 2013 by the following characters (*G. egregius* in parentheses): urosomite I with one-one-one-one spines accompanied by setae on dorsal margin (bare); urosomite II with one-one-one spines accompanied by setae on dorsal margin (with two single spines); inner ramus of uropod III 0.9 times the length of proximal article of outer ramus (0.6 times the length of outer ramus); and both rami of uropod III with plumose setae on inner margins (simple setae).

The new species is similar to *G. platvoeti* Hou & Li, 2003a in accessory flagellum of antenna I with four articles; antenna II calceoli absent; epimeral plates II and III with subacute posterodistal corners; and uropod I peduncle without basofacial spine. It differs from *G. platvoeti* Hou & Li, 2003a (*G. platvoeti* in parentheses) by merus and carpus of pereopod III with long setae on posterior margins (with a few short setae); urosomites I and II with spines accompanied by setae on dorsal margin (only with setae); inner ramus of uropod III 0.9 times the length of proximal article of outer ramus (0.85 times the length of outer ramus); and both lobes of telson with simple and plumose setae on surface (bare).

***Gammarus mosuo* Hou & Li, sp. n.**

http://zoobank.org/FF370401-2EC9-4E35-B043-11FBFE09FB87

Figs 33–38

Material examined. Holotype: male (IZCAS-I-A1570-1), 8.0 mm, Yanyuan County (101.53°E, 27.40°N), altitude 2620 m, Xichang City, Sichuan Province, China, March 23, 2014, collected by Yunchun Li and Jincheng Liu. Paratype: female (IZCAS-I-A1570-2), 6.4 mm, same data as holotype.

Etymology. The name derives from the Mosuo people, living in the type locality; noun in apposition.

Diagnosis. Antenna II calceoli absent; merus to carpus of pereopod III with clusters of long setae on posterior margins; pereopods V–VII with long setae on anterior margins; epimeral plate II with five plumose setae, two simple setae and one spine on ventral margin, posterodistal corner blunt; urosomites with two clusters of spines accompanied by setae on dorsal margins; inner ramus of uropod III reaching 0.4 times the length of outer ramus, both inner and outer rami armed with simple setae.

Description of holotype male (IZCAS-I-A1570-1). 8.0 mm.

Head (Fig. 33A): eyes oval, inferior antennal sinus deep.

Antenna I (Fig. 33B, C): peduncle articles I–III in length ratio 1.0: 0.6: 0.4, with distal setae; flagellum with 20 articles, articles III–IX with aesthetascs; accessory flagellum with three articles; both primary and accessory flagella with short distal setae.

Antenna II (Fig. 33D): peduncle articles III–V in length ratio 1.0: 2.9: 2.9, articles IV and V with lateral and medial setae; flagellum with seven articles, each article with numerous setae; calceoli absent.

Upper lip (Fig. 33E): ventral margin rounded, bearing short minute setae.

Mandible (Fig. 33G, H): left mandible incisor with five teeth; lacinia mobilis with four teeth; spine row with five pairs of plumose setae; articles I–III of palp in length ratio 1.0: 2.9: 2.2, second article with 13 marginal setae, article III with three A-setae, three B-setae, a row of D-setae, and six E-setae apically; incisor of right mandible with four teeth, lacinia mobilis bifurcate, with small teeth.

Lower lip (Fig. 33F): inner lobes lacking, outer lobes covered with thin setae.

Maxilla I (Fig. 33I, J): asymmetrical, left inner plate with 11 plumose setae on medial margin; outer plate with 11 robust serrated apical spines; second article of left palp with seven slender spines apically; second article of right palp with four stout spines, one stiff seta and one slender spine.

Maxilla II (Fig. 33K): inner plate with ten plumose facial setae in an oblique row; inner and outer plates with long setae apically.

Maxilliped (Fig. 33L): inner plate with four stout apical spines, one subapical spine, and 15 plumose setae; outer plate bearing a row of 14 blade spines and two plumose setae apically; article IV of palp hooked, with three setae at hinge of unguis.

Pereon. *Gnathopod I* (Fig. 34A, B): coxal plate bearing two setae and one seta on anterior and posterior margins, respectively; basis with long setae on anterior and posterior margins; merus bearing setae on posterodistal corner; carpus 1.8 times as long as wide, 0.8 times as long as propodus, bearing clusters of setae along ventral margin and two clusters of setae on dorsal margin; propodus oval, palm with one medial spine and 11 spines on posterior margin and surface; dactylus with one seta on outer margin.

Gnathopod II (Fig. 34C, D): coxal plate bearing three setae and one seta on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins; merus bearing setae on posterodistal corner; carpus 1.7 times as long as wide, 0.9 times as long as propodus, bearing five clusters of setae along ventral margin and two clusters of setae on dorsal margin; propodus subrectangular, palm margin with one medial spine and four spines on posterodistal corner; dactylus with one seta on outer margin.

Pereopod III (Fig. 35A, B): coxal plate bearing two setae and one seta on anterior and posterior margins, respectively; basis elongated, with setae along anterior and posterior margins; merus with eight clusters of long setae on posterior margin and one spine accompanied by one seta on anterior margin, anterodistal corner with one spine accompanied by setae; carpus with two spines accompanied by groups of long setae on posterior margin, anterodistal corner with one spine accompanied by setae and posterodistal corner with two spines accompanied by setae; propodus with three pairs of spines

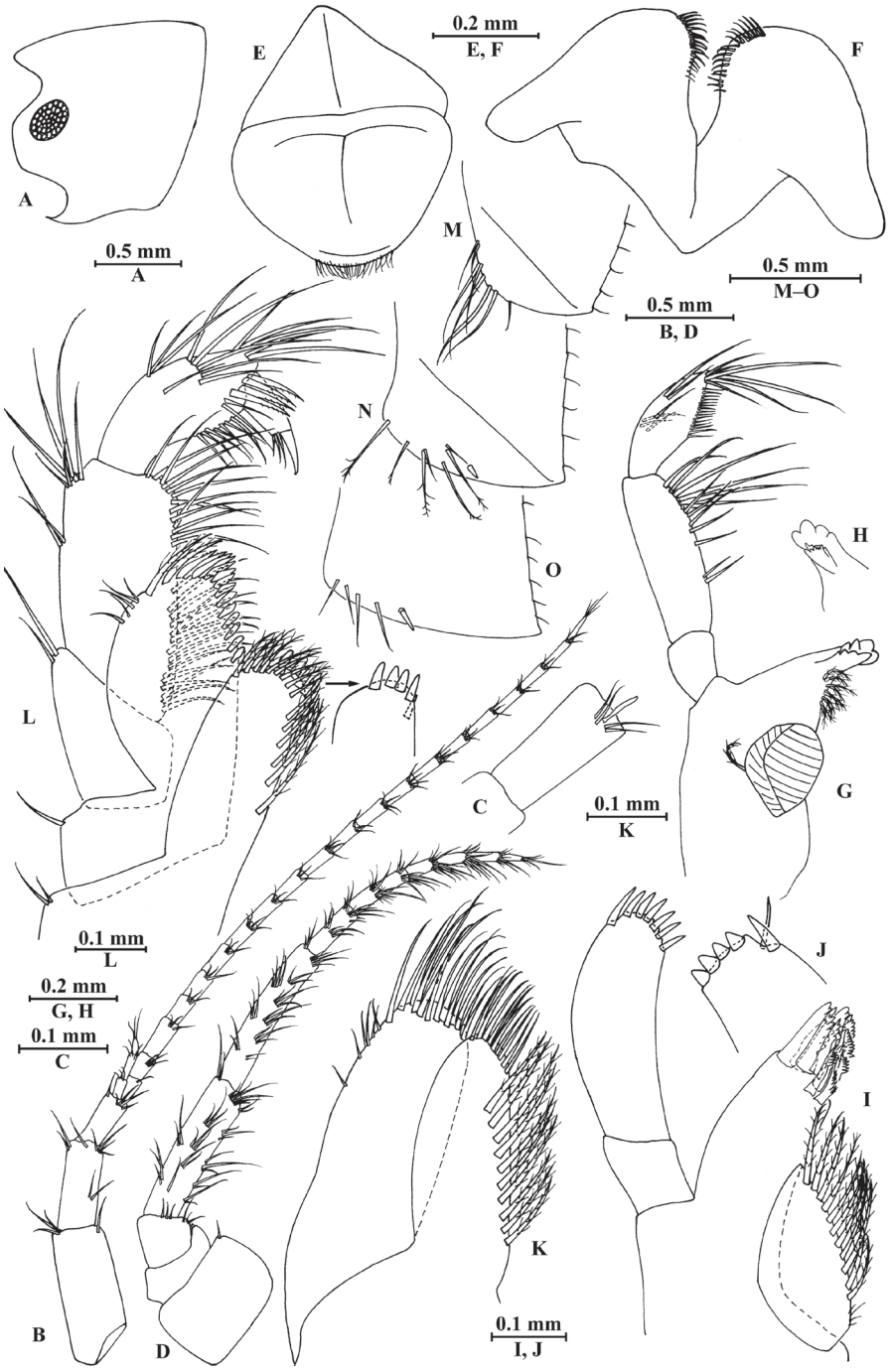

Figure 33. *Gammarus mosuo* Hou & Li, sp. n., male holotype. **A** head **B** antenna I **C** flagellar article of antenna I with aesthetasc **D** antenna II **E** upper lip **F** lower lip **G** left mandible **H** incisor and lacinia mobilis of right mandible **I** left maxilla I **J** distal part of palp article II of right maxilla I **K** maxilla II **L** maxilliped **M** epimeral plate I **N** epimeral plate II **O** epimeral plate III.

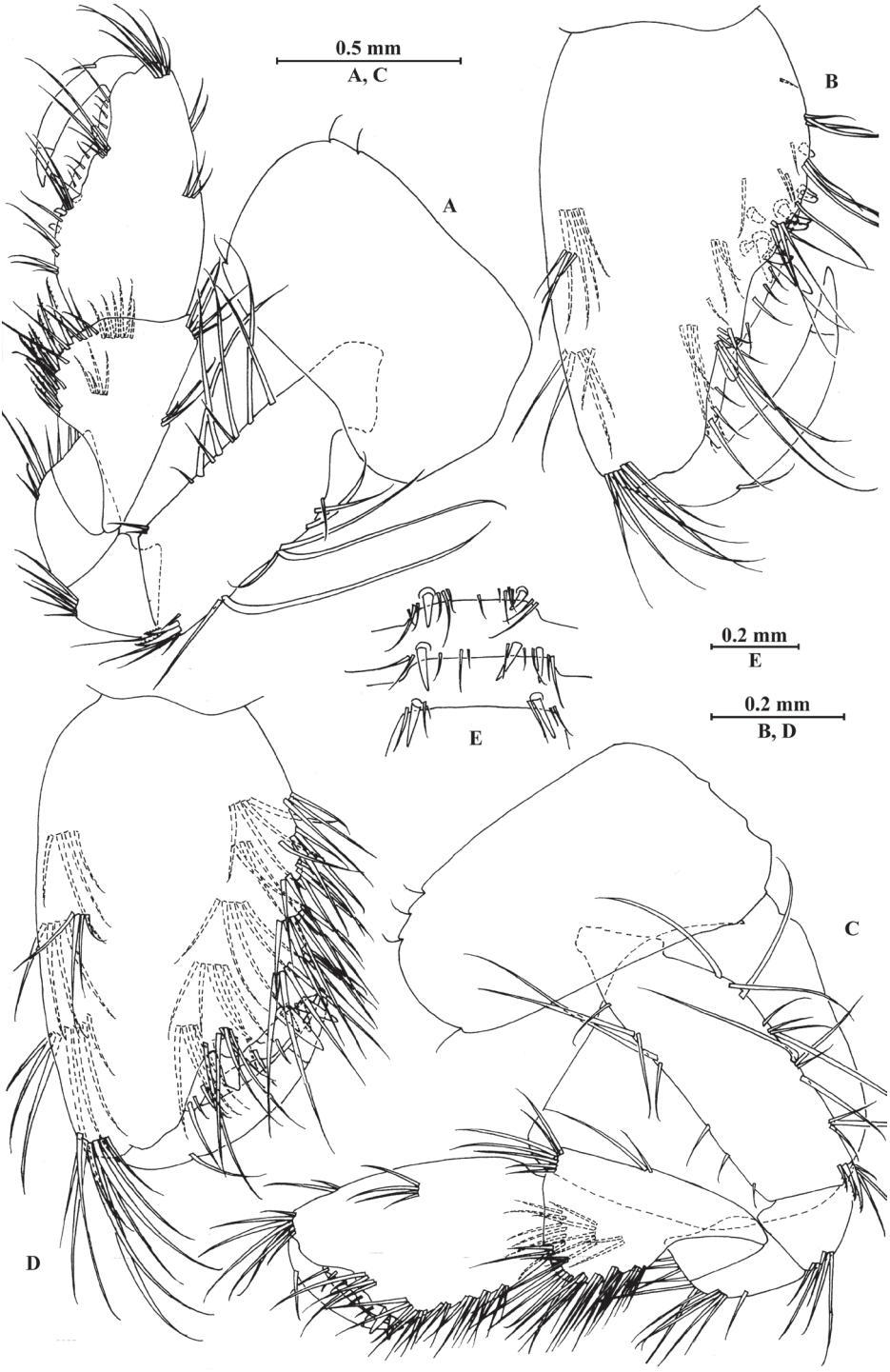

Figure 34. *Gammarus mosuo* Hou & Li, sp. n., male holotype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C** gnathopod II **D** propodus and dactylus of gnathopod II **E** dorsal margins of urosomites I–III.

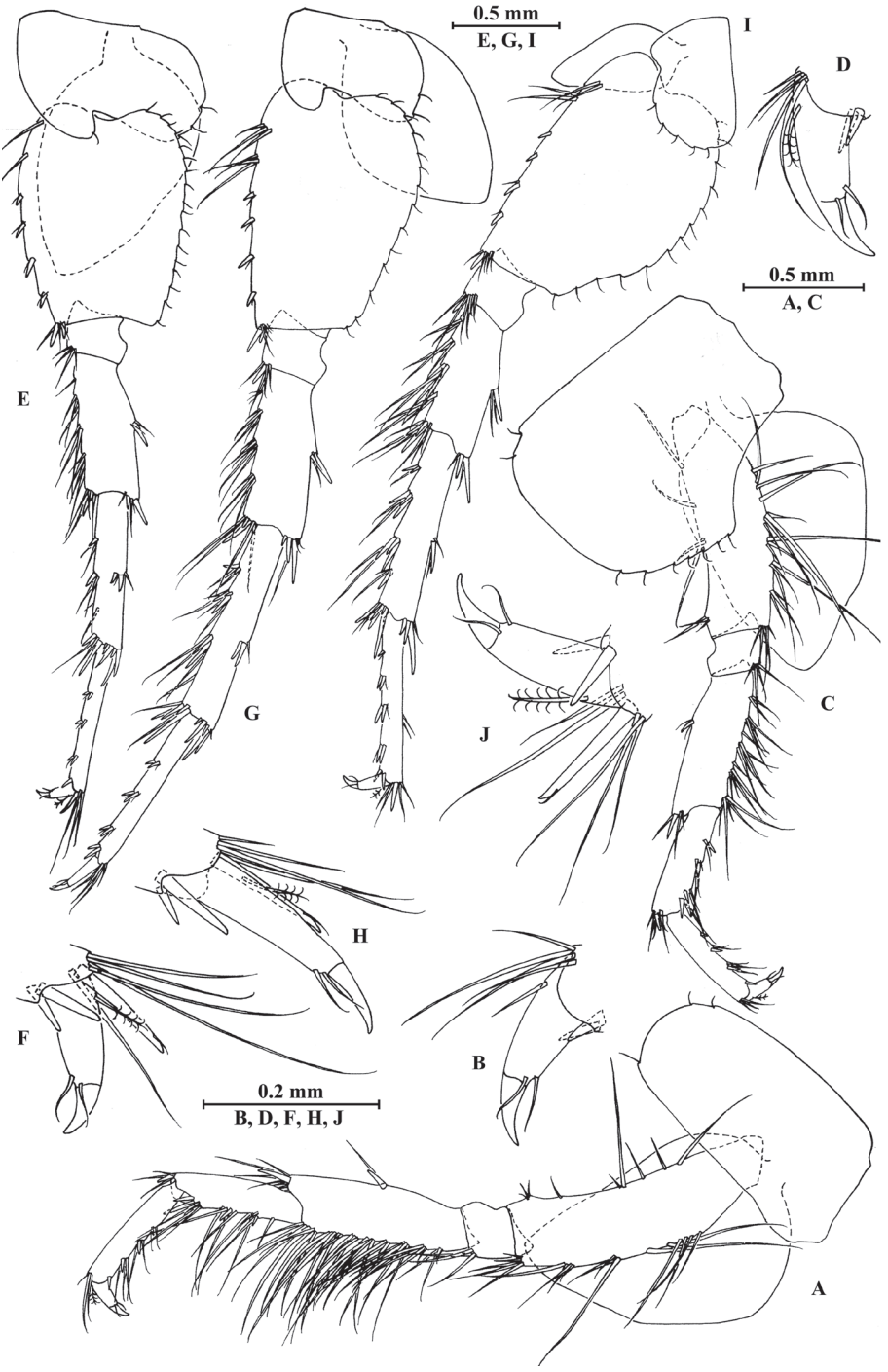

Figure 35. *Gammarus mosuo* Hou & Li, sp. n., male holotype. **A** pereopod III **B** dactylus of pereopod III **C** pereopod IV **D** dactylus of pereopod IV **E** pereopod V **F** dactylus of pereopod V **G** pereopod VI **H** dactylus of pereopod VI **I** pereopod VII **J** dactylus of pereopod VII.

accompanied by setae on posterior margin and two spines on posterodistal corner; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

Pereopod IV (Fig. 35C, D): coxal plate concave, bearing two setae on anterior margin and seven setae on posterior margin; basis with setae along anterior and posterior margins; merus with five clusters of setae on posterior margin and one spine accompanied by two setae on anterior margin, anterodistal corner with one spine accompanied by setae; carpus and propodus with spines accompanied by setae on posterior margins; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

Pereopod V (Fig. 35E, F): coxal plate bearing one seta and three setae on anterior and posterior margins, respectively; basis expanded, with two setae and four spines accompanied by setae on anterior margin, anterodistal corner with two spines accompanied by setae, posterior margin with a row of 17 setae; merus with four clusters of setae on anterior margin and one spine accompanied by two setae on posterior margin, anterodistal corner with one spine accompanied by setae and posterodistal corner with two spines accompanied by setae; carpus and propodus with groups of spines accompanied by fine setae on anterior margins; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Pereopod VI (Fig. 35G, H): coxal plate bearing two setae on posterior margin; basis elongated, with two clusters of long setae and four spines accompanied by short setae on anterior margin, anterodistal corner with two spines accompanied by setae, posterior margin with a row of 14 setae; merus with four clusters of setae on anterior margin and one spine accompanied by two setae on posterior margin, anterodistal and posterodistal corners with two and three spines accompanied by setae respectively; carpus with three groups of spines accompanied by straight setae on anterior margin; propodus with three groups of spines accompanied by fine setae on anterior margin; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Pereopod VII (Fig. 35I, J): coxal plate with five setae on posterior margin; basis with two clusters of long setae and four spines accompanied by setae on anterior margin, anterodistal corner with one spine accompanied by setae, posterior margin with a row of 13 setae; merus with four clusters of setae on anterior margin and one spine accompanied by two setae on posterior margin, anterodistal and posterodistal corners with three and two spines accompanied by setae, respectively; carpus with four groups of spines accompanied by straight setae on anterior margin; propodus with groups of spines accompanied by fine setae on anterior margin; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Coxal gills: coxal gill of gnathopod II and gill of pereopod IV a little longer than bases; gills of pereopods III, V and VI shorter than bases; gill of pereopod VII smallest, less than half of the basis.

Pleon. *Epimeral plates* (Fig. 33M–O): plate I ventrally rounded, bearing eight long setae on anteroventral margin and five setae on posterior margin; plate II with five sub-plumose setae, two simple setae and one spine on ventral margin and six setae on posterior margin, posterodistal corner blunt; plate III with four setae and one spine on ventral margin and six setae on posterior margin, posterodistal corner subacute.

Pleopods I–III (Fig. 36A–C): similar, peduncle with two or three retinacula accompanied by one seta; outer ramus slightly shorter than inner ramus, both rami fringed with plumose setae.

Urosome. *Urosomites* (Fig. 34E): urosomite I with one spine accompanied by six setae on each side and one seta on dorsal margin; urosomite II with one and two spines accompanied by setae on each side; urosomite III with one spine accompanied by three setae on each side.

Uropods I–III (Fig. 36D–F): uropod I peduncle with one basofacial spine, one and three spines on inner and outer margins, respectively, inner and outer distal corners with one spine each; inner ramus with one spine on inner margin; outer ramus with one spine and two spines on inner and outer margins, respectively; both rami with five terminal spines. Uropod II short, peduncle bearing one seta and one spine on inner and outer margins respectively, one distal spine accompanied by one seta on inner corner and one spine on outer corner; inner ramus with two spines on inner margin and one spine on outer margin; outer ramus with two spines on inner margin; both rami with five terminal spines. Uropod III peduncle with two setae on surface and six distal spines; both inner and outer rami armed with simple setae, inner ramus 0.9 times as long as peduncle, reaching 0.4 times the length of outer ramus, with one spine accompanied by two simple setae on inner margin and two spines accompanied by long setae distally; proximal article of outer ramus with three groups of spines accompanied by simple setae on outer margin, simple setae on inner margin, and four distal spines, terminal article with simple setae, slightly shorter than adjacent spines.

Telson (Fig. 36G): deeply cleft, 0.9 times as long as wide, each lobe with two plumose setae on surface and with one distal spine accompanied by three or four simple setae and a plumose seta.

Description of paratype female (IZCAS-I-A1570-2). 6.4 mm.

Pereon. *Gnathopod I* (Fig. 37A, B): coxal plate bearing one seta on anterior and posterior margins each; basis with long setae on anterior and posterior margins; propodus oval, palm with five spines on posterior margin, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Gnathopod II (Fig. 37C, D): coxal plate bearing two setae and one seta on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins; propodus subrectangular, palm margin with three spines on posterodistal corner, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Pereopod III (Fig. 38A): similar to that of male.

Pereopod IV (Fig. 38B): merus and carpus with longer setae on posterior margins than that of male.

Pereopod V (Fig. 38C): similar to that of male; basis to carpus with a few plumose setae on anterior or posterior margins.

Pereopods VI–VII (Fig. 38D, E): similar to those of male, but with more setae on anterior margins.

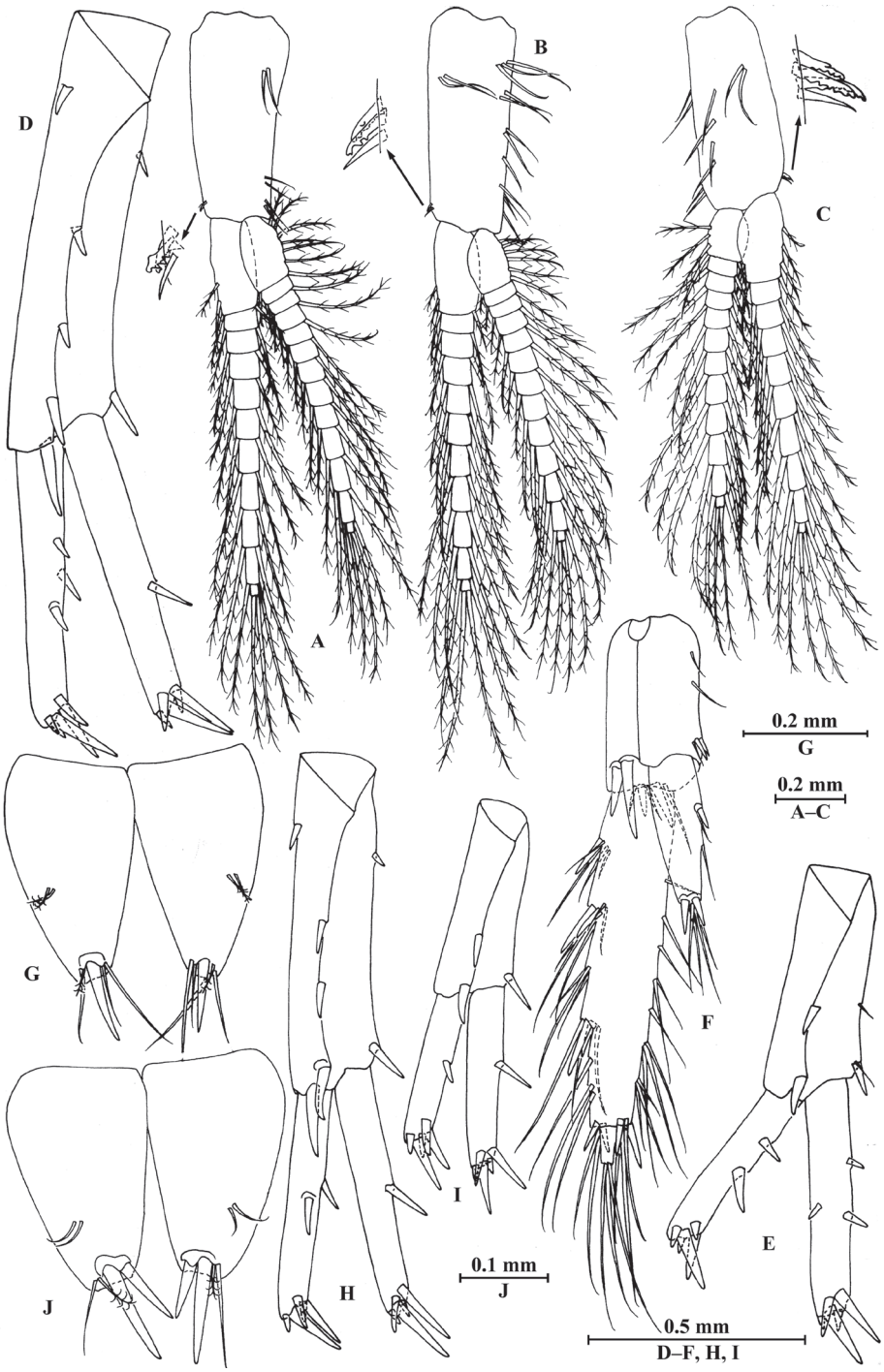

Figure 36. *Gammarus mosuo* Hou & Li, sp. n., **A–G** male, holotype; **H–J** female, paratype. **A** pleopod I **B** pleopod II **C** pleopod III **D** uropod I **E** uropod II **F** uropod III **G** telson **H** uropod I **I** uropod II **J** telson.

Figure 37. *Gammarus mosuo* Hou & Li, sp. n., female paratype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C** gnathopod II **D** propodus and dactylus of gnathopod II **E** oostegite of gnathopod II **F** oostegite of pereopod III **G** oostegite of pereopod IV **H** oostegite of pereopod V.

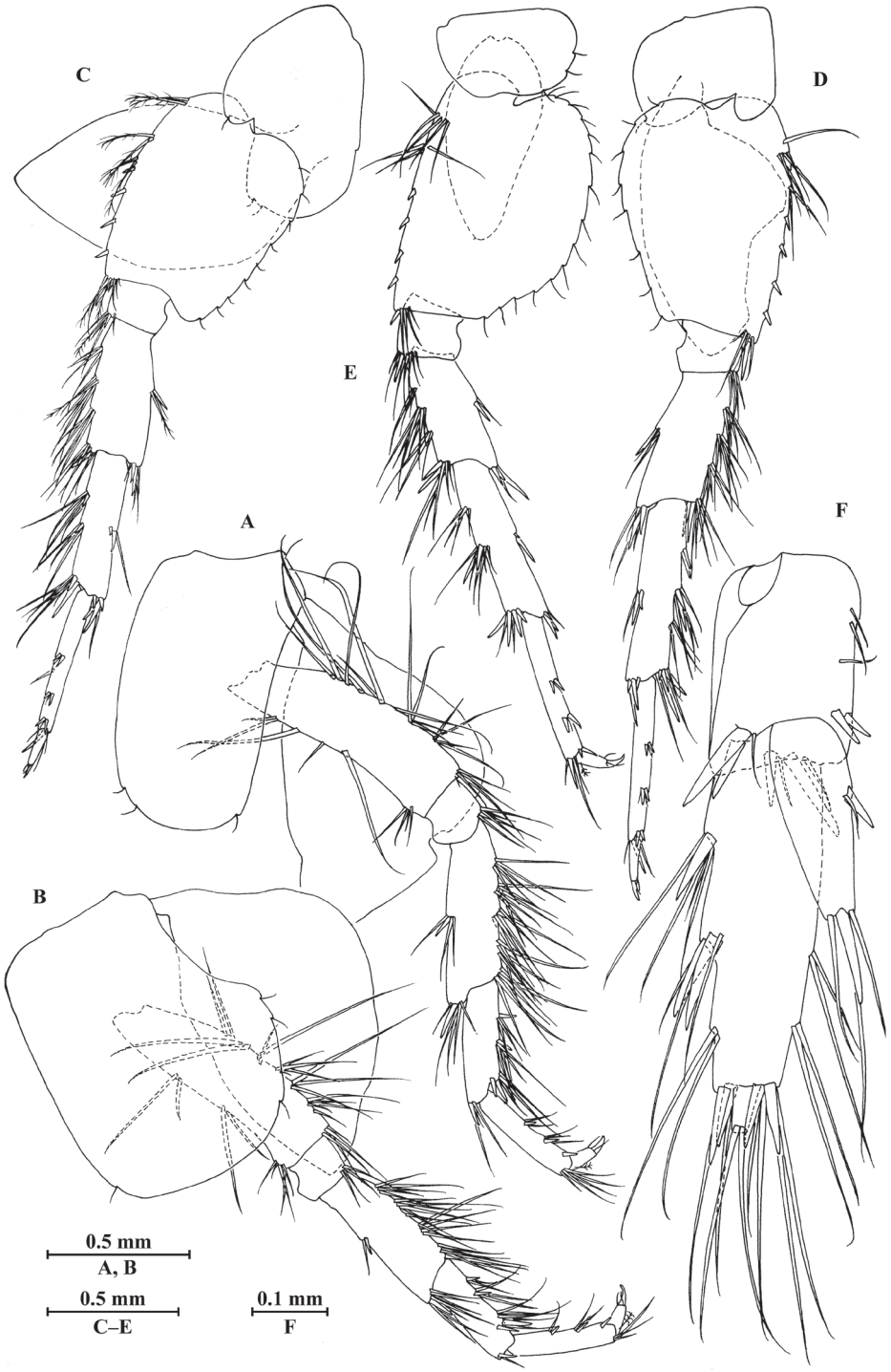

Figure 38. *Gammarus mosuo* Hou & Li, sp. n., female paratype. **A** pereopod III **B** pereopod IV **C** pereopod V **D** pereopod VI (right) **E** pereopod VII **F** uropod III.

Oostegite (Fig. 37E–H): oostegite of gnathopod II broad, with marginal setae, oostegites of pereopods III and IV elongated, oostegite of pereopod V smallest.

Urosome. *Uropods I–III* (Figs 36H, I; 38F): uropod I peduncle with one basofacial spine, one and two spines on inner and outer margins, respectively, inner distal corner with one spine and outer distal corner with two spines; inner ramus with one spine on inner margin; outer ramus with one spine on inner and outer margins each; both rami with five terminal spines. Uropod II short, peduncle bearing one spine on outer margin, each corner with one distal spine; both rami with one spine on inner margin and five terminal spines. Uropod III peduncle with three setae on surface and six distal spines accompanied by setae; both inner and outer rami with simple setae, inner ramus approx. as long as peduncle, reaching 0.6 times the length of outer ramus, with one spine accompanied by one seta on inner margin and one spine accompanied by long setae distally; proximal article of outer ramus with three spines accompanied by simple setae on outer margin and simple setae on inner margin, terminal article slightly shorter than adjacent spines.

Telson (Fig. 36J): cleft, 1.2 times as long as wide, each lobe with two simple setae on surface and with two distal spines accompanied by one simple seta and one plumose seta.

Habitat. This species was collected under decomposing leaves alongside a pool.

Remarks. The new species of *Gammarus mosuo* Hou & Li, sp. n. is most similar to *G. sinuolatus* Hou & Li, 2004b in propodus of gnathopod II with long straight setae on anterior margin; pereopods III and IV with long setae on posterior margins; epimeral plates with long setae on ventral margins; and uropod III inner ramus approx. one-third of outer ramus, both rami armed with simple setae. *Gammarus mosuo* Hou & Li, sp. n. can be distinguished from *G. sinuolatus* in the following characters (*G. sinuolatus* in parentheses): antenna II calceoli absent (present); pereopods V–VII with long setae on anterior margin (with few setae on anterior margin); urosomites with two clusters of spines accompanied by setae (four groups of spines accompanied by long setae); and telson with a pair of short facial setae on each lobe (with long setae on dorsal surface).

The new species of *Gammarus mosuo* Hou & Li, sp. n. is similar to *G. curvativus* Hou & Li, 2003b in pereopods III and IV with long straight setae on posterior margins; uropod I with one basofacial spine; and uropod III inner ramus less than half of outer ramus, both rami densely with simple setae. *Gammarus mosuo* Hou & Li, sp. n. differs from *G. curvativus* Hou & Li, 2003b (*G. curvativus* in parentheses) by eyes oval and small (reniform, and relatively large); antenna II calceoli absent (present); gnathopod II propodus with groups of long setae on anterior margin (with long curled setae on anterior margin); pereopods V–VII with long setae along anterior margin (with no long setae); and urosomites with two clusters of spines and setae on dorsal margins (with four groups of spines and setae).

The new species is similar to *G. paucispinus* Hou & Li, 2002b in eyes oval; antenna II calceoli absent; merus and carpus of pereopod III with clusters of long setae on posterior margins; and both rami of uropod III with simple setae. It differs from *G. paucispinus* Hou & Li, 2002b (*G. paucispinus* in parentheses) by urosomite I with two clusters of spines and setae on dorsal margin (with a few short setae); telson 0.9 times as long as wide (0.8 times as long as wide); and each lobe with a pair of setae on surface (with two groups of long setae).

***Gammarus caecigenus* Hou & Li, sp. n.**
http://zoobank.org/C6A67FAB-DC7A-4E2D-8C30-5D7B14A65827
Figs 39–44

Material examined. Holotype: male (IZCAS-I-A1587-1), 10.0 mm, Xingwen County (105.12°E, 28.19°N), altitude 840 m, Yibin City, Sichuan Province, China, April 25, 2014, collected by Yucheng Lin, Huifeng Zhao, Yunchun Li, Jianglang Wu and Fengyuan Li. Paratype: female (IZCAS-I-A1587-2), 5.9 mm, same data as holotype.

Etymology. The epithet derives from the Latin word "*caecigenus*", referring to the eyes absent; adjective.

Diagnosis. Eyes absent; antenna II with long setae, calceoli absent; merus and carpus of pereopod III with clusters of long setae on posterior margins; armature of urosomites degenerated, urosomite I with setae on dorsal margin, urosomite II with two groups of spines accompanied by setae; uropod I peduncle without basefacial spine; uropods I–II with more marginal spines; inner ramus of uropod III reaching 0.9 times the length of outer ramus, terminal article of outer ramus vestigial.

Description of holotype male (IZCAS-I-A1587-1), 10.0 mm.

Head (Fig. 39A): eyes absent, inferior antennal sinus deep.

Antenna I (Fig. 39B, C): peduncle articles I–III in length ratio 1.0: 0.8: 0.4, with distal setae; flagellum with 28 articles, most with aesthetascs; accessory flagellum with four articles; both primary and accessory flagella with short distal setae.

Antenna II (Fig. 39D): peduncle articles III–V in length ratio 1.0: 2.1: 2.4, articles IV and V of peduncle with long lateral and medial setae; flagellum with ten articles and one tiny distal article, with setae along dorsal and ventral margins; calceoli absent.

Upper lip (Fig. 39E): ventral margin rounded, bearing short minute setae.

Mandible (Fig. 39G, H): left mandible incisor with five teeth; lacinia mobilis with four teeth; spine row with seven pairs of plumose setae; articles I–III of palp in length ratio 1.0: 3.1: 2.6, second article with 12 marginal setae, article III with five A-setae, two clusters of B-setae, a row of D-setae, and five E-setae apically; incisor of right mandible with four teeth, lacinia mobilis bifurcate, with small teeth.

Lower lip (Fig. 39F): inner lobes lacking, outer lobes covered with thin setae.

Maxilla I (Fig. 39I, J): asymmetrical, left inner plate with 18 plumose setae and five fine setae on medial margin; outer plate with 11 robust serrated apical spines; second article of left palp with two simple setae and eight slender spines apically; second article of right palp with five stout spines, one stiff seta and one slender spine.

Maxilla II (Fig. 39K): inner plate with three simple setae and 14 plumose facial setae in an oblique row; inner and outer plates with long setae apically.

Maxilliped (Fig. 39L, M): inner plate with three stout apical spines, two subapical spines, and 25 plumose setae; outer plate bearing four simple setae, a row of 16 blade spines and five plumose setae apically; article IV of left palp missing, right palp hooked, with two setae at hinge of unguis.

Pereon. *Gnathopod I* (Fig. 40A, B): coxal plate bearing one seta on anterior and posterior margins each; basis with long setae on anterior and posterior margins; merus

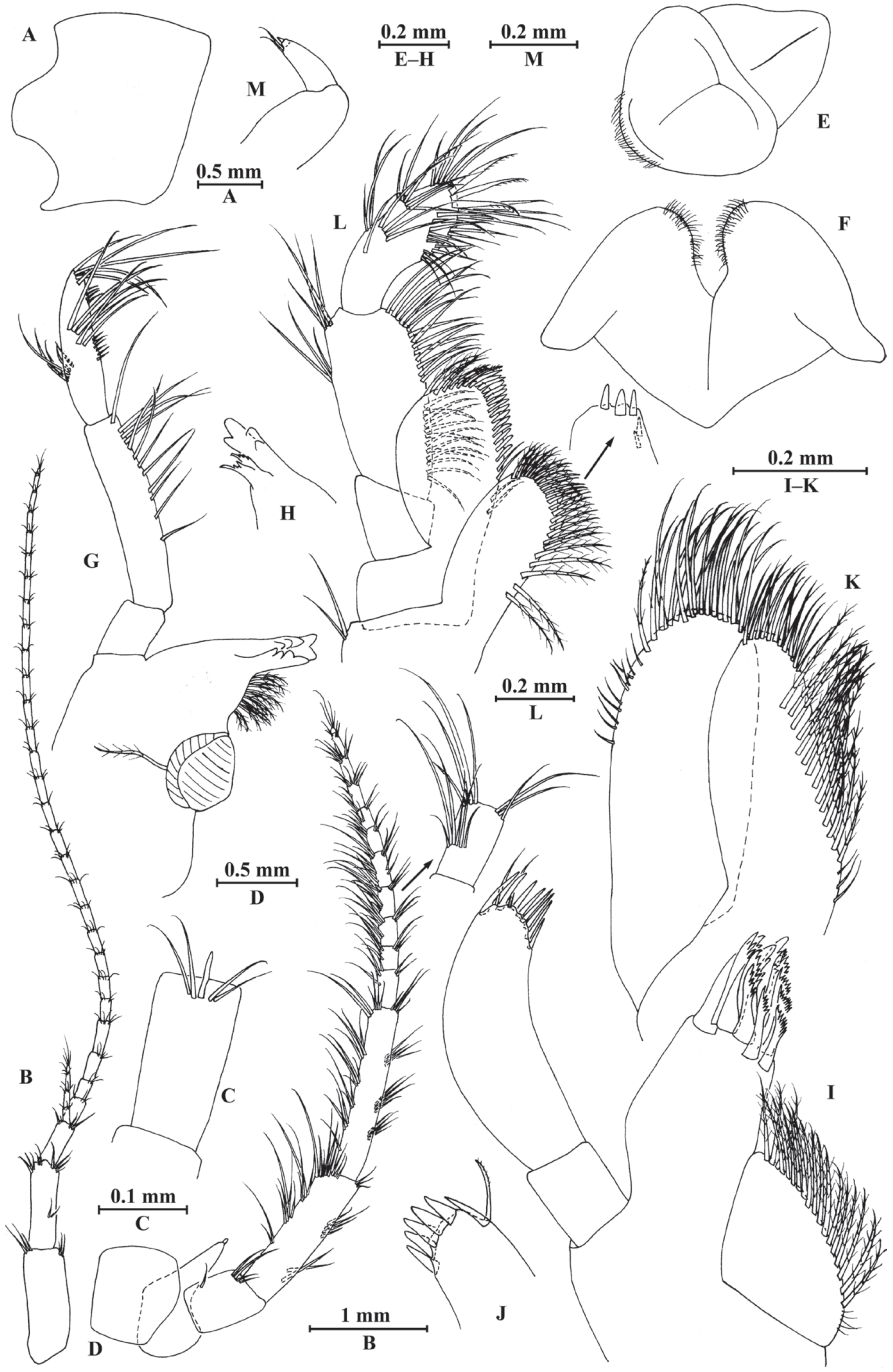

Figure 39. *Gammarus caecigenus* Hou & Li, sp. n., male holotype. **A** head **B** antenna I **C** flagellar article of antenna I with aesthetasc **D** antenna II **E** upper lip **F** lower lip **G** left mandible **H** incisor and lacinia mobilis of right mandible **I** left maxilla I **J** distal part of palp article II of right maxilla I **K** maxilla II **L** maxilliped **M** article IV of maxilliped right palp.

Figure 40. *Gammarus caecigenus* Hou & Li, sp. n., male holotype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C** gnathopod II **D** propodus and dactylus of gnathopod II **E** epimeral plate I **F** epimeral plate II **G** epimeral plate III **H** dorsal margins of urosomites I–III.

bearing setae on posterodistal corner; carpus 1.6 times as long as wide, 0.8 times as long as propodus, bearing four clusters of setae along ventral margin and two clusters of setae on dorsal margin; propodus oval, palm with one medial spine and 13 spines on posterior margin and surface; dactylus with one seta on outer margin.

Gnathopod II (Fig. 40C, D): coxal plate bearing two setae and one seta on anterior and posterior margins, respectively; basis with setae on anterior and posterior margins; merus bearing setae on posterodistal corner; carpus 2.2 times as long as wide, 0.8 times as long as propodus, bearing eight clusters of setae along ventral margin and two clusters of setae on dorsal margin; propodus subrectangular, palm margin with one medial spine and seven spines on posterodistal corner; dactylus with one seta on outer margin.

Pereopod III (Fig. 41A, B): coxal plate bearing two setae and one seta on anterior and posterior margins, respectively; basis elongated, with setae along anterior and posterior margins; merus with two short setae and five clusters of long straight setae on posterior margin and two groups of spines accompanied by setae on anterior margin, anterodistal corner with one spine accompanied by setae; carpus with three groups of spines accompanied by long setae on posterior margin, anterodistal corner with one spine accompanied by setae and posterodistal corner with two spines accompanied by setae; propodus with two spines accompanied by setae on posterior margin and two spines on posterodistal corner; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

Pereopod IV (Fig. 41C, D): coxal plate concave, bearing two setae on anterior margin and five setae on posterior margin; basis with setae along anterior and posterior margins; merus with a single seta and four clusters of straight setae on posterior margin and one spine accompanied by two setae on anterior margin, anterodistal corner with two spines accompanied by setae; carpus and propodus with spines accompanied by setae on posterior margins; dactylus with one plumose seta on anterior margin, and two setae at hinge of unguis.

Pereopod V (Fig. 41E, F): coxal plate bearing one seta and two setae on anterior and posterior margins, respectively; basis expanded, with two setae and five spines accompanied by setae on anterior margin, anterodistal corner with two spines accompanied by setae, posterior margin with a row of 13 setae; merus with one spine accompanied by clusters of short setae on anterior margin and one spine accompanied by two setae on posterior margin, anterodistal corner with one spine accompanied by setae and posterodistal corner with two spines accompanied by setae; carpus and propodus with three to four groups of spines accompanied by fine setae on anterior margins; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Pereopod VI (Fig. 41G, H): coxal plate bearing two setae on posterior margin; basis elongated, with two long setae and three spines accompanied by setae on anterior margin, anterodistal corner with three spines accompanied by one seta, posterior margin with a row of 13 setae; merus with three spines accompanied by setae on anterior margin and two spines accompanied by two setae on posterior margin, anterodistal and posterodistal corners with four and three spines accompanied by setae respectively; carpus with groups of spines accompanied by setae on anterior and posterior margins;

propodus with groups of spines accompanied by fine setae on anterior margin; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Pereopod VII (Fig. 41I, J): coxal plate with five setae on posterior margin; basis with one seta and four spines accompanied by setae on anterior margin, anterodistal corner with one spine accompanied by setae, posterior margin with a row of 15 setae; merus with three spines accompanied by setae on anterior margin and two spines accompanied by two setae on posterior margin, anterodistal and posterodistal corners with five and three spines accompanied by setae, respectively; carpus with groups of spines accompanied by setae on anterior and posterior margins, respectively; propodus with groups of spines accompanied by fine setae on anterior margin and three clusters of long setae on posterior margin; dactylus with one plumose seta on posterior margin, and two setae at hinge of unguis.

Coxal gills: coxal gill of gnathopod II and gill of pereopod V a little shorter than bases; gill of pereopod III approx. as long as basis; gill of pereopod IV a little longer than basis; gill of pereopod VI approx. half of the basis; gill of pereopod VII smallest, less than half of the basis.

Pleon. *Epimeral plates* (Fig. 40E–G): plate I ventrally rounded, bearing five long setae on anteroventral margin and four setae on posterior margin; plate II with four spines on ventral margin and seven setae on posterior margin, posterodistal corner blunt; plate III with five spines on ventral margin and seven setae on posterior margin, posterodistal corner blunt.

Pleopods I–III (Fig. 42A–C): similar, peduncle with two retinacula accompanied by one to three setae; outer ramus approx. as long as inner ramus, both rami fringed with plumose setae.

Urosome. *Urosomites* (Fig. 40H): urosomite I with two clusters of dorsal setae; urosomite II with one spine accompanied by five setae on each side; urosomite III with one spine accompanied by three setae on each side.

Uropods I–III (Fig. 42D–F): uropod I peduncle longer than rami, without basofacial spine, with four and seven spines on inner and outer margins, respectively, inner and outer distal corners with one spine and two spines respectively; inner ramus with three spines on inner margin and two spines on outer margin; outer ramus with two spines and five spines on inner and outer margins, respectively; both rami with five terminal spines. Uropod II short, peduncle a little longer than rami, bearing two spines on inner margin, four spines on outer margin and one distal spine on each corner; inner ramus with three spines on inner and outer margins each; outer ramus with one spine on inner margin and four spines on outer margin; both rami with five terminal spines. Uropod III peduncle with two setae on surface and seven distal spines; inner ramus 2.0 times as long as peduncle, reaching 0.9 times the length of outer ramus, with two spines accompanied by simple and plumose setae on inner margin, four plumose setae accompanied by simple setae on outer margin and two spines accompanied by long setae distally; proximal article of outer ramus with three groups of spines accompanied by simple setae on outer margin, simple and plumose setae on inner margin, and four distal spines, terminal article vestigial.

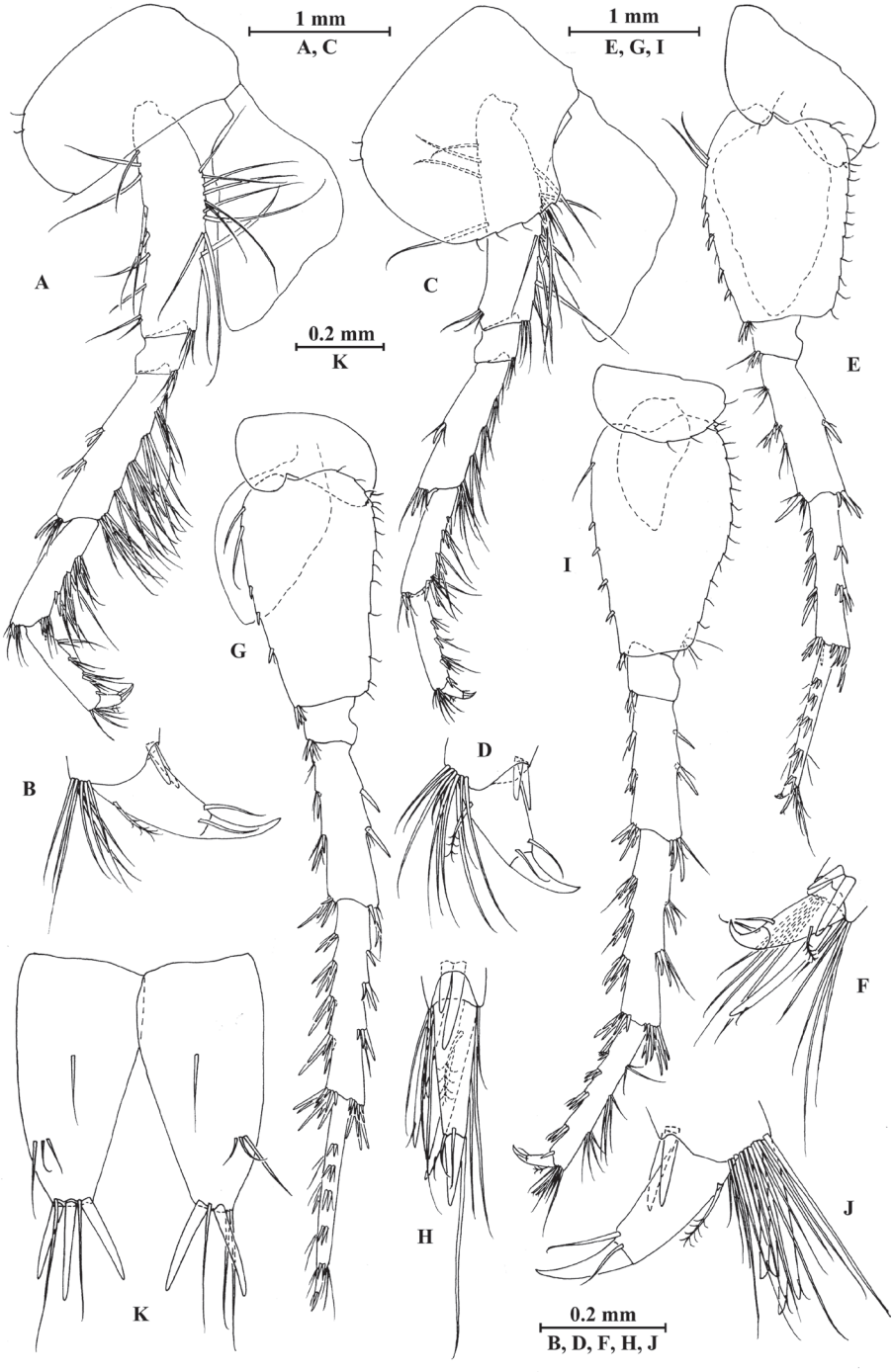

Figure 41. *Gammarus caecigenus* Hou & Li, sp. n., male holotype. **A** pereopod III **B** dactylus of pereopod III **C** pereopod IV **D** dactylus of pereopod IV **E** pereopod V **F** dactylus of pereopod V **G** pereopod VI **H** dactylus of pereopod VI **I** pereopod VII **J** dactylus of pereopod VII **K** telson.

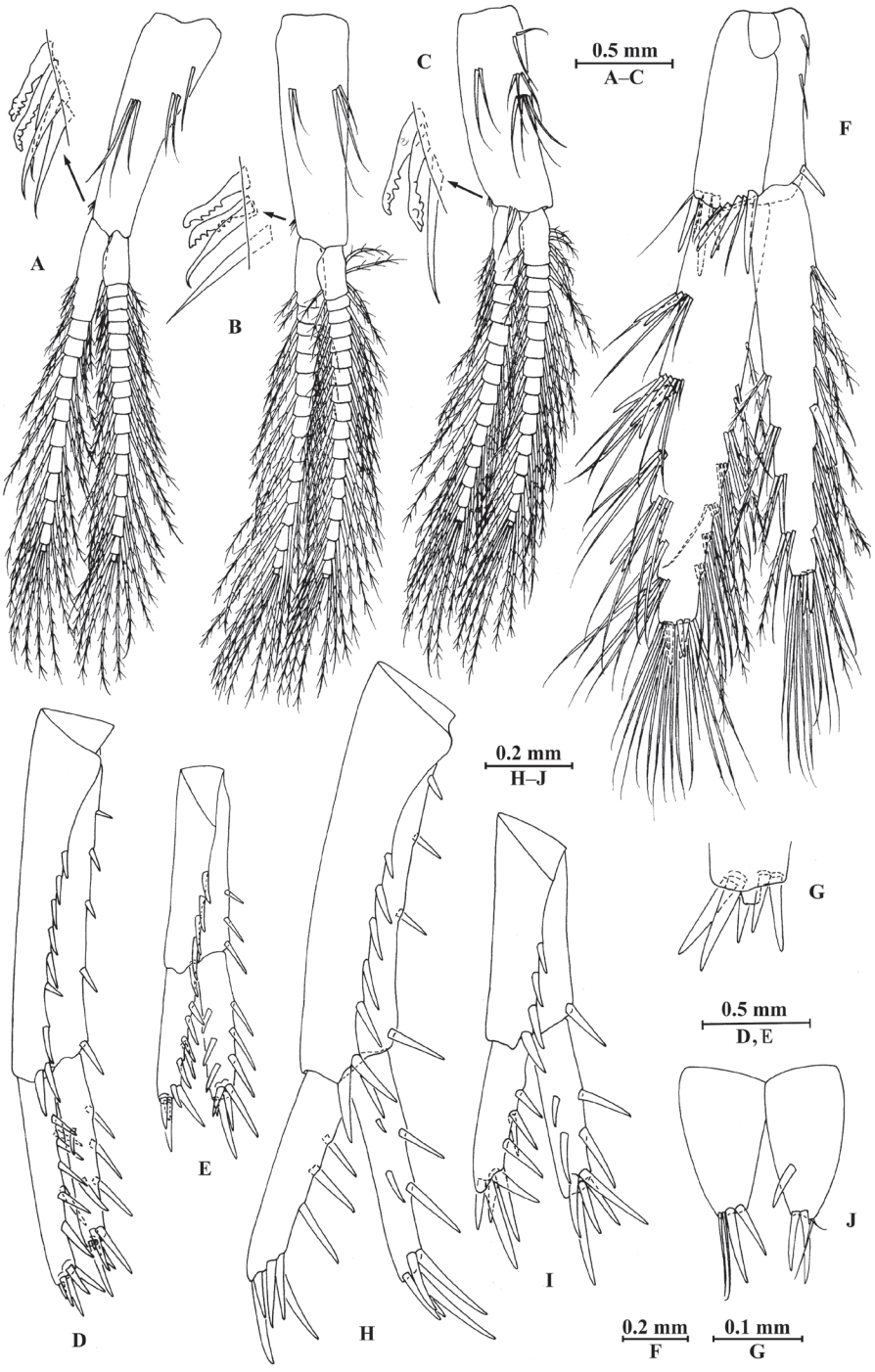

Figure 42. *Gammarus caecigenus* Hou & Li, sp. n., **A–G** male, holotype; **H–J** female, paratype. **A** pleopod I **B** pleopod II **C** pleopod III **D** uropod I **E** uropod II **F** uropod III **G** terminal article of outer ramus (another male) **H** uropod I **I** uropod II **J** telson.

Telson (Fig. 41K): deeply cleft, 1.1 times as long as wide, each lobe with four setae on surface; left lobe with three distal spines accompanied by two simple setae and right lobe with two distal spines accompanied by three simple setae.

Description of paratype female (IZCAS-I-A1587-2). 5.9 mm.

Pereon. *Gnathopod I* (Fig. 43A, B): coxal plate bearing one seta on anterior and posterior margins each; basis with long setae on anterior and posterior margins; propodus oval, palm with four spines on posterior margin, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Gnathopod II (Fig. 43C, D): coxal plate bearing one seta on anterior and posterior margins each; basis with setae on anterior and posterior margins; propodus subrectangular, palm margin with three spines on posterodistal corner, bearing long setae along anterior and posterior margins; dactylus with one seta on outer margin.

Pereopods III and IV (Fig. 44E, F): merus and carpus with fewer setae on posterior margins than those of male.

Pereopods V–VII (Fig. 44G–I): similar to those of male.

Oostegite (Fig. 44A–D): oostegite of gnathopod II broad, with marginal setae, oostegites of pereopods III and IV elongated, oostegite of pereopod V smallest.

Urosome. *Uropods I–III* (Figs 42H, I; 44J): uropod I peduncle longer than rami, without basofacial spine, with three and five spines on inner and outer margins, respectively, inner distal corner with one spine and outer distal corner with three spines; inner ramus with two spines on inner and outer margins each; outer ramus with three spines on inner margin; both rami with five terminal spines. Uropod II short, peduncle a little longer than rami, bearing three spines on outer margin, each corner with one distal spine; inner ramus with two spines on inner and outer margins each; outer ramus with one spine on inner margin and three spines on outer margin; both rami with five terminal spines. Uropod III peduncle with two setae on surface and six distal spines accompanied by setae; inner ramus 1.1 times as long as peduncle, reaching 0.7 times the length of outer ramus, with one spine accompanied by three simple setae and two plumose setae on inner margin; proximal article of outer ramus with two pairs of spines accompanied by simple setae on outer margin and three plumose setae accompanied by three simple setae on inner margin, terminal article much shorter than distal setae; adjacent spine absent.

Telson (Fig. 42J): cleft, 1.1 times as long as wide, right lobe with one spine on surface, each lobe with two distal spines accompanied by two setae.

Variability. Outer ramus of uropod III without terminal article or much shorter than adjacent spines.

Habitat. This species was collected from a cave, where a pool with an area of one square meter was formed by dripping water from stalactites.

Remarks. The new species of *Gammarus caecigenus* Hou & Li, sp. n. is most similar to *G. hirtellus* Hou, Li & Li, 2013 in eyes absent; epimeral plate III posterodistal corner subacute; and uropod III inner ramus 0.9 times the length of outer ramus, terminal article vestigial. *Gammarus caecigenus* Hou & Li, sp. n. differs from *G. hirtellus* Hou, Li & Li, 2013 (*G. hirtellus* in parentheses) in antenna II calceoli

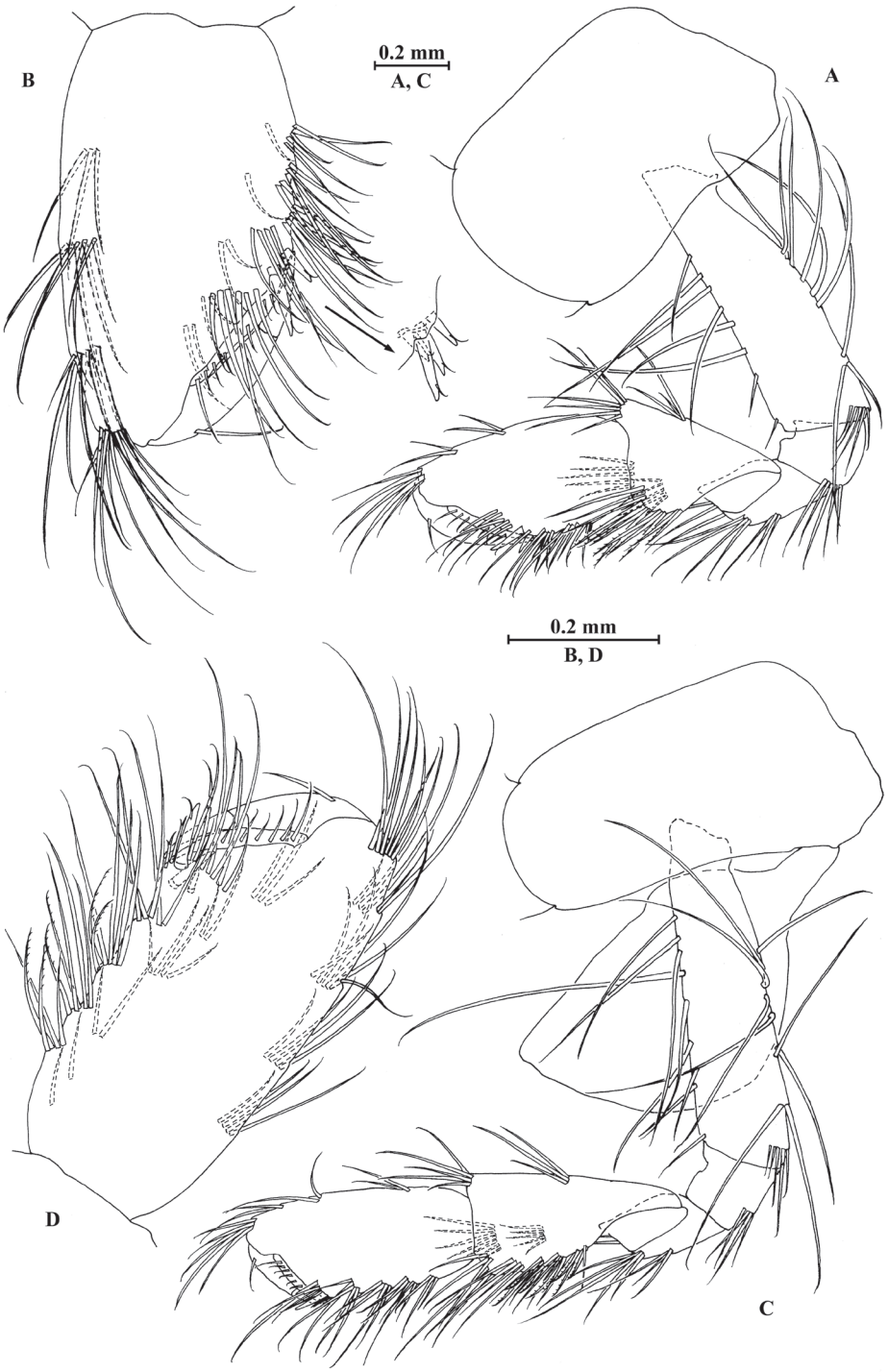

Figure 43. *Gammarus caecigenus* Hou & Li, sp. n., female paratype. **A** gnathopod I **B** propodus and dactylus of gnathopod I **C**, gnathopod II **D** propodus and dactylus of gnathopod II.

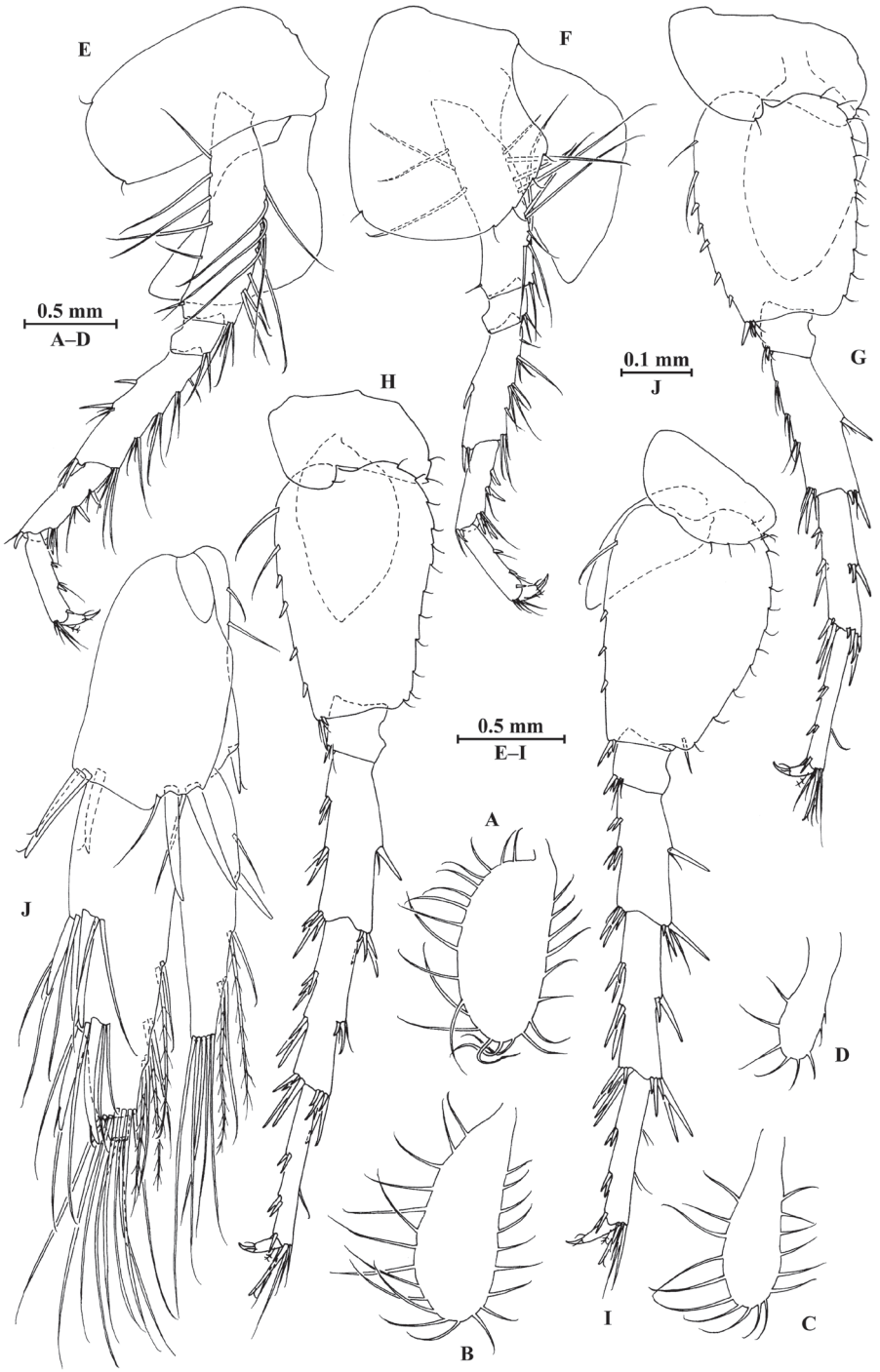

Figure 44. *Gammarus caecigenus* Hou & Li, sp. n., female paratype. **A** oostegite of gnathopod II **B** oostegite of pereopod III **C** oostegite of pereopod IV **D** oostegite of pereopod V **E** pereopod III **F** pereopod IV **G** pereopod V **H** pereopod VI **I** pereopod VII **J** uropod III.

absent (present); pereopod III with long straight setae on posterior margin (with long curled setae); pereopods V–VII with groups of spines on anterior margins, but with few setae (with spines accompanied by long setae); uropods I and II with more spines along peduncle and both rami (with one spine on each side of inner and outer rami); and urosomites I and II with two groups of spines and setae (with four groups of spines and setae).

The comparison between these seven species is presented in the following key.

Key to the new species of *Gammarus* from southern China

1 Eyes present **2**
– Eyes absent ..... ***G. caecigenus* Hou & Li, sp. n.**
2 Uropod III inner ramus reaching 0.9 times the length of outer ramus..... ..... ***G. longdong* Hou & Li, sp. n.**
– Uropod III inner ramus less than 0.6 times the length of outer ramus **3**
3 Pereopods V–VII with many long setae on anterior margins..... ..... ***G. mosuo* Hou & Li, sp. n.**
– Pereopods V–VII with a few short setae on anterior margins..... **4**
4 Uropod III both margins of inner and outer rami with plumose setae..... ..... ***G. qinling* Hou & Li, sp. n.**
– Uropod III outer margin of outer ramus with no plumose setae..... **5**
5 Antenna II peduncular articles IV and V with long setae, terminal article of uropod III shorter than adjacent spines..... ***G. jidutanxian* Hou & Li, sp. n.**
– Antenna II peduncular articles IV and V with short setae, terminal article of uropod III subequal or longer than adjacent spines..... **6**
6 Antenna II calceoli present in male, inner margin of outer ramus in uropod III with a row of ten plumose setae ..... ***G. zhigangi* Hou & Li, sp. n.**
– Antenna II calceoli absent, inner margin of outer ramus in uropod III with three or four plumose setae ..... ***G. vallecula* Hou & Li, sp. n.**

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RESEARCH ARTICLE

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A new synonym in the subfamily Thrigmopoeinae Pocock, 1900 (Araneae, Theraphosidae)

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Abstract

As the species *Haploclastus devamatha* Prasanth & Jose, 2014 is indistinguishable from *Thrigmopoeus psychedelicus* Sanap & Mirza, 2014, the latter is herein considered junior synonym of the former. Occurrence of polychromatism in *H. devamatha* is noted, and two distinct colour morphs of the species are recognised, a pink form and a blue form. The natural history and conservation of the species are discussed and its known distribution is updated.

Keywords

India, junior synonym, polychromatism, taxonomy, Western Ghats

Introduction

The subfamily Thrigmopoeinae Pocock, 1900, a group of large, ground-dwelling, burrowing mygalomorph spiders endemic to the Western Ghats of India (Mirza and Sanap 2013), is the smallest of all the eight theraphosid subfamilies (Raven 1985) and currently comprises ten nominal species under two genera: *Haploclastus* Simon, 1892 (with seven species) and *Thrigmopoeus* Pocock, 1899 (with three species) (World Spider Catalog 2018). Though the genus *Haploclastus* is numerically rich, all the described species except *Haploclastus tenebrosus* Gravely, 1935 and *Haploclastus validus* (Pocock,

1899), are known only from original descriptions and most of them lack detailed descriptions and illustrations (Simon 1892, Pocock 1899, Gravely 1915, Barman 1978). Recent taxonomic treatment of *Haploclastus* (Siliwal and Raven 2010) indicates the possibility of uncertain placement of species within the subfamily. Similarly, *Thrigmopoeus* species are difficult to distinguish from *Haploclastus* species with morphological features. In the present paper, a proposal to synonymise *Thrigmopoeus psychedelicus* Sanap & Mirza, 2014 with *Haploclastus devamatha* Prasanth & Jose, 2014 is presented. Additionally, the current distribution of *H. devamatha* is mapped.

Materials and methods

The specimens were studied under a Zeiss Stemi 2000-C stereomicroscope. Drawings were made by the aid of a drawing tube attached to the microscope. Field photos were taken with Canon EOS 6D camera with Canon 100mm Macro photo lens. The specimens are deposited in a reference collection housed at the Division of Arachnology, Department of Zoology, Sacred Heart College, Thevara, Cochin, Kerala, India (**ADSH**).

Taxonomy

Theraphosidae Thorell, 1869
Thrigmopoeinae Pocock, 1900
***Haploclastus* Simon, 1892**

***Haploclastus devamatha* Prasanth & Jose, 2014**
Figs 1A–D, 2A–B, 3

Haploclastus devamatha Prasanth & Jose, 2014: 495, figs 1, 2A–I, 3A–D, 4A–D (Description and illustration of female).

Thrigmopoeus psychedelicus Sanap & Mirza, 2014: 481, figs 1, 2a–d, 3a–c, 3e, 4 (Misidentification; description and illustration of female). **New synonym**.

Type material. Holotype female of *H. devamatha* (DMCK 13/110) from INDIA: *Kerala*: Kollam: Kulathupuzha Forest Reserve, 8°54'6.37"N, 77°3'51.70"E, 134 m alt., Prasanth M. T. & Sunil Jose K. leg., 31 July 2013, repository Deva Matha College, Kuravilangad, Kerala (DMCK), not examined. Paratype female collected together with the holotype deposited in the reference collection of Sacred Heart College, Thevara (ADSH101501), examined.

Holotype female of *T. psychedelicus* (BNHS SP115) from INDIA: *Kerala*: Kollam: near Thenmala: Ambanad Tea Estate, 9°2'18"N, 77°5'22"E, 561 m alt., Rajesh Sanap, Zeeshan Mirza & Karthik Prabhu leg., 22 December 2013, repository Bombay Natural History Society, Mumbai, (BNHS), not examined.

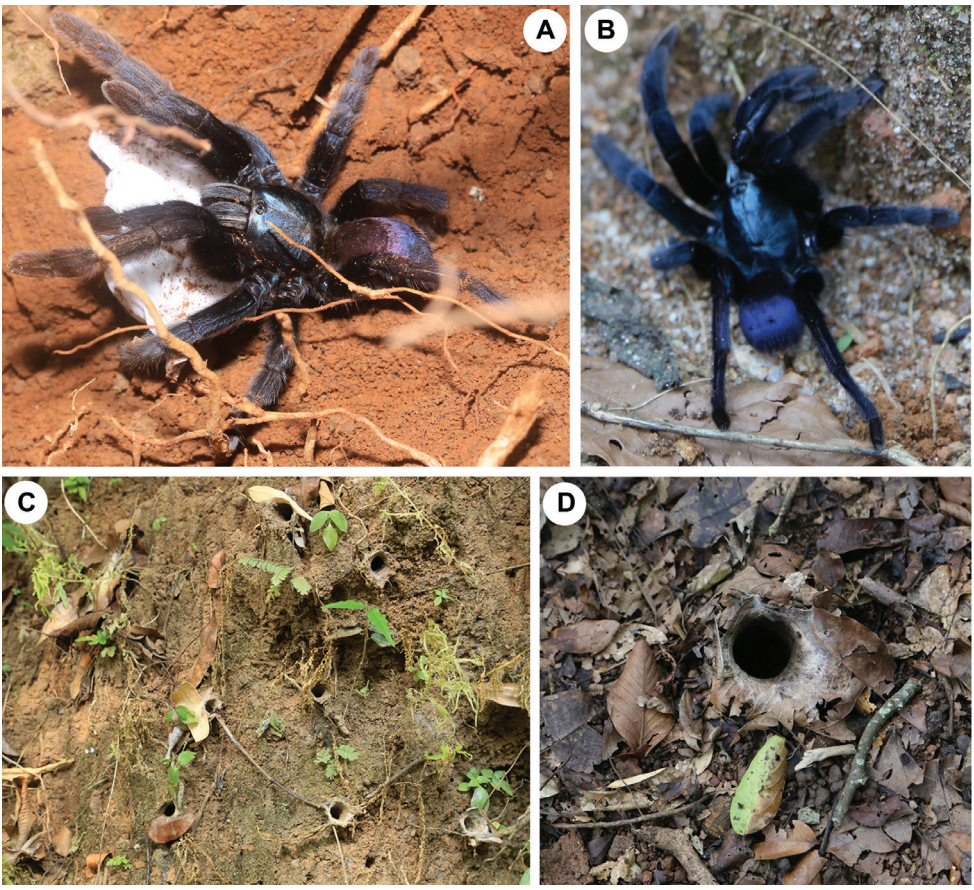

Figure 1. *Haploclastus devamatha* Prasanth & Jose, 2014 **A** female with egg sac from Thenmala (*pink form*), dorso-retrolateral **B** female from Thenmala (*blue form*), dorsal **C** active burrows of juveniles on the road side mud embankment, Thenmala **D** active burrow of adult female on the forest floor, Kulathupuzha Forest Reserve. Photo credit Jimmy Paul.

Other material examined. INDIA, Kerala: Kollam: Thenmala, 8°57'30.7"N, 77°10'38.9"E, 567 m alt., 10 January 2015, M. S. Pradeep leg., from burrows on mud embankment, by hand: 2 females (ADSH101502) (NEW RECORD); Kulathupuzha Forest Reserve, 8°54'6.37"N, 77°3'51.70"E, 134 m alt., 11 January 2015, M. S. Pradeep leg., from burrows on mud embankment and forest floor, by hand: 4 females, 3 subadult females (ADSH101503).

Description. For description and other details of the species, see Sanap and Mirza (2014).

Justification of the synonymy. Although the types of *T. psychedelicus* were not examined, good illustrations and images of this species are available (Sanap and Mirza 2014: figs 1, 2a–d, 3a–e). In the original description of *H. devamatha*, Prasanth and Jose (2014) pointed out several diagnostic somatic features for this species. The first

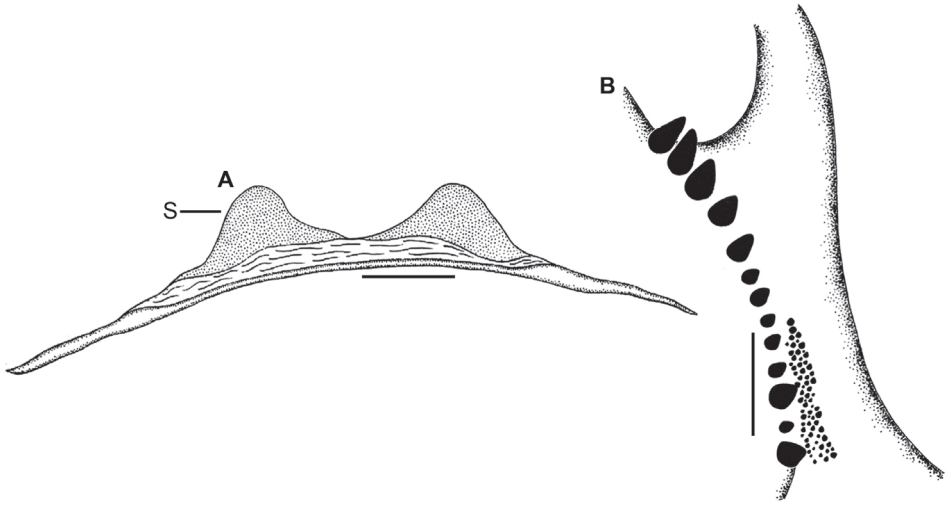

Figure 2. *Haploclastus devamatha* Prasanth & Jose, 2014 **A** genitalia, dorsal **B** left chelicera, prolateral showing teeth arrangement. **S** = Spermatheca. Scale bars: 1 mm (**A**); 2 mm (**B**).

and most important diagnostic character refers to the body colouration of this species, which has iridescent blue and pink colouration. Sanap and Mirza (2014) also noted the same body colouration for *T. psychedelicus* (compare Prasanth and Jose 2014: fig. 1 with Sanap and Mirza 2014: fig. 4). The original illustrations of cheliceral and maxillary lyrae of *T. psychedelicus* are exact matches with the colour photographs of the same provided for *H. devamatha* by Prasanth and Jose (2014) (compare Sanap and Mirza 2014: fig. 3a–c with Prasanth and Jose 2014: figs 3B, 3D, 4A–B). Though the spermathecae of *H. devamatha* (Prasanth and Jose 2014: fig. 2F) seem quite different from that of *T. psychedelicus*, detailed examination of the paratype and topotypes of *H. devamatha* reveals that their illustration is imperfect and misleading, and that both these specimens indeed belong to the same species. The species *T. psychedelicus* should thus be regarded as a junior synonym of *H. devamatha*.

Note. Prasanth and Jose published their findings in January 2014, whereas Sanap and Mirza published their discovery in July 2014, so priority must go to the name *Haploclastus devamatha* and the name *Thrigmopoeus psychedelicus* becomes its junior synonym.

Distribution. India (Kerala: Kollam, Pathanamthitta) (Fig. 3).

Polychromatism. Females of *H. devamatha* are remarkable for their polychromatism (Sanap and Mirza 2014). Two distinct colour forms have been observed in the population of *H. devamatha*: a 'pink form' with bluish prosoma and pinkish opisthosoma and the 'blue form' with uniform bluish black prosoma and opisthosoma (Fig. 1A–B). Perhaps this change in colour is related to the age of the spider as suggested by Sanap and Mirza (2014), but confirmation requires further investigations.

Natural history and conservation. *Haploclastus devamatha* builds unbranched burrows lined with silk. The burrows have single entrance, which is a circular opening

Figure 3. Current distribution of *Haploclastus devamatha* Prasanth & Jose, 2014 ○ new record, ● literature records (Prasanth and Jose 2014, Sanap and Mirza 2014).

ornamented with dried leaves pasted together using silk to form a short turret (Fig. 1D). As noted by Sanap and Mirza (2014), the burrows are found to occur on the roadside mud embankments inside and nearby regions of the forests at a height of 1–6 metres from the ground (Fig. 1C). Rarely, adult burrows are observed on the forest floors. In the Thenmala and Kulathupuzha regions, we were able to locate a large number of juvenile and subadult burrows that are built on the roadside mud embankments. Within a stretch of 2 kilometres in the Thenmala region, 110 burrows were observed and at a stretch of 1.5 kilometres in the Kulathupuzha region, 52 burrows were found. The tendency of this species to build its burrows predominantly on the roadside mud embankments points to the fact that its survival is under threat due to the common anthropogenic activities like soil removal from the mud embankments and burning dried leaves gathered together near the mud embankments.

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repository information of *H. devamatha* holotype. We extend our heartfelt thanks to Drs Rogerio Bertani, Brazil, Volker von Wirth, Germany and an anonymous reviewer for their constructive comments on an earlier version of the MS and to Dr Chris Hamilton, USA for his editorial efforts. We especially acknowledge the Science and Engineering Research Board (SERB)-DST, New Delhi for providing funding support under the Major Research Project No. SR/SO/AS-99/2012.

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CHECKLIST

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Initial commented checklist of Iranian mayflies, with new area records and description of *Procloeon caspicum* sp. n. (Insecta, Ephemeroptera, Baetidae)

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Abstract

An initial checklist of mayflies (Ephemeroptera) of Iran is compiled based on critical review of available literature data, complemented with new data from 38 localities of Gilan and Ardabil provinces. At present, altogether only 46 species and 25 genera are known from Iran, 18 species are reported as new to Iran in this study. Some previously published data are critically evaluated and doubtful taxa are excluded from the list. Basic analysis of the distribution and biogeography of recorded species is given. *Procloeon* (*Pseudocentroptilum*) *caspicum* Sroka, **sp. n.** is described based on mature larva and egg. Critical differential diagnostic characters distinguishing the species from related taxa are discussed in detail.

Keywords

aquatic biodiversity, biogeography, faunistic research, Middle East, taxonomy

Introduction

In comparison to Europe, the mayfly fauna of the Middle East is less known and data from some regions are still fragmentary. Extensive research on mayflies has been mainly focused on the Arabian Peninsula (Thomas and Sartori 1989, Sartori and Gillies 1990, Sartori 1991, Gattolliat and Sartori 2008) and neighbouring countries, namely Syria and Lebanon (Koch 1980, 1981, 1988, Thomas and Dia 1982, 1983, 1984, 1985, 1999, 2007, Thomas et al. 1988, 2007), Jordan (Gattolliat et al. 2012), and Israel (Demoulin 1973, Malzacher 1992, Sartori 1992, Yanai et al. 2017). Extensive literature is available from Turkey (for a review see Kazancı and Türkmen 2012 and Salur et al. 2016). In contrast, Iran, Iraq, Afghanistan, and Pakistan have been poorly investigated and only random findings of mayflies have been published to date (e.g., Kimmins 1950, Demoulin 1964, Allen 1973, Al-Zubaidi et al. 1987, Bojková and Soldán 2015).

Iran, the second largest (more than 1.6 million km²) country of the region after Saudi Arabia, has been studied only occasionally so far. Only 19 species of mayflies have been reported in 16 short taxonomic contributions published in international entomological journals. They include mostly simple faunistic records of species already known from neighbouring countries (Tshernova 1949, Soldán and Landa 1977, Braasch 1981, Kluge 1987, Jacobus 2009, Soldán and Godunko 2013, Godunko et al. 2017). Descriptions of new species were often based on few specimens, often of a single developmental stage (Soldán 1978a, Braasch and Soldán 1979, Braasch 1981, 1983a,b, Sartori and Sowa 1992, Jacobus et al. 2009). The vast majority of records are limited to the northern part of Iran (mostly Alborz Mts. and its surroundings). The only comprehensive study of Iranian mayflies is a monography by Mohammadian (2005). It is written in Persian, thus inaccessible for a wider scientific audience. Moreover, it does not include new records, but is a mere compilation of literature without any own data contributed by the author. It enumerates 55 mayfly species presumably occurring in Iran. However, the list includes species reported from the Iranian Plateau, an area roughly extending from Tigris River to Indus River, which not only comprises Iran, but also some parts of neighbouring countries, Iraq, Azerbaijan, Turkmenistan, Afghanistan and Pakistan. Consequently, a significant part of the species listed should not be regarded as valid records actually documenting the occurrence of species in Iran unless being further corroborated.

Other sources of information on the mayfly diversity in Iran are some ecological studies on benthic macroinvertebrates over the last decades in order to assess water quality. Sharifinia (2015) reviewed 57 references (37 of them written in Persian) published after 2000 and compiled a list of 37 mayfly taxa (identified to species or genus level) known from Iranian rivers. However, this list is partially based on studies presenting species/genera which identity should be regarded as highly unlikely (Ahmadi et al. 2011, 2012, Mahboobi Soofiani et al. 2012, Amri et al. 2014, Farasat and Sharifi 2014, Golchin Manshadi et al. 2015). They list as many as 27 taxa (species or genera) known exclusively from the Nearctic and Neotropic Regions, the occurrence of which can be definitively excluded in the Middle East. Therefore, Sharifinia's as

well as Mohammadian's lists of mayfly species should not be regarded as reliable, thus maintaining a significant gap in our knowledge. The area of Iran should be viewed a certain transitory zone hosting West Palaearctic (European) and Caucasian elements of fauna on one hand and Central Asian or even Oriental faunal elements on the other being certainly worth of the detailed and extensive study. Controversial or irrelevant distributional data should be deleted from faunistic lists, and existing data should be critically evaluated based on extensive, large-scale collecting of new material at localities covering the entire territory of Iran. The *sine qua non* condition is proper species identification even if requiring taxonomic revision of some taxa.

As a first step to achieve this ambitious goal, in May 2016 we collected mayflies at 38 localities in the Gilan and Ardabil Provinces in the north western Iran, the areas of presumably high Ephemeroptera diversity. This study represents the first part in a series of contributions aiming to provide a realistic and more complex picture of the Iranian mayfly fauna for future reference. Hence, the objective of the present study is to (i) critically review all mayfly records so far published from Iran with an emphasis on the validity of species occurrence in Iran and status of species from the taxonomic point of view, (ii) provide new data on the occurrence of species in the western part of the Caspian Sea region, and (iii) describe a new species of the genus *Procloeon* recently found in the studied area.

Study area

Mayflies were collected at 38 localities in the Gilan and Ardabil Provinces in 2016 (Fig. 1). Studied localities included four types of landscape common at the region. (i) Five streams in the Caspian Sea coastal plains in the Gilan Province at the altitude from -6 to 40 m a.s.l. (localities No. 5, 13, 27, 36, 37 in Table 1). The Caspian Sea coastal plains are almost entirely covered by agricultural and urban land. Studied streams drained substantial area of rice fields and a mosaic of various croplands. Stream network of the Caspian Sea coastal plains was modified by numerous channels irrigating fields and interconnections of streams enabling needed distribution of water. Streams are often impacted by pollution from intensive agriculture and urban sewage. (ii) In total, 22 streams flow in the humid deciduous broadleaved forest at the northern slopes of the western part of the Alborz Mts. The altitude of the localities ranged from 80 to 820 m a. s. l. and they include relatively untouched, rapid, turbulent mountain streams (localities No. 6, 11, 15, 17, 32 in Table 1), shaded small, clear brooks (localities No. 2, 7, 8, 10, 16, 28, 30, 31, 33, 34), and eutrophic streams influenced by agriculture and settlements in the river valleys (localities No. 1, 3, 4, 9, 18, 35). (iii) Three streams (localities No. 12, 14, 29) were sampled above 1000 m a.s.l. in the Gilan Province and (iv) eight streams and one pond in the Ardabil Province (altitude 1430–2240 m a.s.l., localities No. 19–26, 38). Localities in the Ardabil Province included only streams in the Sabalan Mt. (4811 m a.s.l.) environ. This region is prone to very extensive agricultural exploitation.

Figure 1. Map of the localities sampled in May 2016 with a list of provinces of Iran.

Studied localities belong to the Euxino-Hyrcanian Province of the Euro-Siberian subregion of the Palaearctic Region (Sagheb Talebi et al. 2014). The climate is very humid, with cold winters, without dry period (annual precipitations 2000 mm, annual mean temperature 15 °C) in the western part of the Province and humid with mild winters and short dry period (annual precipitations 600 mm, annual mean temperature 18 °C) in its eastern part. The growing season lasts 7–9 months (Sagheb Talebi 2005, Sagheb Talebi et al. 2014). The Euxino-Hyrcanian Province is famous for its Hyrcanian and Arasbaran forest zones (Sagheb Talebi et al. 2014). The Hyrcanian Forest contains remnants of the broad leaf forests that covered most of the North Temperate Zone in the early Cenozoic (25–50 million years ago), as it was little impacted by Pleistocene climatic changes. Among 65 tree species known from the Hyrcanian Forest, there are several Tertiary relict species such as Caucasian zelkova *Zelkova carpinifolia*, Persian ironwood *Parrotia persica*, and Caucasian walnut *Pterocarya fraxinifolia*. Due to high humidity, the Hyrcanian Forest

Table 1. List of localities studied in the Gilan and Ardabil Provinces in May 2016 (RT – right tributary, LT – left tributary).

Stream types	Site no.	Stream name	Stream	Location	Nearest town	Latitude	Longitude	Altitude	Sampling date
rivers in the coastal plains	5	Sefid Rud	about 55 km from its mouth	SE of Sangar	Sangar	37°07'16"N	49°44'06"E	39	12/05/2016
rivers in the coastal plains	13	Shakhzar	about 32 km from its mouth	NE of Fuman	Fuman	37°14'13"N	49°20'43"E	5	15/05/2016
rivers in the coastal plains	27	Chelvand	about 2.5 km from its mouth	W Chelvand (S of Lavandvil)	Lavandvil	38°17'20"N	48°51'35"E	-6	19/05/2016
rivers in the coastal plains	36	Karganrud	about 7 km from its mouth	in Talesh	Talesh	37°48'22"N	48°54'27"E	36	22/05/2016
rivers in the coastal plains	37	Navrud	about 5 km from its mouth	in Asalem	Asalem	37°43'56"N	48°57'13"E	34	22/05/2016
clear forest rivers	6	Zilaki River	RT of Sefid Rud	in Mush Bijar (E of Shahr-e Bijar)	Shahr-e Bijar	37°00'28"N	49°40'24"E	125	13/05/2016
clear forest rivers	11	Shafa Rud	about 20 km from its mouth	W of Punel	Punel	37°31'47"N	49°00'52"E	218	15/05/2016
clear forest rivers	15	Machian	LT of Bala Rud	Lunak waterfalls (S of Siahkal)	Siahkal	37°00'31"N	49°51'51"E	484	16/05/2016
clear forest rivers	17	Shamrud	RT of Sefid Rud	south of Tushi (S of Siahkal)	Siahkal	37°03'00"N	49°53'54"E	252	16/05/2016
clear forest rivers	32	Semoosh	RT of Polrud	SW of Rahimabad	Rahimabad	37°00'11"N	50°18'06"E	88	21/05/2016
clear forest brooks	2	Eshkaraab	RT of Khara Rud	S of Paein Khara Rud (S of Pashaki)	Sangar	37°02'29"N	49°47'52"E	198	12/05/2016
clear forest brooks	7	Sefidab	RT of Siah Rud	in Divarsh (NE of Shirkuh)	Tutkabon	36°53'59"N	49°35'06"E	273	13/05/2016
clear forest brooks	8	Chulak waterfall	LT of Reshte Rud	NE of Khulak (W of Oskolak)	Oskolak	37°00'11"N	49°29'49"E	201	13/05/2016
clear forest brooks	10	Sangdeh	LT of Shafa Rud	W of Punel	Punel	37°31'47"N	49°00'52"E	218	15/05/2016
clear forest brooks	16	unnamed brook	Lunak waterfalls	Lunak waterfalls (S of Siahkal)	Siahkal	37°00'31"N	49°51'49"E	495	16/05/2016
clear forest brooks	28	unnamed brook	LT of Shalman Rud1	SW of Amlash	Amlash	37°02'46"N	50°05'42"E	184	21/05/2016
clear forest brooks	30	unnamed brook	RT of Shalman Rud	in Bolurdekan	Amlash	37°01'55"N	50°04'39"E	282	21/05/2016
clear forest brooks	31	unnamed brook	LT of Shalman Rud2	SW of Amlash	Amlash	37°02'13"N	50°04'57"E	287	21/05/2016
clear forest brooks	33	unnamed brook	LT of Rudkhan	NE of Masuleh	Masuleh	37°09'47"N	49°00'17"E	820	22/05/2016

Stream types	Site no.	Stream name	Stream	Location	Nearest town	Latitude	Longitude	Altitude	Sampling date
clear forest brooks	34	unnamed brook	RT of Rudkhan	NE of Masuleh	Masuleh	37°09'42"N	49°01'17"E	697	22/05/2016
polluted forest rivers	1	Khara Rud	RT of Sefid Rud	S of Paein Khara Rud (S of Pashaki)	Sangar	37°05'01"N	49°46'25"E	81	12/05/2016
polluted forest rivers	3	Kalardeh Rukhan	left fork of Khara Rud	in Madarsara (S of Pashaki)	Sangar	37°04'12"N	49°46'36"E	103	12/05/2016
polluted forest rivers	4	unnamed brook	right fork of Khara Rud	in Golestansara (S of Pashaki)	Sangar	37°02'20"N	49°47'27"E	186	12/05/2016
polluted forest rivers	9	Reshteh Rud	LT of Sefid Rud	NE of Khulak (W of Oskolak)	Oskolak	37°00'07"N	49°30'13"E	185	13/05/2016
polluted forest rivers	18	Choshal		E of Ezbaram (S of Lahijan)	Lahijan	37°07'33"N	49°56'39"E	146	16/05/2016
polluted forest rivers	35	Masuleh Rudkhan	about 50 km from its mouth	E of Masuleh	Masuleh	37°10'02"N	49°05'03"E	369	22/05/2016
streams above 1000 m in Gilan Prov.	12	unnamed brook	LT of Shafa Rud	NW of Sangdeh	Sangdeh	37°31'46"N	48°45'19"E	1337	15/05/2016
streams above 1000 m in Gilan Prov.	14	Kakrud	LT of Polrud	in Ishku-ye Bala (SW of Deylaman)	Deylaman	36°51'44"N	49°52'52"E	1356	16/05/2016
streams above 1000 m in Gilan Prov.	29	unnamed brook		N of Chaldasht	Amlash	36°59'86"N	50°05'73"E	1250	21/05/2016
streams above 1000 m in Ardabil Prov.	19	unnamed brook	small brook below Alvares ski areal	in Alvaresi (W of Sarein)	Sarein	38°09'38"N	47°56'21"E	2237	17/05/2016
streams above 1000 m in Ardabil Prov.	20	Bulakhlar chayi	left fork of the river	NW of Nir	Nir	38°02'09"N	47°58'55"E	1622	17/05/2016
streams above 1000 m in Ardabil Prov.	21	Bulakhlar chayi	LT of Hakim Geshlaghi chayi	NW of Nir	Nir	38°02'09"N	47°58'55"E	1622	17/05/2016
streams above 1000 m in Ardabil Prov.	22	unnamed brook		in Sardabe (W of Vakilabad)	Vakilabad	38°17'03"N	48°02'10"E	1927	18/05/2016
streams above 1000 m in Ardabil Prov.	23	unnamed brook		below Sardabe (W of Vakilabad)	Vakilabad	38°16'58"N	48°02'28"E	1901	18/05/2016

Stream types	Site no.	Stream name	Stream	Location	Nearest town	Latitude	Longitude	Altitude	Sampling date
streams above 1000 m in Ardabil Prov.	24	Hakim Geshlaghi chayi	RT of Qareh-Su	SW of Almas (SW of Ardabil)	Ardabil	38°08'27"N	48°10'36"E	1433	18/05/2016
streams above 1000 m in Ardabil Prov.	25	Bulakhlar chayi	LT of Hakim Geshlaghi chayi	in Nir	Nir	38°01'56"N	47°59'48"E	1602	18/05/2016
streams above 1000 m in Ardabil Prov.	26	unnamed brook		E of Kadijan (E of Sarab)	Sarab	37°56'25"N	47°41'03"E	1717	18/05/2016
streams above 1000 m in Ardabil Prov.	38	pond	pond on brook 22 & 23	SE of Jomadi (E of Vakilabad)	Vakilabad	38°16'55"N	48°06'14"E	1589	18/05/2016

hosts many epiphytes, mosses, ferns, lichens, mistletoes, and flowering plants (greenbriar *Smilax excelsa* and ivy *Hedera pastuchovii*). It is also characterized by the lack of conifers (except for, e.g., European yew *Taxus baccata*, Junipers, and Mediterranean Cypress *Cupressus sempervirens* var. *horzontalis*) (Sagheb Talebi 2005, Sagheb Talebi et al. 2014). The *Querco-Buxetum* forests of the Caspian coastal plains have been almost completely converted to agricultural land. On the relatively less humid lower slopes of the mountains (below 700 m a.s.l.) in Gilan and Mazandaran provinces, chestnut-leaved oak (*Quercus castaneifolia*) and European hornbeam (*Carpinus betulus*) are mixed with Persian ironwood forming diverse *Querco-Carpinetum* and *Parrotio-Carpinetum* forests. These forests have been extensively exploited. Between 700–1500 m a.s.l., oriental beech (*Fagus orientalis*) is the dominant tree forming the *Fagetum hyrcanum* community, the most diverse and productive forest in the region, which is linked with European beech forests (Sagheb Talebi et al. 2014). Above the beech belt, Caucasian oak and Oriental hornbeam occur up to the timberline at approx. 2700 m a.s.l., forming the *Querco macranthero-Carpinetum orientalis* community (Sagheb Talebi 2005, Sagheb Talebi et al. 2014).

Materials and methods

Published records of mayfly species/genera in Iran were excerpted from available literature and summarised in Table 2. System and nomenclature of Palaearctic species included in Table 2 mostly follow Bauernfeind and Soldán (2012), with some exceptions (classification of Kluge and Novikova (2014) is used for the genus *Nigrobaetis*, Jacobus and McCafferty (2008) for the family Ephemerellidae). Generic and species names of Nearctic/Neotropic species mentioned in ecological studies of Iranian freshwaters were presented in the original form, later taxonomic or nomenclatoric changes were not taken into account.

Table 2. Commented list of Ephemeroptera of Iran with notes to their distribution. Species representing new area records to Iranian mayfly fauna are **in bold**, data on taxa with unlikely occurrence are marked with an asterisk (*). See Table 1 for numbers and for precise location of localities in the Gilan and Ardabil Provinces studied recently. Basic information on the area of species is based on Bauernfeind and Soldán (2012), detailed information concerning the Middle East and Central Asia is provided by references. Data on the occurrence of solely Nearctic/Neotropic species and genera are mentioned below the table (#).

Species/genus	Records from Iran	Notes to the global area and distribution	Remarks to records in Iran
Ameletidae			
**Ameletus* sp.	Qazvin Prov.: Shahrud	Holarctic genus, with the area extension to Central America and Oriental Region. The only Euro-Siberian species is *A. inopinatus* Eaton, 1887, in Central Asia *A. alexandrae* Brodsky, 1930.	Unidentified species reported by Sharifinia et al. (2016a, b). The nearest record of the genus (*Ameletus inopinatus*) was published from Turkey.
Siphlonuridae			
**Siphlonurus* sp.	Isfahan Prov.: Zayanderud,	Holarctic genus, including subarctic areas. Twelve species known from the West Palearctic Region.	Unidentified species reported by Mahboobi Soofiani et al. (2012).
Ametropodidae			
Ametropus sp.	„117 km south of Rasht“	Holarctic genus. In the West Palearctic Region, the only species *Ametropus fragilis* Albarda, 1878. *Ametropus eatoni* Brodsky, 1930 described from Siberia, Ural requires re-evaluation.	Unidentified species reported from unclear locality 117 km S of Rasht by Braasch (1981). Family Ametropodidae reported from the unnamed stream NW of Shiraz by Bashti and Ostovan (2014). The nearest record of the genus (*Ametropus fragilis*) was published from the Caucasus (Eaton 1883–1888, Sadovsky 1940).
Baetidae			
Baetis (*Acentrella*) sp.	Isfahan Prov.: Zayanderud	Holarctic and Oriental genus. Five species known from the West Palearctic Region, additional species known from Central Asia.	Unidentified species reported by Mahboobi Soofiani et al. (2012).
Baetis sp.	Qazvin Prov.: Shahrud; Alborz Prov.: Kordan riv., Haraz riv., Tehran Prov.: Jajrud, Bareghan riv.; Mazandaran Prov.: Tajan riv., Dalir riv., Chatan riv., Firuz Abad riv.; Ardabil Prov.: Gharasou riv.; Kermanshah Prov.: Kavat riv.; Isfahan Prov.: Zayanderud; and 50 km SE of Khorramabad, 1500 m a.s.l.	Cosmopolitan genus except for South America. Very diverse in the West Palaearctic Region, at least 64 species known from Europe.	Unidentified species reported by Sharifinia et al. (2016a,b; Shahrud), Mousavi Nadushan and Ramezani (2011; Kordan riv.), Ghasemi and Kamali (2014; Haraz riv.), Egglishaw (1980; Jajrud, Bareghan riv.), Imanpour Namin et al. (2013; Tajan riv.), Shokri et al. (2014; Tajan riv.), Mousavi and Hakobyan (2017; Haraz riv., Dalir riv., Chatan riv., Firuz Abad riv.), Seyyedsharifi et al. (2014; Gharasou riv.), Farasat and Sharifi (2014; Kavat riv.), Mahboobi Soofiani et al. (2012; Zayanderud) and Braasch (1981, 50 km SE of Khorramabad).
Baetis (*Baetis*) *baroukianus* Thomas & Dia, 1984	Gilan Prov.: 7, 33, 34	Its distribution not known in details, reported from two disjunctive subareas in Lebanon and Iran (Thomas and Dia 1984, 1999, Godunko et al. 2017).	*B. alpinus* species-group. Described from Lebanon (Thomas and Dia 1984, 1999). First record in Iran by Godunko et al. (2017) was based on our material (loc. 7).

Species/genus	Records from Iran	Notes to the global area and distribution	Remarks to records in Iran
**Baetis* (*Baetis*) *bicaudatus* Dodds, 1923	Tehran Prov.: Jajrud	Holarctic species, in Palaearctic Region reported from Altai, Mongolia and Russian Far East (Kluge 1997b).	A species close European representatives to the *B. alpinus* species-group. Reported by Amri et al. (2014). The occurrence in Iran is rather unlikely as its westernmost records were published from Mongolia.
***Baetis* (*Baetis*) *buceratus* Eaton, 1870**	Gilan Prov.: 5, 13, 27, 28, 32, 37; Ardabil Prov.: 24, 38	Widely distributed from Europe to Central Asia including Near East, Iraq (Al-Zubaidi et al. 1987) and Turkey (Kazancı and Türkmen 2012, Salur et al. 2016).	Iran falls within its known distributional range.
***Baetis* (*Baetis*) *monnerati* Gattolliat & Sartori, 2012**	Mazandaran Prov.: brook above Yalrud 36°06'17"N / 51°50'14"E, 2 larvae; brook above Molla Kala, 4 larvae (coll. M. Svitok, unpublished)	Recently described from Jordan (Gattolliat et al. 2012).	*B. buceratus* species-group. Iran represents the easternmost limit of its area.
***Baetis* (*Baetis*) cf. *nexus* Navás, 1918**	Gilan Prov.: 14; Ardabil Prov.: 21–24, 26, 38	Known from Europe and Turkey (Kazancı 1985).	Iran represents easternmost limit of its area. Material shows some morphological differences from European material and requires more detailed examination. The synonymy of *B. pentaphlebodes* to *B. nexus* is highly questionable, we follow the IZCN Opinion No. 2171 (2007), until new evidence is published.
Baetis (*Baetis*) *fuscatus* (Linnaeus, 1761)	„Southern Persia“ New records Gilan Prov.: 1, 6, 13, 18, 27, 32, 36	Transpalaearctic species. Doubtfully distinguishable species from West Palaearctic species *B. scambus* Eaton, 1870 in the larval stage.	*B. fuscatus* mentioned by Eaton (1885) as "… eastwards to Southern Persia (Hagen Mus)". Iran falls within known distributional range of both species.
***Baetis* (*Baetis*) *lutheri* Müller-Liebenau, 1967**	Gilan Prov.: 1–7, 9, 11, 13, 14, 17, 18, 27, 28, 32, 35–37; Ardabil Prov.: 23, 24	Widely distributed from Europe to Caucasus, Turkey (Kazancı and Türkmen 2012, Salur et al. 2016) and Iraq (Al-Zubaidi et al. 1987).	Iran represents the easternmost limit of its area. Larvae of *B. lutheri* species-group from N Iran can be confused with poorly known species *Baetis petrovi* Tshernova, 1938 (see Soldán and Godunko 2008).
***Baetis* (*Baetis*) *vardarensis* Ikonomov, 1962**	Gilan Prov.: 2, 5, 13, 14, 18,–28, 32, 36, 37; Ardabil Prov.: 26	Widely distributed from Europe to Caucasus and Turkey (Kazancı and Türkmen 2012, Salur et al. 2016).	Iran represents the easternmost limit of its area.
***Baetis* (*Baetis*) *samochai* Koch, 1981**	Gilan Prov.: 13	Known from Turkey (Koch 1985), Israel, Lebanon and Syria (Koch 1981).	Iran represents the easternmost limit of its area.
Nigrobaetis (*Takobia*) *muticus* (Linnaeus, 1758)	Mazandaran Prov.: Chatan riv. New records Gilan Prov.: 12, 19, 29, 35, 36; Ardabil Prov.: 21, 22	Widely distributed from North Africa (confirmation needed), Europe, Russia and Turkey to Caucasus and Central Asia (eastern Kazakhstan, Novikova and Kluge 1994). Known also from Korean peninsula and Japan.	In Iran, reported first from Chatan riv. in Mazandaran Prov. by Mousavi and Hakobyan (2017).
***Nigrobaetis* (*Nigrobaetis*) *gracilis* (Bogoescu & Tabacaru, 1957)**	Gilan Prov.: 13	Distributed in the Alps, Carpathians, Caucasus, reported also from Tajikistan (Zimmermann 1981).	Iran falls within its known distributional range.

Species/genus	Records from Iran	Notes to the global area and distribution	Remarks to records in Iran
***Baetis* (*Rhodobaetis*) *braaschi* (Zimmermann, 1980)**	Gilan Prov.: 9, 14; Ardabil Prov.: 22, 24–26	Occurs in neighbouring countries, reported from Eastern Ukraine to Crimea, Turkey, Caucasus and Central Asia (Sroka et al. 2012).	Iran represents the easternmost limit of its area.
***Baetis* (*Rhodobaetis*) cf. *vadimi* Godunko, Palatov & Martynov, 2015**	Gilan Prov.: 7, 10–12, 14, 29, 31, 33; Ardabil Prov.: 19, 23	Probably undescribed species, closely related to *B. vadimi* from Georgia and Turkey. Possibly conspecific with part of material identified as "*Baetis gemellus*" in the past from Europe and Middle East.	Material from Iran morphologically similar to species identified as *B.* cf. *gadeai* from Caucasus (Sroka 2012).
***Baetis* (*Rhodobaetis*) *ilex* (Jacob & Zimmermann, 1978)**	Tehran Prov.: brook in Younza Pass, 35°59'18"N / 51°43'13"E, 5 larvae; brook 36°00'54"N / E 51°47'18", 7 male imagines (coll. M. Svitok, unpublished); Gilan Prov.: 12, 33; Ardabil Prov.: 19, 20, 22	Poorly known species, so far considered endemic to the Caucasus (Jacob and Zimmermann 1978).	Only 20 larvae known from the Caucasus to date (Jacob and Zimmermann 1978). Findings from Iran represent the second published records on its so far insufficiently known area.
Baetis (*Rhodobaetis*) *rhodani* (Pictet, 1843)	West Azerbaijan Prov.: Zarrinehrud; Alborz Prov.: Karaj riv. New records Gilan Prov.: 1–7, 9–14, 27, 28, 30, 32–37; Ardabil Prov.: 16–23, 25, 26, 38	Widely distributed in the Western Palaearctic region. Records from the East Palaearctic appear rather unlikely (Bauenrfeind and Soldán 2012).	Reported from Zarrinehrud in West Azerbaijan Prov. (Ahmadi et al. 2012) and from Karaj riv. in Alborz Prov. (Khatami 2017). Iran falls within its known distributional range.
Cloeon sp.	Alborz Prov.: Kordan riv.; Mazandaran Prov.: Tajan riv., Valasht lake	Almost cosmopolitan, including some remote oceanic islands. About 15 species from three subgenera known from the West Palaearctic Region.	Unidentified species reported by Mousavi Nadushan and Ramezani (2011; Kordan riv.), Imanpour Namin et al. (2013; Tajan riv.) and Mousavi and Hakobyan (2017; Valasht lake).
Cloeon (*Cloeon*) *cognatum* Stephens, 1836	Tehran Prov.: Jajrud	Holarctic species, reported from Central America as well (McCafferty and Waltz 1990). The species requires the revision of the status.	Reported from Jajrud near Tehran (Amri et al. 2014).
Cloeon (*Cloeon*) *dipterum* (Linnaeus, 1761)	Tehran Prov.: Jajrud New record Ardabil Prov.: 38	Widely distributed in the Palaearctic Region, known also from the Nearctic Region (Quebec and Ontario, see Bauernfeind and Soldán 2012).	Except our record known from Jajrud near Tehran (Amri et al. 2014).
Cloeon (*Similicloeon*) *simile* Eaton, 1870	West Azerbaijan Prov.: Zarrinehrud	Transpalearctic species, missing in Japan.	Reported from Zarrinehrud in NW Iran (Ahmadi et al. 2012) and Jajrud near Tehran (Amri et al. 2014).
Centroptilum sp.	Isfahan Prov.: Zayanderud New records Gilan Prov.: 28, 31	Holarctic genus, with an area extension into the Oriental Region. Two West Palaearctic species: *C. luteolum* O. F. Müller, 1776 and *C. pirinense* Ikonomov, 1962.	Our records represent undescribed species related to *C. luteolum*. The species will be described by Martynov (pers. comm.) based on the material from Caucasus (AR Adjara). Unidentified species of the genus *Centroptilum* was also reported by Mahboobi Soofiani et al. (2012) from Zayanderud in Central Iran.

Species/genus	Records from Iran	Notes to the global area and distribution	Remarks to records in Iran
***Procloeon* (*Pseudocentroptilum*) *caspicum* sp. n.**	Gilan Prov.: 7, 27 (type locality), 36	So far known from the type locality in Iran only.	
Oligoneuriidae			
Oligoneuriella sp.	Mazandaran Prov.: Tajan riv., Firuz Abad riv., Poleocean riv.; Isfahan Prov.: Zayanderud	Palaearctic genus, ten species known from the West Palaearctic Region. In the Near East, seven species known from Turkey (Kazancı and Türkmen 2012, Sroka et al. 2015), one from Iraq (Al-Zubaidi et al. 1987) and one from Syria (Koch 1980).	Unidentified species of the genus *Oligoneuriella* was reported from Zayanderud in Central Iran by Mahboobi Soofiani et al. (2012) and from Tajan riv., Firuz Abad riv. and Poleocean riv. in Mazandaran Prov. by Shokri et al. (2014) and Mousavi and Hakobyan (2017).
Oligoneuriella tskhomelidzei Sowa & Zosidze, 1973	Mazandaran Prov.: mountain stream, Gazanak, 1400 m a.s.l. New records Gilan Prov.: 11, 17, 27, 36, 37	Caucasian species described from Georgia (Sowa and Zosidze 1973), known also from Turkey (Kazancı and Türkmen 2012, Salur et al. 2016).	*Oligoneuriella baskale* described from east Turkey, two female imagines reported from Iran (Soldán and Landa 1977). Later, the species was synonymised with *O. tskhomelidzei* by Kluge (2004), however without any supporting argumentation.
Heptageniidae			
**Arthroplea* sp.	Isfahan Prov.: Zayanderud	Holarctic genus, in the Palaearctic Region evidently boreomontane element. One species, *Arthroplea congener* Bengtsson, 1908, in the West Palaearctic Region.	Unidentified species reported by Mahboobi Soofiani et al. (2012). The occurrence of this genus in Iran is highly unlikely as the most southern records of the genus were published from high altitudes in Switzerland, France and Ural Mts. (Bauernfeind and Soldán 2012).
Ecdyonurus sp.	Mazandaran Prov.: Tajan riv.; Qazvin Prov.: Shahrud; Alborz Prov.: Karaj riv.; Isfahan Prov.: Zayanderud New records Gilan Prov.: 14; Ardabil Prov.: 19–22, 25, 26	West Palaearctic genus, about 42 species known.	Unidentified species were reported by Shokri et al. (2014; Tajan riv.), Sharifinia et al. (2016a,b; Shahrud), Khatami (2017, Karaj riv.) and Mahboobi Soofiani et al. (2012; Zayanderud). Larvae and imagines related to *Ecdyonurus ornatipennis* from our material deserve further examination.
Ecdyonurus ornatipennis Tshernova, 1938	„117 km south of Rasht and 50 km SE of Khorramabad, 1500 m a.s.l."	Described from Azerbaijan, known throughout Caucasus and from Turkey (Kazancı and Türkmen 2012, Salur et al. 2016).	First records from Iran by Braasch (1981) with insufficient localisation. Recently reported from Talysh Mts. close to Iranian border by Palatov and Sokolova (2006).
Electrogena bothmeri (Braasch, 1983)	Chalus, Mazandaran Prov. (type locality)	Known only as the holotype male subimago (!) described by Braasch (1983a).	Single record from the type locality (Braasch 1983a), no record since then.
***Electrogena pseudaffinis* (Braasch, 1980)**	Gilan Prov.: 1–4, 6, 7, 10–12, 15–18, 27, 28, 30–32, 35, 36	Caucasian species described from the Russian part of Caucasus (Braasch 1980a). Known from Russia and Georgia (Braasch 1980a,b, Martynov et al. 2016), Turkey (Kazancı and Braasch 1988, Kazancı and Türkmen 2012, Salur et al. 2016) and Azerbaijan (coll. Soldan, unpublished).	Common and often abundant species in streams studied in the Gilan Prov., preferring forest streams and rivers at lower altitudes.

Species/genus	Records from Iran	Notes to the global area and distribution	Remarks to records in Iran
***Electrogena* cf. *squamata* (Braasch, 1978)**	Gilan Prov.: 10–12, 16, 28, 29, 31–35	Caucasian species known from Georgia (Braasch 1978, 1980b, Martynov et al. 2016), Russia (Braasch 1978b) and Azerbaijan (Braasch 1980b).	Common and often abundant species in streams studied in Gilan Prov., preferring forest streams and rivers with no apparent altitude preference. At lower stream sections syntopic with *E. pseudaffinis*.
Electrogena ressli (Braasch, 1981)	Gilan Prov.: Rasht	Type locality in Turkey, paratypes (one male imago and one male subimago) known from Iran (Braasch 1981).	Single record from the type locality, no record since then.
Heptagenia sp.	Tehran Prov.: Jajrud, Bareghan riv.; Alborz Prov.: Karaj riv.; Mazandaran Prov.: Haraz riv., Tajan riv.; Isfahan Prov.: Zayanderud	Holarctic and Oriental genus, not recorded from North Africa. Nine species known from the West Palaearctic Region. Five species known from the Near East.	Unidentified species reported by Egglishaw (1980; Jajrud, Bareghan riv.), Shayeghi et al. (2015; Karaj riv.), Ghasemi and Kamali (2014; Haraz riv.), Shokri et al. 2014; Tajan riv.), and Mahboobi Soofiani et al. (2012; Zayanderud).
Heptagenia samochai Demoulin, 1973	Golestan Prov.: Gorgan	Known from eastern Europe to Asia Minor. Recorded from Georgia, Crimean Peninsula, Russia, Armenia, Israel, and Iran.	Reported from Iran sub *Heptagenia lutea* (syn. subj.) by Kluge (1987).
Epeorus sp.	Alborz Prov.: Kordan riv.; Mazandaran Prov.: Tajan riv.; Ardabil Prov.: Gharasou riv.	Holarctic genus, with an extension to Neotropics and Oriental Region. Representatives of three subgenera, *Caucasiron*, *Epeorus* and *Ironopsis*, (Kluge 1997a) known from the West Palaearctic Region.	Unidentified species without an affiliance to either subgenera were reported by Mousavi Nadushan and Ramezani (2011; Kordan riv.), Imanpour Namin et al. (2013; Tajan riv.), Shokri et al. (2014; Tajan riv.) and Seyyedsharifi et al. (2014; Gharasou riv.).
* *Epeorus* (*Iron*) sp.	Tehran Prov.: Jajrud, Bareghan riv.	Subgenus *Iron* is Holarctic, its species known mainly from Central Asia, Siberia, Far East and North America (Kluge 1997b, Kluge 2004).	Unidentified species reported by Egglishaw (1980) from Jajrud and Bareghan rivers likely refer to some species of *Epeorus* known from the north Iran.
* *Epeorus* (*Ironopsis*) sp.	Tehran Prov.: Jajrud	Subgenus *Ironopsis* is Holarctic, its species known from USA, Central Asia and Europe (Kluge 1997b, Kluge 2004).	Unidentified species reported by Egglishaw (1980) from Jajrud likely refer to some species of *Epeorus* known from the north Iran.
Epeorus (*Caucasiron*) sp.	Gilan Prov.: 12, 17, 27, 30	Subgenus *Caucasiron* is distributed in the East Mediterranean, Caucasus, Central Asia and Southwestern China. Eleven species and two subspecies known up to date. The highest diversity (9 species) in the Caucasus Mts.	Species recorded in low abundace in Gilan Prov.; deserves further examination.
Epeorus (*Caucasiron*) *caucasicus iranicus* (Braasch & Soldán, 1979), comb. nov.	Tehran Prov.: stream in Darband Valley, 2100 m a.s.l., (type locality). Mazandaran Prov.: Dalir riv., Firuz Abad riv., Haraz riv., Koshk Sara riv. New record Ardabil Prov.: 19	Recently known only from the Alborz mountain range. Larva and nymphal protopenis bear features proposed for subgenus *Caucasiron*, imago unknown.	Recorded from Tehran Prov. (Braasch and Soldán 1979), Mazandaran Prov. (Mousavi and Hakobyan 2017), and in several individuals also from the Ardabil Prov.

Species/genus	Records from Iran	Notes to the global area and distribution	Remarks to records in Iran
***Epeorus* (*Caucasiron*) cf. *znojkoi* Tshernova, 1938**	Gilan Prov.: 2–4, 7, 8, 10–12, 15–17, 27, 29, 30, 33–35	Widely distributed in Caucasus and Asia Minor. Known from Turkey (Türkmen and Kazancı 2015, Salur et al. 2016), Georgia (e.g., Martynov et al. 2016), Armenia (Sinitshenkova 1976), Russia (e.g., Chen 1999) and Azerbaijan (e.g., Sinitshenkova 1976).	The most common *Epeorus* (*Caucasiron*) species recorded at the streams studied in Gilan Prov. Iran represents the easternmost limit of its known distribution.
***Epeorus* (*Epeorus*) *zaitzevi* Tshernova, 1981**	Gilan Prov.: 14	Described from Armenia as imago, larva described by Demoulin (1973) as *Epeorus* sp. and Braasch (1978a) as *Epeorus znojkoi*. Widely distributed in Caucasus and Near East: Turkey (Kazancı and Türkmen 2012, Salur et al. 2016), Israel (Sartori 1992), Iraq (Al-Zubaidi et al. 1987), Syria (Koch 1988), Azerbaijan (Chen 1999) and Georgia (coll. Hrivniak, unpublished).	Species recorded from one locality in the Alborz Mts. Iran represents the easternmost limit of its known distribution.
**Cinygmula* sp.	Qazvin Prov.: Shahrud	*Cinygmula* shows Holarctic (East Palaearctic and Nearctic) area. Western limits of this area in Central Asia (Uzbekistan, Kirgizstan) and probably northern mountain ranges in Afghanistan and Pakistan, definitively missing in Caucasus.	Unidentified species reported by Sharifinia et al. (2016a,b). Most probably misidentification at the generic level (*Rhithrogena*?), the occurrence of any representative of *Cinygmula* in Iran very unlikely.
Rhithrogena sp.	Tehran Prov.: Jajrud, Bareghan riv.; Alborz Prov.: Kordan Riv.; Mazandaran Prov.: Tajan Riv.; Isfahan Prov.: Zayanderud; New record Gilan Prov.: 19	Holarctic genus, including North Africa, with the area extension to the Oriental Region. Very diverse genus (more than 150 species) in the West Palaearctic Region.	Unidentified species reported by Egglishaw (1980; Jajrud, Bareghan riv.), Mousavi Nadushan and Ramezani (2011; Kordan riv.), Shokri et al. (2014; Tajan riv.) and Mahboobi Soofiani et al. (2012; Zayanderud).
***Rhithrogena* cf. *decolorata* Sinitshenkova, 1973**	Gilan Prov.: 10–12, 15, 17, 18, 27, 33, 34, 35–37	Widely distributed throughout the Caucasus, known also from the Talysh Mts. in Azerbaijan (Palatov and Sokolova 2016).	Common species in the Gilan Prov.
Rhithrogena iranica Braasch, 1983	Shesavar (type locality), likely referring to Shahsavar	Known only as the holotype (male imago) and paratypes (two female subimagines) described by Braasch (1983b) from a single locality.	Insufficient localisation of the type locality.
Rhithrogena paulinae Sartori & Sowa, 1992	Tehran Prov.: Sefid Khok, Alborz Mts., 2200 m a.s.l. (type locality)	Only holotype (imago male) and paratypes (four female imagos and two larvae) from a single locality known (Sartori and Sowa 1992).	Known only from the Alborz Mts.
Leptophlebiidae			
Paraleptophlebia sp.	Alborz Prov.: Kordan riv.	Holarctic genus, six species known from the West Palaearctic Region.	Unidentified species reported by Mousavi Nadushan and Ramezani (2011) from Kordan riv. in Alborz Prov.

Species/genus	Records from Iran	Notes to the global area and distribution	Remarks to records in Iran
Paraleptophlebia submarginata (Stephens, 1935)	„50 km SE of Khorramabad, 1500 m a.s.l."	Widely distributed in Europe (from Fennoscandia to Mediterranean), in northeast reaching to Ural and W Siberia (e.g., Novikova 1984, Beketov and Kluge 2003), and southeast to Israel (Sartori 1992) and Iran (Braasch 1981).	The only record from Iran with insufficient localisation (Braasch 1981).
***Habroleptoides confusa* Sartori & Jacob, 1986**	Gilan Prov.: 7, 8, 10, 12, 15, 16, 27–29, 31, 33–35.	Widely distributed in Europe (not in Fennoscandia), in east from Greece and Turkey to Armenia and Azerbaijan (Sartori and Jacob 1986). Iran represents the easternmost limit of its area.	Common in small forest brooks in the Gilan Province.
***Habrophlebia* cf. *lauta* Eaton, 1884**	Gilan Prov.: 1, 8, 31	West Palaearctic species, known from North Africa, Europe, Caucasus and Turkey.	Only small-instar larvae found in the Gilan Prov.
**Leptophlebia* sp.	Mazandaran Prov.: Tajan riv.	Holarctic genus, with extension to transitory Palaearctic-Oriental area in China. Only two West-Palaearctic species, *L. vespertina* Linnaeus, 1758 and *L. marginata* Linné, 1767, which occurrence in Iran is unlikely.	Unidentified species reported by (Imanpour Namin et al. 2013).
Choroterpes (*Euthraulus*) *sumbarensis* Kluge, 1984	Razavi Khorasan Prov.: Mashhad (Kopedag Mts.)	Described from the Kopetdag Mts. in Turkmenistan (Kluge 1984).	According to Mohammadian (2005), Kluge (pers. comm.) reported the species from Mashhad.
Ephemerellidae			
Ephemerella sp.	Mazandaran Prov.: Tajan riv.; Alborz Prov.: Karaj riv.	Holarctic and Oriental genus, three species known from the West Palaearctic Region.	Unidentified species reported by Khatami (2017) from Karaj riv. and by Shokri et al. (2014) and Imanpour Namin et al. (2013) from Tajan riv. in Mazandaran Province. Specimens from our collection in the Ardabil Prov. require further examination.
**Ephemerella maculocaudata* Ikonomov, 1961	Mazandaran Prov.: Siah Bisheh riv.	Mediterranean species known from two disjunctive areas, Balkan (Macedonia, Bulgaria) and west Mediterranean (Spain, France). Occurrence in Iran is unlikely. According to Jacobus and McCafferty (2008) the species was synonymised with *Teloganopsis mesoleuca* (Brauer, 1857) which was recently not confirmed by Bauernfeind and Soldán (2012).	Recorded from Iran as *Ephemerella maculocaudata* Ikonomov, 1961 by Mousavi and Hakobyan (2017).
Serratella sp.	Mazandaran Prov.: Shahrud; Isfahan Prov.: Zayanderud	Holarctic and Oriental Regions. Generic classification of species is unstable in the literature.	Unidentified species reported by Sharifinia et al. (2016a,b) from Shahrud and Mahboobi Soofiani et al. (2015) from Zayandehrud.
Serratella elissa Jacobus, Zhou & McCafferty, 2009	Gilan Prov.: Gilan River (?) at Lanak Waterfall, 37°00'N, 49°52'E (type locality); Havigh River, 20 km south of Astara New records 1–4, 6, 7, 11, 15–18, 27, 28, 32, 35, 36	Described from the Gilan Province by Jacobus et al. (2009).	Common species at our streams studied; can occur at high abundance in eutrophicated streams. Found also at the type locality in Lunak (not Lanak in page 55 in Jacobus et al. 2009) waterfall.

Species/genus	Records from Iran	Notes to the global area and distribution	Remarks to records in Iran
Serratella ignita (Poda, 1761)	West Azerbaijan Prov.: Zarrinehrud New records Gilan Prov.: 1–4, 6, 18; Ardabil Prov.: 21, 25	Widely distributed species, known from North Africa and entire Europe, through Asia Minor, Near East to Mongolia, China and Korea.	Reported from Zarrinehrud in NW Iran (Ahmadi et al. 2011, 2012). In our material, not as frequent and abundant as *S. elissa* at studied streams.
Teloganopsis subsolana (Allen, 1973)	Mazandaran Prov.: 13 km NW of Ghalekesh	Described from the Kabul River in Afghanistan (Allen 1973).	The only record since its original description (Jacobus 2009).
Potamanthidae			
Potamanthus sp.	Isfahan Prov.: Zayanderud	Holarctic and Oriental genus, including single Palearctic species *Potamanthus luteus* Linné, 1767. Two subspecies currently recognised: *P. luteus luteus* Linné, 1767 and *P. luteus oriens* Bae & McCafferty, 1991. The former distributed in Europe, North Africa and Asia Minor (Turkey and Syria) and the latter distributed from lower Amur basin to Manchuria, Japan and Korea.	Unidentified species of the genus *Potamanthus* reported by Mahboobi Soofiani et al. (2012) from Zayanderud. Family Potamanthidae was reported by Nemati Varnosfaderany et al. (2010) from the same river.
Ephemeridae			
Ephemera danica (Müller, 1764)	West Azerbaijan Prov.: Zarrinehrud	West Palaearctic species, distributed in Europe and southeast to Turkey (Kazancı and Türkmen 2012, Salur et al. 2016) and Liban (Thomas et al. 2007).	Reported from Zarrineh river in W Azerbaijan (Ahmadi et al. 2012).
Palingeniidae			
Mortogenesia mesopotamica (Morton, 1921)	Karkheh riv., Bsaitin (?)	Described and later confirmed by several records from Tigris river in Iraq (see references in Soldán and Godunko 2013).	Soldán and Godunko (2013) studied the material from Iran (Karkheh riv.). However, proper locality cannot be identified.
Palingenia fuliginosa (Georgi, 1802)	Gilan Prov.: Hassankiade	Known from eastern Europe (E Slovakia, N Ukraine), Caucasus Mts., and northern Iran.	The only historical record by Tshernova (1949) probably refers to the village Hasan Kiadeh on Sefid Rud river.
Palingenia longicauda (Olivier, 1791)	Aras riv.	South-Central European species.	The record is based on 5 male imagines collected on 20 June 1905 available in the collection of the Museum für Naturkunde in Berlin. Material was revised by A.H. Staniczek and R.J. Godunko in February 2017. Previous determination "*Palingenia longicauda* Oliv var. *fuliginosa* Georgi" by E. Schoenemund. As Aras river forms the border between Azerbaijan and Iran, the species can be formally included in the Iranian fauna.
Palingenia orientalis Chopra, 1927	Sistan and Baluchestan Prov.: Seistan (?) (type locality)	Known from two discrete areas; described from "Seistan" by Chopra (1927) and later recorded from Israel (Sartori 1992).	The record from Iran is based on the type series only (Chopra 1927) which is, however, insufficiently localised ("Seistan, Persia"). The author described the species based on imagines and mentioned that "the nymphs have been described by Graverly in detail". Graverly (1920) described the nymphs as "*Palingenia* (s. str.) ? *longicauda*, Olivier" and the material is localised as „Randa stream 4 miles NW of Jellalabad, Seistan".

Species/genus	Records from Iran	Notes to the global area and distribution	Remarks to records in Iran
Caenidae			
Caenis sp.	Tehran Prov.: Jajrud, Bareghan riv.; Alborz Prov.: Kordan riv.; Mazandaran Prov.: Tajan riv., Haraz riv.; Isfahan Prov. Zayanderud	Almost cosmopolitan genus, except for Australia and remote oceanic islands. At least 22 species known from the West Palaearctic Region.	Unidentified species reported by Egglishaw (1980; Jajrud, Bareghan riv.), Mousavi Nadushan and Ramezani (2011; Kordan riv.), Imanpour Namin et al. (2013; Tajan riv.), Shokri et al. (2014; Tajan riv.), Ghasemi and Kamali (2014; Haraz riv.) and Mahboobi Soofiani et al. (2012; Zayanderud).
Caenis kopetdagi Kluge, 1985	Razavi Khorasan Prov.: Mashhad (Kopedag Mts.)	Described from the Kopetdag Mts. in Turkmenistan (Kluge 1985).	According to Mohammadian (2005), Kluge (pers. comm.) reported the species from Mashhad.
Caenis macrura Stephens, 1836	Mazandaran Prov.: Koshk Sara riv., Abbas Abad Dam, Valasht lake New records Gilan Prov.: 1–4, 6, 8–11, 14–18, 27, 30–32, 35–37; Ardabil Prov.: 20–22, 24–26, 38	Palaearctic species distributed from Fennoscandia east to Russia and Minor Asia. Known from Israel (Malzacher 1992), Syria (Koch 1988) and Iraq (Al-Zubaidi et al. 1987).	Records from Mazandaran Prov. provided by Mousavi and Hakobyan (2017).
Cercobrachys sp.	Isfahan Prov.: Zayanderud	Holarctic, Oriental and Neotropic genus. Single Palaearctic species, *C. minutus* Tshernova, 1952 with wide Transpalaearctic distribution.	Unidentified species reported by Mahboobi Soofiani et al. (2012)
Clypeocaenis bisetosa Soldán, 1978	Mazandaran Prov.: mountain stream in Gazenak, 1400 m a.s.l.	Described from India, paratypes from the Alborz Mts. (Soldán 1978a).	No recent record from Iran.

[#] Nearctic/Neotropic species and genera reported from Iran, which are definitely misidentifications:
Jajrud near Tehran (Amri et al. 2014): *Baetis adonis*, *B. bicaudatus*, *B. alius*, *B. magnus*, *B. notos*, *B. persecutor*, *B. tricaudatus*, *Epeorus albertae*, *E. fragilis*, *E. hesperus*, *E. grandis*, *Rhithrogena exilis*, *R. ingalik*, *Caenis tardata*, *Paraleptophlebia adoptiva*, *P. clara*, *P. debilis*, *Lachlania fusca*, *L. lucida*, *L. iops*.
Karaj riv., Alborz Prov. (Shayeghi et al. 2015): *Maccaffertium* sp.
Zarrinehrud, West Azerbaijan Prov. (Ahmadi et al. 2011, 2012): *Callibaetis nigritus*, *Campsurus notatus*.
Kavat riv., Kermanshah Prov. (Farasat and Sharifi 2014): *Ephemerella doris*, *Maccaffertium* sp.
Zayanderud, Isfahan Prov. (Mahboobi Soofiani et al. 2012): *Attenela* sp., *Heterocloeon* sp.
Shapour riv., Fars Prov. (Golchin Manshadi and Ghafari 2015): *Tricorythodes* sp.

Mayfly larvae were collected by T. Soldán, J. Bojková and J. Imanpour Namin from 12 to 22 May 2016, using metal strainers after kick-sampling. Sampling of larvae for about 30–60 minutes was supplemented by sweeping of imagines and subimagines from riparian vegetation by a standard entomological net. The material studied in the present contribution sums up to 9213 larval specimens and 245 subimagines and imagines. Most material is deposited in the collection of the Biology Centre, Czech Academy of Sciences, Institute of Entomology, České Budějovice, Czech Republic. Reference specimens for the species recorded are deposited in the collection of J. Imanpour Namin (Department of Fishery, University of Gilan). All specimens were preserved in 96% ethanol. Some specimens were mounted on slides with HydroMatrix (MicroTech

Lab, Graz, Austria). Drawings for the descriptions of the new species were made using a stereomicroscope Olympus SZX7 and a microscope Olympus BX41, both equipped with a drawing tube. Photographs were made using a Canon EOS 1200D camera mounted on a Leica M205 C stereomicroscope. All photographs were subsequently enhanced with Adobe Photoshop CS5. For scanning electron microscopy, samples were gradually transferred to acetone, critical point dried and coated with gold by sputtering using a Baltec SCD050 Sputter Coater. Observations were taken on the scanning microscope Jeol JSM 7401F at 4 kV (BC CAS, České Budějovice). Eggs were dissected from a pharate female subimago.

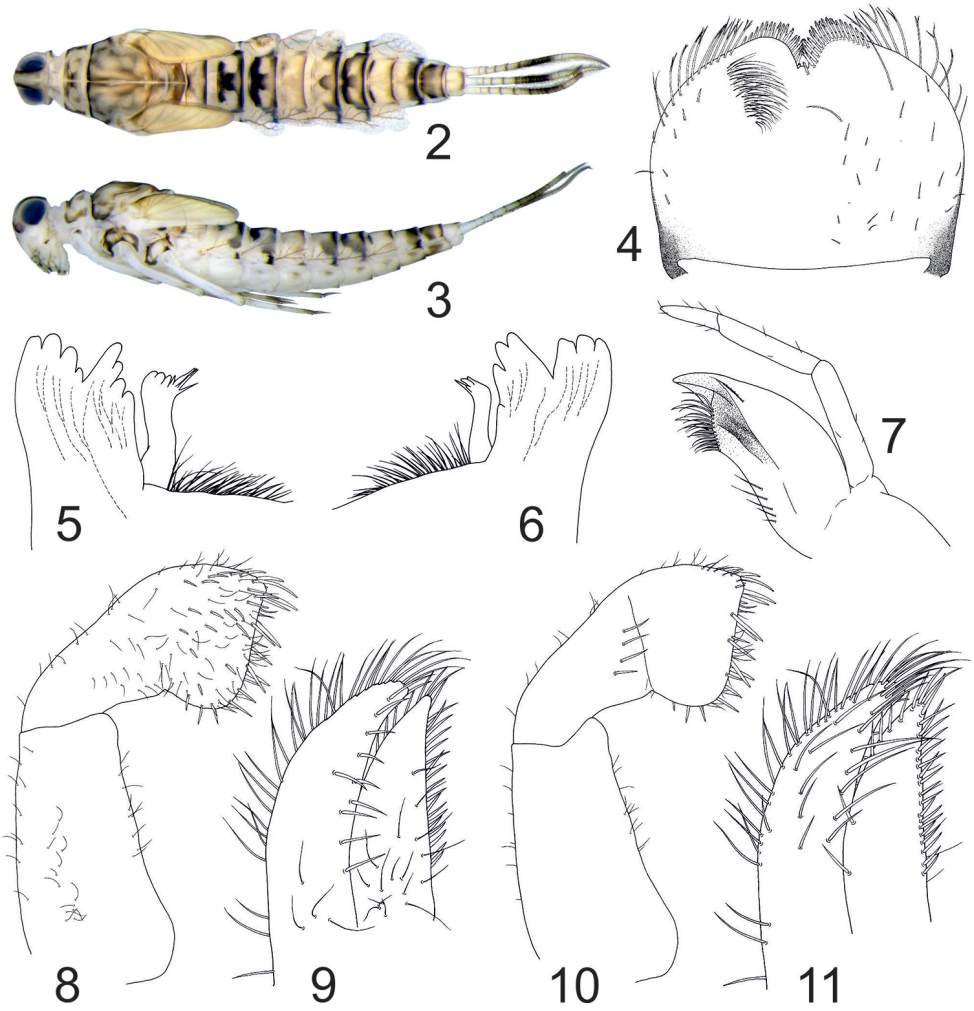
Results and discussion

***Procloeon* (*Pseudocentroptilum*) *caspicum* Sroka, sp. n.**
http://zoobank.org/23B02170-B45C-4782-8473-8E20280EA31C

Diagnosis (based on larvae and eggs). Labrum with pronounced medial notch, anterior margin laterally from medial notch strongly asymmetric; mandible incisor groups separated at distal third of their length; maxillary palps three-segmented, not thickened, length of segment III of maxillary palp reaches 0.5 × segment II length; fully developed hind wing pads; length of tarsal claws 0.44 × tarsus (forelegs); 0.55 × tarsus (middle and hind legs); lateral spines present on abdominal segments VIII–IX; single gill plates with rudimental dorsal lamella; inner margin of paraproct with approximately 8–11 large teeth; egg chorion without equatorial band of large papillae.

Description. ***Mature larva.*** Body length 7–8 mm, length of antennae approximately 2 mm, length of cerci 2–3 mm (0.3 × body length). General colouration yellowish with darker brownish pattern (Figs 2, 3).

Head. Labrum (Fig. 4) approximately 1.3 × broader than long, anterior margin with pronounced medial notch. Anterior margin laterally from medial notch strongly asymmetrically rounded. Along anterior margin, row of bifurcated setae situated anterolaterally and shorter, stout setae anteromedially. Dorsal surface with scattered hair-like setae, not arranged in rows; ventral surface with group of hair-like setae medially. Mandible incisors (Figs 5, 6) divided into two groups, separated at distal third of their length. Each group with 3–4 rounded denticles. Left prostheca broadened apically, with approximately three blunt teeth and four longer sharp teeth (Fig. 5); right prostheca not broadened apically, with approximately three blunt teeth and one longer sharp tooth (Fig. 6). Group of long setae present between incisors and molar area. Maxillary palps (Fig. 7) 3-segmented, second slightly shorter than first segment. Third segment approximately half as long as second segment, apically tapering, bluntly pointed, without scales. Maxillary palps sparsely covered with tiny hair-like setae. Labial palps 3-segmented (Figs 8, 10), third segment with rounded angles and straight margin apically. Ventral side of first and second segment with scattered hair-like setae, third segment with several longer and thicker setae (particularly along apical margin) and numerous hair-like



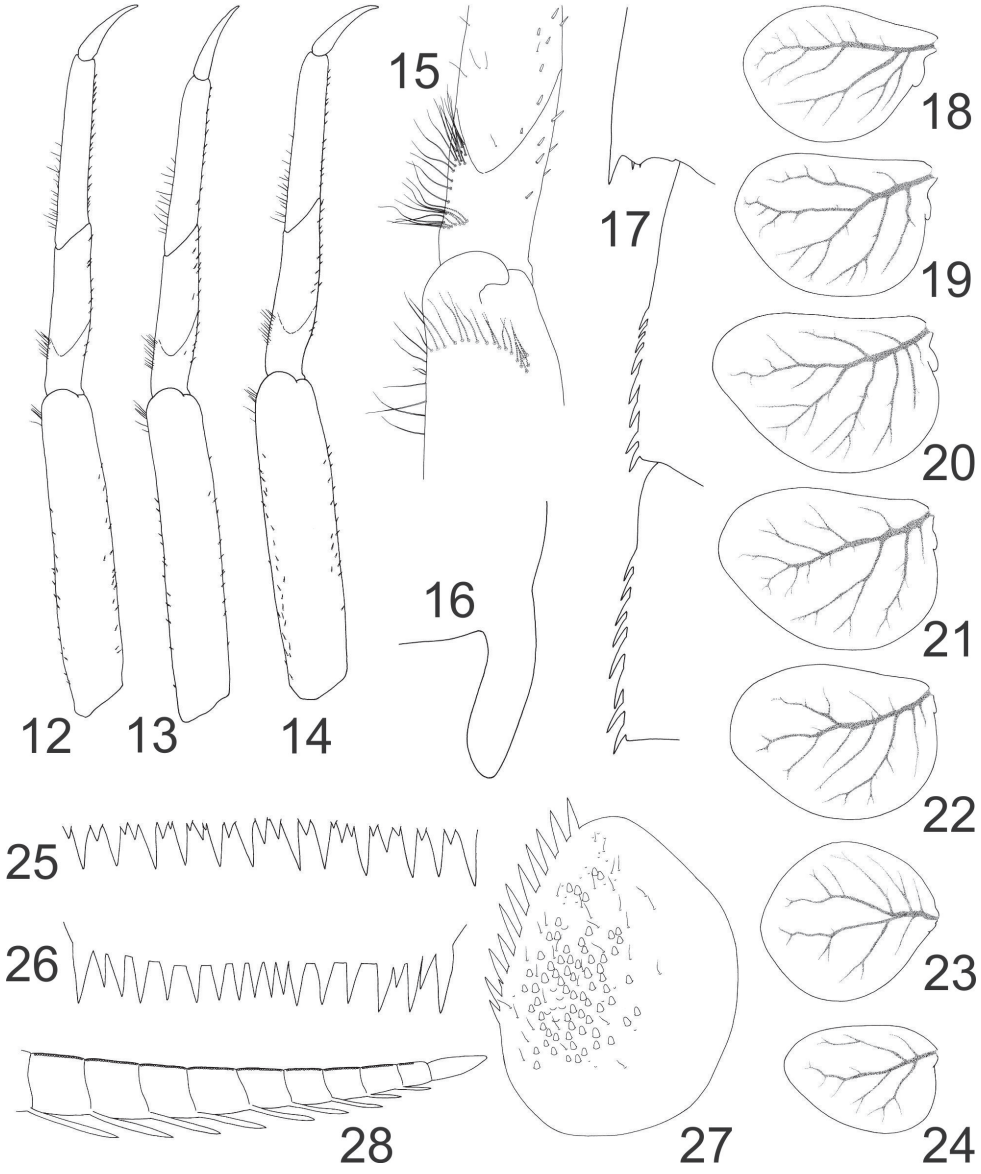
Figures 2–11. *Procloeon* (*Pseudocentroptilum*) *caspicum* sp. n., larva: **2** mature female larva, habitus (dorsal) **3** mature female larva, habitus (lateral) **4** labrum (right side dorsal, left side ventral) **5** left mandible, apicolateral part (dorsal) **6** right mandible, apicolateral part (dorsal) **7** maxilla **8** labial palp (ventral) **9** glossa and paraglossa (ventral) **10** labial palp (dorsal) **11** glossa and paraglossa (dorsal).

setae (Fig. 8). Dorsal side of second segment with group of 4–7 long setae, otherwise dorsal side of all segments without setae (Fig. 10). Glossae as broad as paraglossae, paraglossae slightly longer. Paraglossae ventrally with single irregular submarginal row of setae along inner margin, basal parts of glossae and paraglossae with sparse groups of long hair-like setae (Fig. 9). Glossae and paraglossae dorsally with rows of setae along margins (longer setae on paraglossae, shorter on glossae), denser setation apically, one additional irregular row of long setae in median portion of paraglossae (Fig. 11).

Thorax. Prothorax approximately 3× broader than long, whitish, with darker brownish pattern (Fig. 2). Mesothorax of same colour, metathorax darker posteriorly.

Hind wing pads fully developed (Fig. 16). Legs pale yellowish, femora with darker brown smudges distally. Tibiae darker in proximal portion, tarsi darkened proximally and distally. Femora with oblique transversal row of hair-like setae subapically, extending to outer margin (Fig. 15). Curved row of hair-like setae proximal to tibio-patellar suture along outer margin of tibia (Fig. 15). Tarsi with sparse row of hair-like setae along outer margin in basal half of tarsus. Claws brownish, with numerous minute teeth arranged in two parallel rows, reaching approximately 2/5 of claw length (Fig. 29a, b). Measurements of individual leg segments (femur : tibia : tarsus : claw): 1.15 : 0.68 : 0.71 : 0.27 mm in foreleg, 1.18 : 0.67 : 0.65 : 0.29 mm in middle leg, 1.18 : 0.66 : 0.64 : 0.29 mm in hind leg (averages from six individuals).

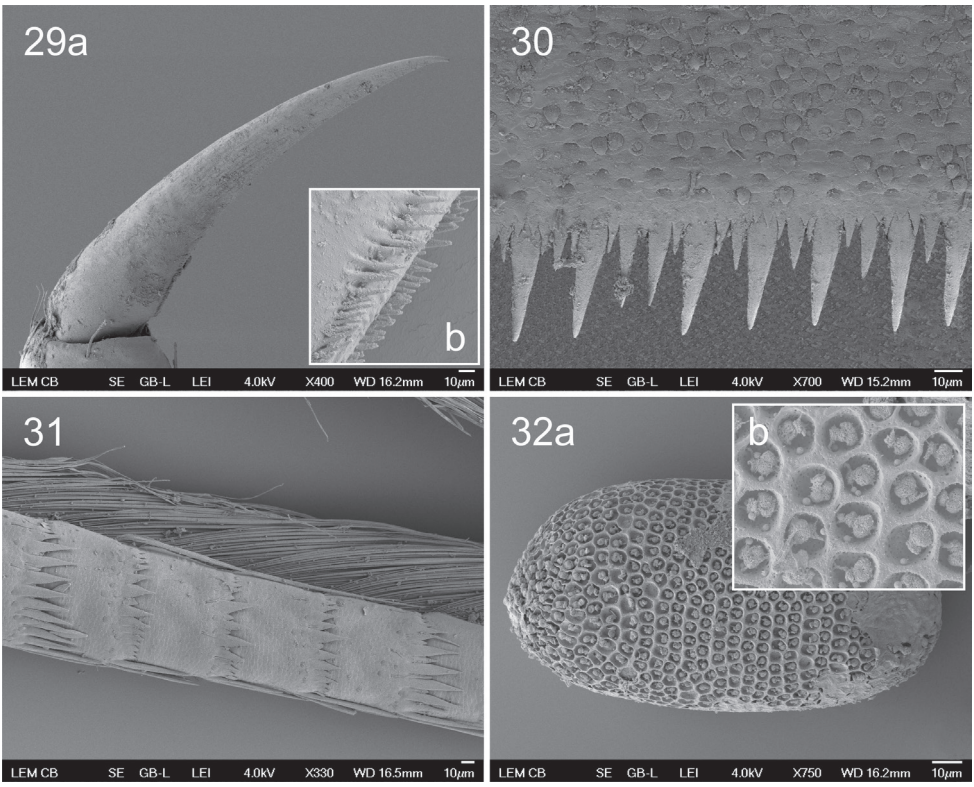
Abdomen. Terga whitish, with dark spots forming clear pattern (Figs 2, 3). Terga I–VIII with dark spot posterolaterally (on segments I–VII near respective gill insertion). Tergum I with dark stripe on posterior margin. Tergum II with distinct dark patch medially, wide band (sometimes interrupted in middle) along anterior margin and thinner stripe on posterior margin, fused with enlarged smudges situated posterolaterally. Tergum III similar to tergum II, band along anterior margin more distinct, sometimes fused with posterolateral smudges. Tergum IV pale, with thin stripe on posterior margin and indistinct smudges medially and laterally. Terga V–VI with dark patch medially and dark stripe on posterior margin, fused with enlarged smudges situated posterolaterally. Tergum V also bears distinct dark band along anterior margin, connected to posterolateral smudges. Tergum VII with thin dark stripe on posterior margin and slightly wider stripe along anterior margin, interrupted in middle. Tergum VIII with wide dark band along posterior margin. Tergum IX with thin dark stripe on posterior margin and wide dark band anteriorly (most dark areas on anterior margin and laterally). Tergum X with dark stripe on posterior margin. Sterna pale whitish with dark patches sublaterally and dark stripe on posterior margin. Distinctiveness of this pattern increasing in more posterior segments. Sterna VIII–IX all dark smudged. Surface of abdomen covered with numerous scales and scale bases (Fig. 30); similar scales also on legs and other body parts. Posterior margin of abdominal terga I–IX with large teeth accompanied by smaller ones (Figs 25, 30). Teeth on tergum X smallest medially, lateral teeth slightly longer (Fig. 26). Segments II–VII with 1–2 prominent posterolateral spines near gill bases, sometimes accompanied by few smaller ones. Lateral spines present on segments VIII–IX (Fig. 17). Gills (Figs. 18–24) whitish, with distinct tracheization. All gills simple, vestigial dorsal lamella present. Gills asymmetric and apically rounded. Paraproct (Fig. 27) with approximately 8–11 large teeth accompanied with scarce smaller ones on inner margin. Ventral surface of paraproct plate covered with scales, scale bases, and tiny hair-like setae. Caudal filaments reaching approximately 1/3 of body length, yellowish, with dark brownish stripe in middle. Paracercus slightly shorter than cerci. Ring of small triangular spines at each articulation of caudal filaments, alternated with larger spines every fourth segment (Fig. 31, these larger spines accompanied by dark brown stripe and distinction more pronounced in basal part of filament). Articulations further equipped with flattened scales and scale bases. Long swimming setae along inner margin of cerci and on both margins of paracercus. In basal third of filaments swimming setae only scarce, apically only last



Figures 12–28. *Procloeon* (*Pseudocentroptilum*) *caspicum* sp. n., larva: **12** foreleg **13** middle leg **14** hind leg **15** foreleg, apical part of femur and basal part of tibia (dorsal, setae on ventral side dashed) **16** hind wing pad **17** lateral margin of abdominal segments VII–IX **18–24** gill plates I–VII **25** tergite V, posterior margin **26** tergite X, posterior margin **27** paraproct **28** cercus, apical part (swimming setae omitted).

one or two segments without setae. Outer margin of cerci with enlarged, long, and thick spines on distal segments, longer than corresponding segment (Fig. 28).

Egg. Oval shaped; 130–140 μm long, 65–75 μm wide. Chorionic surface covered with thick reticulated ridges forming irregular polygonal mesh (Fig. 32a, b). Each polygon with coiled knob-like thread.



Figures 29–32. *Procloeon* (*Pseudocentroptilum*) *caspicum* sp. n., larva, egg: **29a** claw **29b** detail of claw teeth **30** tergite V surface and posterior margin **31** cercus, distal part **32a** egg **32b** detail of chorionic surface.

Imago and subimago. Unknown.

Type material. *Holotype*. Female mature larva, IRAN, Chelvand River above Chelvand (S of Lavandvil), approximately 2.5 km from its inflow into Caspian Sea, -6 m a.s.l., 38°17'20"N, 48°51'35"E (locality 27), 19.5.2016.

Paratypes. 1 male, 7 female larvae (3 specimens mounted on slides), same locality as holotype; 1 female larva, IRAN, Sefidab River in Divresh (SE of Shirkooh), 273 m a.s.l., 36°53'59"N, 49°35'06"E (locality 7), 13.5.2016; 1 female larva, IRAN, Karganrud River in Talesh, ca 7 km from its inflow into the Caspian Sea, 36 m a.s.l., 37°48'22"N, 48°54'27"E (locality 36), 22.5.2016.

All types deposited in the collection of the Biology Centre, Czech Academy of Sciences, Institute of Entomology, České Budějovice, Czech Republic.

Etymology. The species name refers to the proximity of the type locality to the Caspian Sea.

Habitat. Larvae were found in three different stream habitats, two eutrophic streams of different size (Chelvand and Karganrud rivers) in the Caspian Sea coastal plain relatively close to their inflow to the sea and one small, clear and cold brook in the forest. Chelvand at the type locality is a small river with coarse stony substratum rapidly flowing from the hills to the plain so it partially keeps its mountainous charac-

ter also in low altitude (-6 m a.s.l.). *Procloeon caspicum* sp. n. larvae co-occurred with numerous larvae of *Serratella elissa*, *Baetis vardarensis* and *Caenis macrura*, and less numerous *Epeorus* (*Caucasiron*) spp., *Rhithrogena* cf. *decolorata*. Karganrud in Talesh is a warm river flowing in the urban and agricultural area with wide flat alluvium and stony-gravel substratum. Bottom substrate had rich cover of green filamentous algae. *Procloeon caspicum* sp. n. co-occurred with numerous larvae of *Rhithrogena* cf. *decolorata*, *Oligoneuriella tskhomelidzei*, *Baetis vardarensis*, *Baetis rhodani*, and less numerous *Baetis fuscatus* and *Serratella elissa*. Sefidab, the third and completely different stream, is a small cold brook entirely shaded by forest with coarse stony bottom and alternating pools and riffles. *Procloeon caspicum* co-occurred with numerous larvae of *Epeorus* (*Caucasiron*) cf. *znojkoi*, *Electrogena pseudaffinis*, *Baetis baroukianus* and less numerous *Serratella elissa* and *Habroleptoides confusa*.

Affinities of *Procloeon* (*Pseudocentroptilum*) *caspicum* sp. n.

Within the subfamily Cloeoninae, several views on the (sub)generic classification have been published, most recently by Jacob (1991), Kluge and Novikova (1992), Bauernfeind and Soldán (2012), and Kluge (2016). All these authors recognize basically the same higher taxa, the difference is mostly in the hierarchical structuring and grouping of individual (sub)genera. All concepts use some characters of unclear polarity and/or derived characters prone to convergence to define individual taxa, thus all represent more or less "working versions" until a large-scale phylogenetic analysis of Baetidae is accomplished.

In this study, we follow Bauernfeind and Soldán (2012), where the new species is attributable to the genus *Procloeon* Bengtsson 1915. *Procloeon caspicum* sp. n. corresponds with all diagnostic characters given for *Procloeon* by Bauernfeind and Soldán (2012), most importantly the presence of long, blade-shaped, apicolateral spines in distal part of cerci. This character is suggested as synapomorphy of the clade *Procloeon* + *Pseudocentroptiloides* by Kluge and Novikova (1992), who treated both taxa as subgenera of *Cloeon*. Within *Procloeon* sensu Bauernfeind and Soldán (2012), the new species is attributable to the subgenus *Pseudocentroptilum* Bogoescu, 1947, based on the presence of hind wings and mandibular incisor groups separated in apical part only. This subgenus contains 18 species distributed in the Holarctic and Oriental regions (Bauernfeind and Soldán 2012).

The new species is characterized by a relatively uncommon (within *Procloeon*) combination of two characters, i.e., the presence of fully developed hind wing pads and single gill plates. Such a combination is present in three *Procloeon* species only, namely *Procloeon* (*Pseudocentroptilum*) *albisternum* (Novikova, 1986), *Procloeon* (*Pseudocentroptilum*) *maritimum* (Kluge, 1983) and *Procloeon* (*Pseudocentroptilum*) *calabrum* (Belfiore & D'Antonio, 1990). Occurrence of these species in Iran is extremely unlikely, since the former two species are distributed in the Far East – Russia (Novikova 1987, Kluge 1983, Tiunova 2009) and South Korea (Bae and Park 1997), and the latter species is endemic to a very small area of southern Apennine (Belfiore pers. comm.).

Furthermore, these species can be differentiated from *P. caspicum* sp. n. using several morphological characters:

Both *P. albisternum* and *P. maritimum* differ from *P. caspicum* sp. n. in the absence of rudimental dorsal lamella of gill plates (figs 105–109 in Kluge 1983, fig. 2 in Novikova 1987). The extent of the dorsal lamella reduction may exhibit intraspecific variability within Cloeoninae (e.g., in related *Procloeon* (*Pseudocentroptilum*) *heterophyllum* Kluge & Novikova, 1992, the minute dorsal lamella may be present or absent, see figs 1–14 in Kluge and Novikova, 1992).

However, in contrast to *P. caspicum* sp. n., *P. albisternum* possesses a different shape of labrum (almost rectangular with a very shallow notch in the middle of anterior margin), more deeply divided mandibular incisors, and a two-segmented maxillary palp (fig. 1 in Novikova 1987). *P. albisternum* is equipped with lateral spines on abdominal segments II–IX (only on segments VIII–IX in *P. caspicum* sp. n.) and has a different shape of gill plates, in particular gills II–IV being more asymmetric with the inner margin extended anteriorly (fig. 2 in Novikova 1987).

Procloeon maritimum differs in the shape of maxillary palp, which is apically rounded and distinctly thicker in *P. maritimum* compared to *P. caspicum* sp. n. (figs 5, 20 in Bae and Park 1997). Moreover, length of the apical segment of maxillary palp reaches less than 1/3 the length of segment II (Bae and Park 1997), compared to approximately 1/2 in *P. caspicum* sp. n. Tarsal claws are slightly shorter in *P. maritimum*, reaching 0.38 × foretarsus length compared to 0.44 × in *P. caspicum* sp. n. and 0.45 × middle and hind tarsus length compared to 0.55 × in *P. caspicum* sp. n. (see Kluge 1983). The arrangement of the inner margin of paraproct also slightly differs, with a higher number of teeth of more irregular size occurring in *P. maritimum* (fig. 110 in Kluge 1983).

Procloeon calabrum can be reliably distinguished from *P. caspicum* sp. n. based on several characters. It differs in the shape of labrum, with medial notch on anterior margin much more pronounced in *P. caspicum* sp. n. compared to *P. calabrum*. Anterior margin laterally from the medial notch is symmetrically rounded in *P. calabrum* (fig. 9 in Belfiore and D'Antonio 1990), whereas it is strongly asymmetric in *P. caspicum* sp. n. (Fig. 4). Maxillary palps are only two-segmented in *P. calabrum*, contrary to a distinguishable third segment in *P. caspicum* sp. n. Another diagnostic character is represented by the length of tarsal claws (see Figs 12–14). In *P. calabrum*, tarsal claws in forelegs are equal to 3/4 of tarsi, in middle and hind legs hardly reaching 3/4 of tarsi (Belfiore and D'Antonio 1990). In *P. caspicum* sp. n., tarsal claws in all legs are distinctly shorter (see Figs 12–14). The egg chorion of *P. caspicum* sp. n. also lacks the equatorial band of large papillae, present in *P. calabrum*.

List of species known from Iran. A detailed review of literature revealed 42 references published in international journals accessible to the scientific public. Publications written in Persian (Farsi) were previously reviewed by Sharifinia (2015) and they did not include any species not reported in international sources reviewed (cf. Table 2 summarizing macroinvertebrate diversity in Sharifinia 2015). Despite relatively high number of recent (after 2000) publications on macroinvertebrates based on routine sampling of benthic communities, the knowledge on aquatic diversity seems to be very

limited. Most studies include data on macroinvertebrates determined to family level (e.g., Nemati Varnosfaderany et al. 2010, Montajami et al. 2012, Abbaspour et al. 2013, Bashti and Ostovan 2014, Eyidozehi et al. 2014, Nasirian 2014, Aazami et al. 2015, Shayeghi et al. 2016) or generic level only (e.g., Egglishaw 1980, Mousavi Nadushan and Ramezani 2011, Mahboobi Soofiani et al. 2012, Imanpour Namin 2013, Ghasemi and Kamali 2014, Seyyedsharifi et al. 2014, Shokri et al. 2014, Shayeghi et al. 2015, Sharifinia et al. 2016a,b), reporting predominantly common Palaearctic families and genera. Unfortunately, determination to species level (if present) is erroneous in most cases in question. Altogether 27 records of species or genera (Table 2, comments below) with restricted distribution to the Nearctic and Neotropic Region are listed, suggesting that the authors used inappropriate determination keys. For example, the listed Nearctic/Neotropic genus *Lachlania* in fact most likely represents *Oligoneuriella* that is widely distributed in north Iran (cf. Table 2); the same concerns the Nearctic/Neotropic genus *Campsurus* which in fact most probably represents *Ephoron*. Likewise, the Nearctic/Neotropic genus *Callibaetis* could refer to cosmopolitan *Cloeon,* and the Nearctic/Neotropic genus *Tricorythodes* seems to refer to cosmopolitan *Caenis*, etc. A review of macroinvertebrates of Iranian running waters by Sharifinia (2015), despite promising "critical re-identification of the reported species", includes such confusing data not only in mayflies, but also in Plecoptera. Therefore, we do not recommend using this list as reliable and valid source of information on the diversity of Iranian benthic insects. Relevant information on mayfly diversity was only found mainly in 20th century publications in international entomological journals. However, these are highly fragmented and refer to material often limited to occasional collections with only several specimens examined. Moreover, these records are almost completely confined to the northern part of Iran, mostly Alborz Mts.

Broadening literature data with new material sampled in 2016, we conclude altogether 48 species records and 22 records at generic/subgeneric level of determination (Table 2). Records of Nearctic/Neotropic species and genera were excluded. We included all records of species and genera distributed in the Palaearctic Region, although we regard the occurrence of seven of them as doubtful. This concerns species/genera which have never been recorded at such low latitude (*Ameletus*, *Arthroplea*, and *Leptophlebia*) and so easternmost (*Siphlonurus*, *Ephemerella maculocaudata*) or westernmost (*Cinygmula*, *Baetis bicaudatus*) in the West Palaearctic Region. The genus *Arthroplea*, although exhibiting some southern area disjunctions in Europe, is predominantly boreal (Bauernfeind and Soldán 2012) and thus, its occurrence in the Middle East could be excluded. The genus *Leptophlebia* shows similar distribution as *Arthroplea* (although not so strictly boreal) in the West Palalearctic Region and is missing even in eastern Mediterranean and Caucasus. The occurrence of *Ephemerella maculocaudata* in Iran is very unlikely as its easternmost records are from the Balkans (Bulgaria and Macedonia). This record most probably refers to the recently described *Serratella elissa*, as its larvae similar to *E. maculocaudata* exhibit few basal dark brown segments of cerci (cf. Soldán 1982, Jacobus et al. 2009). Moreover, *S. elissa* is very common and abundant in the coastal area of the Caspian Sea and the type locality of *S. elissa* is about 150

km far from the locality of *E. maculocaudata*. The remaining four doubtful records are not fully improbable and need to be confirmed. The genus *Siphlonurus*, common in Europe, Far East and Japan, is very sparsely distributed in eastern Turkey and western Caucasus, but missing in the Middle East countries and Central Asia (Bauernfeind and Soldán 2012). The genus *Ameletus* is widely distributed in Europe, Siberia, Central Asia and Far East, however, its southern area border is insufficiently known (Bauernfeind and Soldán 2012). It occurs in Turkey but is missing in the Caucasus. The western limit of the areas of the genus *Cinygmula* and *Baetis bicaudatus* is in Central Asia and Mongolia, respectively (Bauernfeind and Soldán 2012). Moreover, the genus *Cinygmula* can be easily confused with the genus *Rhithrogena*.

Excluding *B. bicaudatus* and *E. maculocaudata* as discussed above, 46 reliable species were recorded, 18 species of them were recorded to Iran for the first time (in bold in Table 2). These species can be classified into the following groups from the biogeographical point of view.

(i) Holarctic and Transpalaearctic species form the minority of the mayfly fauna of Iran, encompassing six eurytopic species: *Baetis fuscatus*, *Baetis rhodani*, *Cloeon simile*, *C. cognatum*, *C. dipterum*, and *Serratella ignita*. Concerning the genus *Cloeon*, there are persisting taxonomic and determination problems, especially in the subgenus *Cloeon* s. str. and actual findings in Iran, thus, should be considered with caution. Likewise, *B. rhodani* is currently considered a polytypic species with the cryptic species throughout the geographical range (Williams et al. 2006).

(ii) West Palaearctic species with southern area limit in the Middle East included 13 species. Most of them are widely distributed throughout the whole area: *Baetis buceratus*, *B. lutheri*, *B. nexus*, *B. vardarensis*, *Paraleptophlebia submarginata*, *Habroleptoides confusa*, *Habrophlebia lauta*, *Ephemera danica*, *Palingenia longicauda*, and *Caenis macrura* (Bauernfeind and Soldán 2012). Iran is the natural south eastern area limit for many West Palaearctic species since the Caspian Sea, arid areas in central Iran, and large deserts in east Iran are the barriers separating Central Asia and the Indian subcontinent. Three species, *Palingenia fuliginosa*, *Heptagenia samochai* and *Epeorus zaitzevi*, show a peculiar central Palaearctic distribution, missing in central, northern and western Europe. *P. fuliginosa* shows an arc-like area spreading from eastern Slovakia and Ukraine to Caucasus and Caucasian part of north Iran (Soldán 1978b, Bauernfeind and Soldán 2012). *Heptagenia samochai* is distributed in Israel and from the Crimean Peninsula and Transcaucasia to Iran (Bauernfeind and Soldán 2012). *E. zaitzevi* is known from several Middle Eastern countries (Israel, Iraq, Syria, and Turkey) and from the Caucasus (Azerbaijan and Armenia) (Kluge 1997b, Bauernfeind and Soldán 2012).

(iii) West Palaearctic species with area disjunction to Central Asia, *Baetis gracilis* to Tajikistan, *B. muticus* to Kazakhstan (Bauernfeind and Soldán 2012), and *Baetis braaschi* distributed continuously from the Eastern Ukraine, Crimea and Caucasus Mts. through Iran and Turkmenistan to Central Asia (Sroka et al. 2012).

(iv) Caucasian species with the distribution reaching Alborz Mts. and Azerbaijan Provinces in north Iran: *Baetis ilex*, *B. vadimi*, *Oligoneuriella tskhomelidzei*, *Ecdyonurus ornatipennis*, *Electrogena pseudaffinis*, *E. squamata*, *Rhithrogena decolorata*, *Epeorus znojkoi*.

(v) Near and Middle East species include those described and known from Iran only: *Procloeon caspicum* sp. n., *Electrogena bothmeri*, *Rhithrogena iranica*, *R. paulinae*, *Epeorus caucasicus iranicus*, and *Serratella elissa*. Most of them are insufficiently known; *E. bothmeri* and *R. iranica* were described based on imagines (subimagines) only, the status of the latter species should be revised. The same concerns *Electrogena ressli* described from Turkey with paratypes from Gilan Province in Iran. On the contrary, only larvae were described in *E. caucasicus iranicus*, *S. elissa* and *P. caspicum* sp. n. Real distribution of all these species is unknown. Other species are, beside Iran, known from a single neighbouring country: *Baetis baroukianus* (Lebanon), *Baetis monnerati* (Jordan), *Choroterpes sumbarensis* and *Caenis kopetdagi* (Turkmenistan), *Teloganopsis subsolana* (Afghanistan), *Mortogenesia mesopotamica* (Iraq), *Palingenia orientalis* (Israel), and *Clypeocaenis bisetosa* (India). The only exception is *B. samochai* which inhabits the whole Near East (Turkey, Israel, Lebanon, Syria, and Iran).

Most studies and records on mayflies are available from northern Iran which belongs to Euxino-Hyrcanian Province of the Euro-Siberian subregion of the Palaearctic Region (Sagheb Talebi et al. 2014). They provide a good example of species of West Palaearctic (or European) origin with eastern area limits in Iran. Additionally, the Caucasian faunistic elements are reaching eastwards the northern mountains (Alborz Mts., Talysh Mts., Arasbaran Mts. and their foothills). Future detailed research will probably reveal a closer relation to the Caucasus bioregion and simultaneously, some endemic species could be expected there. This region is exceptional and attractive for scientists due to the Hyrcanian Forest, which is the hot spot of biodiversity of flora and fauna (Tohidifar et al. 2016). The Caspian Hyrcanian Forest in Iran and Azerbaijan is among the last extensive relicts of temperate primeval forests in the world hosting diverse insect specialists that are extinct in Europe and other parts of the world (see Müller et al. 2015, 2017). In contrast, knowledge on mayflies of the large area of central Iran, biogeographically belonging to the Irano-Turanian Province of the Central Asian subregion, is insufficient. This area includes arid and desert Central Plateau and large mountain range of Zagros Mts., which hardly ever were investigated. Local endemic species restricted to isolated or relict aquatic biotopes can hypothetically be discovered in this region. The southernmost part of Iran belongs to the Saharo-Sindian Province of the Euro-Siberian subregion, which covers also several other Middle East countries, such as neighbouring Iraq, part of Saudi Arabia and Syria. The occurrence of faunistic elements from the western part of this Province (Arabian Peninsula and North Africa) in the southern Iran can be hypothesized. Unfortunately, there are no data on mayflies from southern Iran to date.

This list of Ephemeroptera of Iran is undoubtedly preliminary and incomplete due to limited literature sources and lack of correct determination of material collected for water quality assessment. Thus, the total number of 46 species recorded is very low and does not represent the real diversity of mayflies in Iran. In comparison, Odonata, a very attractive and popular group of aquatic insects, have been better investigated at least from the faunistic point of view, with records of 100 species and subspecies

throughout Iran (see current check list by Heidari and Dumont 2002 and many recent studies: Ebrahimi et al. 2009, Sadeghi and Mohammadalizadeh 2009, Ghahari et al. 2009, 2012, Eslami et al. 2014, 2015, Kiany and Sadeghi 2016). Likewise, faunistic records of Trichoptera include 130 species (see current check list by Mirmoayedi and Malicky 2002 and some important recent studies: Malicky 2004, Mey 2004, Chvojka 2006), pointing at the real diversity of the area. Comparatively less is known about Iranian stoneflies, which were studied in detail only in the northern part of the country (Aubert 1964, Murányi 2005), or aquatic beetles (e.g., Olmi 1981, Vafaei et al. 2007, 2008, 2009, Ghahari and Jedryczkowski 2011, Ghahari et al. 2015, Jäch et al. 2016). However, the distribution and diversity of all these aquatic groups were investigated predominantly based on their adults and/or terrestrial stages. Larvae of many species have not been described yet and, consequently, virtually nothing is known on their biology and ecological requirements.

To fill evident gaps in our knowledge resulting from this review, we aim to work on a more extensive study of Iranian Ephemeroptera covering the geographical gradients within Iran. This may unravel unknown species and diversity in different biogeographical provinces of Iran. This however would require to set up a network of localities and to study at least some of them in different seasonal aspects. Our first field trips to Iran in 2016 and 2017, however, showed us that aquatic ecosystems have been under strong, long-term anthropogenic pressure and some areas unfortunately presumably no longer maintain their original aquatic biodiversity. We observed many rivers with severe pollution that most probably wiped out local populations of the aquatic fauna. Overexploitation of water sources and growing pollution from fertilisers, pesticides and municipal and industrial wastewaters are serious threats to aquatic biodiversity. Iran has 7.2 million ha of agriculture land dependent on irrigation, the largest area in the Middle East, thus, agricultural use accounts for more than 90% of total water withdrawal. About 1.7 million ha of irrigated land is affected by salinization (World Commission on Dams 2000, Afkhami 2003). About 96 % of the urban population of Iran is connected to public water supplies; however, only 16 % are connected to adequate sewage treatment facilities (see Charkhabi et al. 2005, Afkhami et al. 2007). There are also significant problems caused by insufficient treatment of industrial wastewaters leading to serious impacts of heavy metals and other toxic compounds (e.g., Gheshlagh et al. 2013, Khodadadi et al. 2013, Mollazadeh et al. 2013, Majnoni et al. 2015) which affect, beside aquatic ecosystems, also human health (e.g., Karrari et al. 2012). Moreover, the absence of real regulations of water abstraction from rivers and lakes and obligatory minimal flows from impoundments seriously impacts hydrology of streams and their ecosystem functioning. It underlines the importance to study both regional and local aquatic diversity until it totally disappears. The discovery of possible refugia for aquatic biota, which should be proposed as priority for immediate conservation, is an urgent goal to preserve the aquatic biodiversity of Iran. However, only thorough basic taxonomic and faunistic research can contribute to water and conservation management set by the local authorities.

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RESEARCH ARTICLE

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The smallest known species of Afrotropical *Scolytoplatypus* Schaufuss (Curculionidae, Scolytinae) – with unique features and an isolated phylogenetic position

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Abstract

Recent flight intercept trapping in Gabon provided four female specimens of a new species of *Scolytoplatypus* Schaufuss with several unusual features. It is the smallest known Afrotropical species found to date (1.6 mm long), it has unusually long antennal clubs, and some characters show resemblance to small Asian species or to the Malagasy genus *Remansus* Jordal. Genetic data from four genes nevertheless place this species as the sister lineage to all other Afrotropical species where it forms an isolated position corresponding to deviant morphological features.

Keywords

Afrotropics, ambrosia beetle, molecular phylogeny, Scolytoplatypodini

Introduction

Species in the tribe Scolytoplatypodini are ambrosia beetles which cultivate fungi in wood tunnels as the only food source for larvae and adults. They are mainly old world tropical in distribution, with a few species found in temperate areas of Japan to

India. Most species in the tribe are found in Asia with 29 known species (Beaver and Gebhardt 2006; Knížek 2008), whereas 11 or 12 are known in Africa (Browne 1971; Schedl 1975), and seven in Madagascar (Jordal 2013)

Scolytoplatypus Schaufuss has previously been regarded as a morphologically homogeneous genus. However, recent work has pointed out considerable variation in crucial anatomical parts such as the shape of the scutellum and the protibiae (Jordal 2013), or variation in sexual dimorphism across continents (Beaver and Gebhardt 2006). This led to the erection of a new genus *Remansus* Jordal and phylogenetic analyses documented deep divergence between this genus and *Scolytoplatypus*, and between Asian and African species. African species form a largely coherent group with rather few large differences between the species known to date.

An undescribed species with several unusual and intermediate features was recently collected in Gabon. DNA data clearly associate this species with the Afrotropical clade, and phylogenetic analyses indicate a rather isolated position of the species.

Materials and methods

Samples were collected by flight intercept traps baited with vittatol and ipsenol lures in the Ipassa National Park, Gabon. Specimens were compared to types and co-types of most Afrotropical species in the Natural History Museum of Vienna, and some superficially similar Asian species.

DNA was extracted from a specimen using the Qiagen DNEasy kit. Amplification of four gene fragments (COI, EF1α, CAD, 28S) was made by PCR, using primers and cycling conditions described previously (Jordal et al. 2011). Concatenated DNA sequence data from Jordal (2013) were analysed in MrBayes v. 3.2.6 (Ronquist et al., 2012). Partitions were based on nucleotide positions per gene, or nucleotide positions combined, or by gene. Models were estimated in MrModeltest, selecting a GTR+G+I for each partition. 10 million generations were run, with 25% of the generations as burn-in. Stationarity was obtained after 500,000 generations and runs with PSRF close to 1.0 and standard deviation of split frequencies below 0.05 were accepted.

Results

***Scolytoplatypus unipilus* Jordal, sp. n.**
http://zoobank.org/592D85B6-195F-4B4E-B2A6-23596B98BC73
Figs 1–4

Type material examined. Holotype, female: Gabon: Ivindo National Park, Ipassa, 6 km W. Makokou. GIS: 0.512, 12.802, #23 vittatol trap. Paratypes (2): same data as holotype, except one taken from Ipsenol trap. The holotype and two paratypes

Figures 1–4. Habitus, head and elytral declivity of *Scolytoplatypus unipilus* sp. n.

("ZMBN/ENTScol4942 – ZMBN/ENTScol4944") are deposited in the University Museum of Bergen (ZMBN).

Diagnosis, female. Typical female *Scolytoplatypus* with broad protibiae with transverse rows of granules and rugae, an anteromedian mycangial pore on pronotum, and a depressed triangular scutellum. Distinguished from all species in the genus by the unusually long antennal club, further from all African and Malagasy species by the small size (1.7 vs. >2.3 mm), the lack of striae on elytral declivity (and disk), by the undivided, simple setae on the metanepisternum, and the rounded hind corners of the pronotum.

Description, female. *Length* 1.6–1.7 mm, 2.0 × longer than wide; *colour* dark brown to black, ventral side and legs brown.

Head. Eyes separated above by 3.9 × their width. Frons generally convex, slightly flattened on upper half, rounded below, with a transverse, broad, impression just above

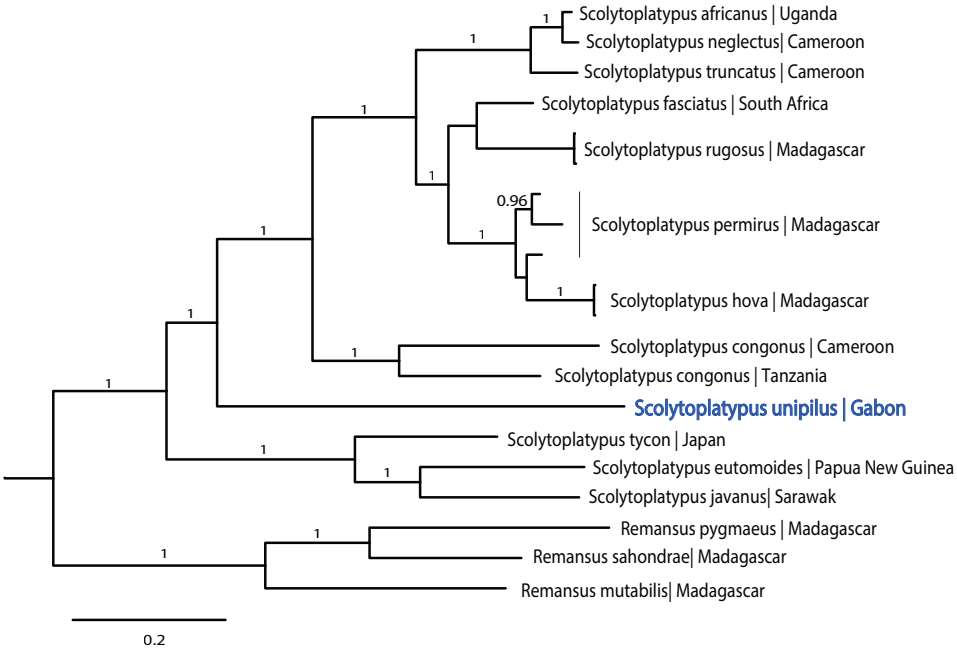

Figure 5. Tree topology (excluding outgroups) resulting from all Bayesian analyses (PSRF = 1.0, sd = 0.003) and the parsimony analysis (L = 3503, CI = 0.48, RI = 0.54), of four gene fragments.

epistoma; surface smooth and shiny on lower half, reticulated and dull above, with small shallow punctures separated by 2–4 × their diameter. Vestiture consisting of scattered, short, fine setae mainly in reticulated area on upper half. Antennal club 3 × longer than funicle, densely covered by very short scale-like setae and fewer and much longer fine setae. Funiculus 5-segmented.

Pronotum 0.9 × as long as wide, sides subparallel on anterior half, constricted on posterior half, 0.9 × as wide as anterior part; surface finely reticulated with shallow punctures spaced by 1–2 × their diameter; pronotal vestiture consisting of fine short setae arising from punctures, a few longer setae scattered close to anterior margin. Mycangial pore slightly elliptical, with long yellow setae emerging, center of pore located on anterior fifth.

Elytra 1.1 × longer than wide, 1.3–1.4 × longer than pronotum; basal area notched for depressed triangular scutellum; sides of elytra straight, broadly rounded behind; striae not indicated, punctures confused, spaced on disc by 1–2 × their diameter; declivity finely rugose, strongly reticulated. Interstriae 10 weakly elevated to level of ventrite 1. Vestiture consisting of minute setae on declivity.

Legs. Procoxae separated by width of antennal club. Mesocoxae separated by width of a mesocoxa. Protibial shape typical for genus.

Ventral vestiture. Metanepisternum with relatively few, fine, simple setae.

Male. Not known.

Molecular data. Phylogenetic analysis based on four genes resulted in a fully resolved tree topology (Fig. 5). Different partition schemes and model selection had no influence on tree topology. *Scolytoplatypus unipilus* formed a maximally supported sister lineage to all other African and Malagasy species in the genus, and yet clearly separate from the Asian species. GeneBank accession numbers: COI, MG979488; EF1a, MG979489; CAD, MG979490; 28S, MG980072.

Etymology. The Latin name *unipilus* is composed of the masculine adjective *unus* in its form *uni-*, meaning one, and the masculine noun *pilus*, meaning hair, referring to the simple, single, hair-like setae on the metanepisternum and metasternum.

Distribution and biology. Only known from the type locality in Gabon. All specimens were collected in black flight intercept traps baited with vittatol (3) or ipsenol (1) lures.

Key to females of African *Scolytoplatypus* species groups

1	Antennal club as long as the eye, hind corners of pronotum rounded, setae on metanepisternum simple, not divided, female size 1.6-1.7 mm long ..... ***S. unipilus* Jordal, sp. n.**
–	Antennal club at most 0.7 × as long as the eye, hind corners of pronotum acutely pointed laterally, setae on metanepisternum bifid, trifid or plumose, female size >2.3 mm long **2**
2	Scutellum flush with elytra ..... ***S. congonus* group** (*S. congonus* Schedl, *S. kivuensis* Schedl)
–	Scutellum depressed, narrowly elongated 3
3	Profemur with a dorsal spine near its distal end..... ***S. africanus* group** (*S. africanus* Eggers, *S. neglectus* Schedl, *S. occidentalis* Browne, *S. truncatus* Browne)
–	Profemur smooth, without dorsal spine **4**
4	Sutural apex of elytra emarginated, notched..... ..... ***S. armatus* group** (*S. armatus* Eggers, *S. eichelbaumi* Hagedorn)
–	Apex of elytra evenly rounded..... **5**
5	Vestiture on declivity consisting of white scale-like setae ..... ***S. uter* Schedl**
–	Declivity glabrous or with very fine setae ..... ***S. fasciatus* group** (*S. fasciatus* Hagedorn, *S. opacicollis* Eggers, *S. obtectus* Schedl)

Discussion

Scolytoplatypus is a very characteristic genus of ambrosia beetles, and even the smallest of the known species are larger than the average wood boring beetle. Nevertheless new species are being discovered and described after rather limited collecting efforts (Beaver and Gebhardt 2006; Browne 1971; Jordal 2013; Knížek 2008). This indicates quite strongly that many more species remain to be discovered.

It is interesting that recent field collections have revealed scolytoplatypodine taxa which are unique by having an isolated phylogenetic position. The genus *Remansus* was discovered only after collecting several new species in Madagascar (Jordal 2013). Likewise, the new species *S. unipilus* is the sister lineage to all other African species (Fig. 5) and shows several intermediate morphological traits. This taxon is, therefore, crucial to understand the evolution of the genus.

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SHORT COMMUNICATION

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On two forgotten European species of Coleoptera

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Abstract

Two Coleoptera species described by Ferdinand Joseph Schmidt in 1834 have been forgotten. One, *Chlaenius carniolicus,* is placed here in synonymy with *Chlaenius* (*Chlaenites*) *spoliatus* (Rossi, 1792), while the other, *Oedemera lippichii*, is synonymized with *Nacerdes* (*Xanthochroa*) *carniolica carniolica* Gistel, 1834 (**new synonymies**). *Chlaenius carniolicus* Gistel, 1834, a primary homonym of *C. carniolicus* Schmidt, 1834 which has been forgotten too in the literature, is also placed in synonymy with *Chlaenius spoliatus* (**new synonym**).

Keywords

Coleoptera, beetles, Carabidae, Oedemeridae, Ljubljana, Ferdinand Joseph Schmidt

Introduction

In 1834, Franz Wilhelm Lippich [1799–1845], a Slovenian physician, published a book providing various information about Ljubljana, the capital of Slovenia, which at the time was part of the Austrian Empire. Part of the information relates to the natural history of the city (pp. 43–66) and includes among others a list of the insects (pp. 58–66). The Coleoptera are on pages 60–66 and two new species are described in footnotes: *Chlaenius carniolicus* (p. 60) and *Oedemera lippichii* (p. 62). The descriptions of both new species were provided by Ferdinand Joseph Schmidt [1791–1878], an

Austro-Hungarian entomologist and businessman, to whom the species names should be attributed.

As far as is known, these two species have not been recorded subsequently. For example, *Chlaenius carniolicus* is not listed in the Chlaeniini section for the first (Kirschenhofer 2003) and second (Kirschenhofer 2017) editions of Volume 1 of the *Catalogue of Palaearctic Coleoptera* and *Oedemera lippichii* is not listed in the Oedemeridae section (Švihla 2008) in Volume 5 of the same series. Neither name is recorded in Sherborn's *Index Animalium* or in Gemminger and Harold's *Catalogus Coleopterorum*.

The descriptions of the two species are provided here, following by my translation.

"Eine neue Species, über welche mir Hr. Schmidt Folgendes mittheilt: *Chlaenius carniolicus*, (mihi) viridi-aeneus, thorace subcordato-ruguloso, antennis pallidis, elytris glabris, subtiliter punctato-striatis, margine flavis, pedibus rufo-piceis. - Hat einige Aehnlichkeit mit dem *Chlaenius spoliatus*, ist jedoch 1 bis 1 1/2 Linie länger und verhältnissmässig auch breiter. Der Kopf ist stark gerunzelt, eben so der mit einer tiefen Mittel- und zwei Seitenfurchen versehene flache Halsschild, worauf unter dem Oberrande zwei Eindrucke sich befinden. Fühler und Fressspitzen sind braungelb, die Füsse pechbraun. Die Oberseite des ganzen Käfers ist metallgrün, die Flügeldecken sind kahl, seicht gefurcht, und mit feinen Puncten in den Streisen besetzt. An den Ufern des Gruber'schen Kanals hinter dem Laibacher Schlossberge bisher allein aufgefunden, sehr selten." [A new species for which Schmidt wrote the following: *Chlaenius carniolicus,* (mihi) greenish bronze, pronotum subcordate and rugose, antennae pale, elytra glabrous, slightly punctate and striate, margins yellowish, legs rufopiceus. The species has some resemblance to *Chlaenius spoliatus*, but is 1 to 1½ lines longer and comparatively broader. The head is heavily wrinkled, as well as the pronotum which is flat and has a deep median and two lateral furrows, as well as two impressions at the anterior margin. Antennae and extremities of palps brownish, the legs pitch-brown. The dorsum of the beetle is metallic green, the elytra bare, the striae shallowly and finely punctured. A single specimen found on the banks of the Gruber's canal behind Ljubljana castle hill.]

"*Oedemera lippichii* (Schmidt). *Oedemera* thorace lato nigro-marginato, elytris fusco-viridibus striatis, pedibus flavis. - Etwas grösser als *Oedemera annulata*. Hat einen gelben Kopf und Halsschild, schwarze Augen, ziemlich breiten, schwarz gerandeten Thorax, das Schildchen ist gelb, eben so die Füsse, die Flügeldecken stahlgrün, mit erhabenen Streifen. Ich habe von dieser Art in sechs Jahren blos drei Individuen, auf Dolden des Krimberges vorkommend, gefunden." [*Oedemera* with large black pronotal margins, elytra dark green with striae, legs yellowish. Somewhat bigger than *Oedemera annulata*. Head and pronotum yellowish, eyes black, relatively large, pronotum margins black, the disc yellow like the legs, the elytra steel-green with uneven striae. In six years I have found only three specimens on umbellifers on Mount Krim].

Based on the description, particularly the coloration, *Chlaenius carniolicus* is very likely a synonym of *C.* (*Chlaenites*) *spoliatus* (Rossi, 1792). The same year Gistel (1834: 149) also described a new species under the name *Chlaenius carniolicus* from Laibach

(= Ljubljana), which has likewise been forgotten in the literature. The few descriptive words provided by Gistel suggest that his *C. carniolicus* is the same as that described by Schmidt. In fact, it is possible that both descriptions are based on the same specimen. In his paper, Gistel (1834: 147) mentioned under *Geocharis thoracica* "Museum Dr. Schmidt Labaci" indicating that he probably had access to Schmidt's collection or was in possession of some of Schmidt's specimens. Gistel's (1834) work was issued in the third part of the first volume of his journal *Faunus*, which was published by 16 August 1834 as noted in *Die Bayer'sche Landbötin* (No 98: 802); it was also noted in the 31 August 1834 issue of *Bibliographie von Deutschland* (vol 9: 195). I have been unable to find a more specific date of publication for Lippich's work in 1834. As it stands now, *Chlaenius carniolicus* Schmidt, 1834 is a junior primary homonym of *Chlaenius carniolicus* Gistel, 1834.

Gistel (1834: 150) described *Oedemera carniolica* (p. 150) also from Mount Krim ["Krimmberge in Krain"] which is currently considered a valid species in the subgenus *Xanthochroa* W.L.E. Schmidt, 1844 of the genus *Nacerdes* Dejean, 1834 (Švihla 2008: 363). The color described by Schmidt for *O. lippichii* clearly suggests that both taxa are identical. It is interesting to note that Schmidt (1846: 36) himself listed "*Necydalis Lippichii*. Kunze in litt." as synonym of *Xanthochroa carniolica* Gistel.

According to Horn et al. (1990: 350), Schmidt's collection was acquired in 1935 by the Slovenian Museum of Natural History in Ljubljana [formely known as *Krainer Landesmuseum „Rudolfinum"* in honor of the Crown Prince Rudolph (1858-1889)]. Upon my request Dr. Tomi Trilar of the Slovenian Museum checked Schmidt's collection but was unable to find any specimens under the names *Chlaenius carniolicus* and *Oedemera lippichii*. Even if the type specimens cannot be study at this time, I believe the original descriptions clearly suggest that *Chlaenius carniolicus* Gistel, 1834 and *Chlaenius carniolicus* Schmidt, 1834 are junior synonyms of *Chlaenius spoliatus* (Rossi, 1792) and *Oedemera lippichii* a junior synonym of *Nacerdes carniolica carniolica* Gistel, 1834 (**new synonymies**).

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RESEARCH ARTICLE

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Ptomaphaginus troglodytes sp. n., the first anophthalmic species of Ptomaphaginina from China (Coleoptera, Leiodidae, Cholevinae, Ptomaphagini)

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Abstract

Ptomaphaginus troglodytes **sp. n.**, the first anophthalmic species of *Ptomaphaginus* Portevin, 1914 is described from two close caves in Libo Karst, south Guizhou Province, China.

Keywords

Anophthalmy, China, Guizhou Province, new species, troglobiomorphy

Introduction

Ptomaphagini is, after Leptodirini, the richest tribe of Cholevinae in species living in subterranean environment (caves or other subterranean habitats). Unlike Leptodirini, in which all species except a few dozen are anophthalmic, cave-dwelling species of Ptomaphagini are at most microphthalmic, a single species is fully anophthalmic. The tribe is presently divided into three subtribes: Baryodirina, Ptomaphagina, and Ptomaphaginina (Perreau 2000). The phylogenetic relevance of this division has been discussed (Gnaspini 1996) but recently confirmed (Antunes Carvalho et al. 2017).

Subterranean Ptomaphagina occur mainly in the Nearctic and Neotropical Regions (Peck 1973, 1984, 1998), but the only fully anophthalmic species, *Ptomaphagus* (*Ptomaphagus*) *troglodytes* Blas & Vives, 1983, occurs in Spain, in the Palaearctic Region (Blas and Vives 1983). All Nearctic cave-dwelling species of Ptomaphagina are at most microphthalmic, even the most troglobiomorphic species *Ptomaphagus parashant* Peck & Wynne, 2013 has remnants of eyes (Peck and Wynne 2013). Microphthalmy in Ptomaphagina has been recently investigated by genetic methods on a population of *Ptomaphagus* (*Adelops*) *hirtus* (Tellkampf, 1844) from the Mammoth cave system in Kentucky, USA (Friedrich et al. 2011; Friedrich 2013). These studies showed the presence of transcripts of all critical components of the phototransduction protein network and a strong photonegative behaviour, which indicate a reduced, but functional visual system.

Ptomaphaginina are mainly distributed in the Oriental Region (Szymczakowski 1964), including the Sunda Islands (Schilthuizen et al. pers. comm.). A single genus with six species, *Proptomaphaginus* Szymczakowski, 1969, lives in Central America (Peck 1983). The Oriental species of Ptomaphaginina belong to three genera: *Ptomaphaginus* Portevin, 1914 (96 species), *Pandania* Szymczakowski (two species) and *Ptomaphaminus* Perreau, 2000 (24 published species + 9 species under description). Some species of *Ptomaphaginus* live preferably in caves (*P. lipsae* Perreau & Lemaire, 2018, *P. otusus* Szymczakowski, 1959, *P. tomellerii* Zoia, 1997) but without significant eye reduction (Szymczakowski 1959, Zoia 1997, Perreau and Lemaire 2018). Most of the species of *Ptomaphaminus* live in caves and many of them have reduced eyes (Perreau 2009; Schilthuizen et al. pers. comm.). Currently, no anophthalmic species of Ptomaphaginina is known, and the purpose of the present paper is to describe the first anophthalmic species of Ptomaphaginina: *Ptomaphaginus troglodytes* sp. n. from Guizhou Province in China.

Guizhou comprises extended karst areas with a high diversity of cave-adapted arthropods and is the Chinese province with the highest number of known troglobitic species (Latella and Hu 2008; Tian and Clark 2012). Most of the known troglobitic Coleoptera from Guizhou belong to highly troglobiomorphic ground beetles, Carabidae: Trechinae (e.g. Deuve 1993, 1995; Deuve et al. 1999; Uéno 2000a, b, 2002; Tian 2009, 2010, 2011, 2013, 2014; Tian and Clarke 2012; Tian et al. 2014a, b, 2017; Tian and Deuve 2016a, b; Huang et al. 2017; Wei et al. 2017; for broader review see Latella and Hu 2008). More recently, three additional papers on troglobiont Staphylinidae: Pselaphinae were published from Guizhou (Yin et al. 2011, 2015; Yin and Li 2015).

Material and methods

Dissected specimens were relaxed in warm water. Male genitalia were directly dehydrated in ethanol 95% then mounted in Euparal. The female abdomen was cleared in a hot water solution of potassium hydroxide 0.1 N for 10 minutes, then rinsed in distilled water, coloured with Azoblack then dissected to extract the genital segment, which was mounted in DMHF. Photonic microscopic pictures (Figs 15–19)

were taken on a Zeiss Axiolab microscope with a Spot Insight IN1820 digital camera. A photograph of the habitus in dorsal view was taken using a Canon macro photo lens MP-E 65mm on a Canon 550D. Multiple layers of focus were combined using Zerene Stacker. High-resolution electronic pictures of external morphology were taken using a Hitachi S-3700N environmental electron microscope at the National Museum, Praha.

Specimens examined are deposited in the following collections:

JRUC collection of Jan Růžička, Praha, Czech Republic
MPEC collection of Michel Perreau, Paris, France
NMPC National Museum, Praha, Czech Republic (M. Fikáček, J. Hájek)
NSMT National Museum of Nature and Science, Tokyo, Japan (S. Nomura)

The distribution map was produced and edited in ESRI ArcMap 10.5 of ArcGIS Desktop 10.5 suite. For map layers, free levels 0–2 data from Global Administrative Areas (http://www.gadm.org, ver. 2.8) and Natural Earth (http://naturalearthdata.com, Cross Blended Hypso with Relief, Water, Drains, and Ocean Bottom) were used.

Taxonomy

***Ptomaphaginus troglodytes* sp. n.**
http://zoobank.org/957DADD8-4248-4CCE-874C-68C693144DDA
Figs 1–11, 15–20

Type locality. China: Guizhou Province, Libo Xian County, Shuiboshu Dong cave [ca. 25°29'05"N, 107°52'54"E], 490 m.

Material examined. Holotype male (NSMT): "Shuiboshu Dong cave (490 m) / Shuipu cun [ca. 25°29'05"N, 107°52'54"E], Yuiping Zhen / Libo Xian // (Guizhou, CHINA) / 13.ix.1997, T. Kishmoto [leg.] // HOLOTYPUS / *Ptomaphaginus troglodytes* sp. n. / M. Perreau & J. Růžička, 2018". Paratypes (NSMT, JRUC, MPEC): 1 male and 2 females, same data; 1 male and 1 female, "Yamen Dong cave [ca. 25°29'N, 107°54'E] / Shuibo Zhai, Shuipu Cun / Libo Xian // (Guizhou, CHINA) / 13.ix.1997, T. Kishmoto [leg.] // PARATYPUS / *Ptomaphaginus troglodytes* sp. n. / M. Perreau & J. Růžička, 2018".

Description. Length 1.85 mm. Body widely ovoid, uniformly light brown (depigmented). Body covered with recumbent setae inserted along tight transverse strigae (Fig. 5). Habitus in Figs 1, 2.

Head without eyes (Fig. 3), antenna slender, the club weakly dilated (Fig. 4), the ratio of the lengths of antennomeres to the length of the first one are as follows: 1.00, 0.60, 0.36, 0.26, 0.31, 0.29, 0.45, 0.19, 0.38, 0.45, 1.07. Mandibles with two teeth along the internal side (Fig. 9). Maxillary palpus with the apical segment slender and very elongated, slightly longer than the penultimate (Fig. 8).

Figure 1. *Ptomaphaginus troglodytes* sp. n., male holotype from Shuiboshu Dong cave, habitus in dorsal view.

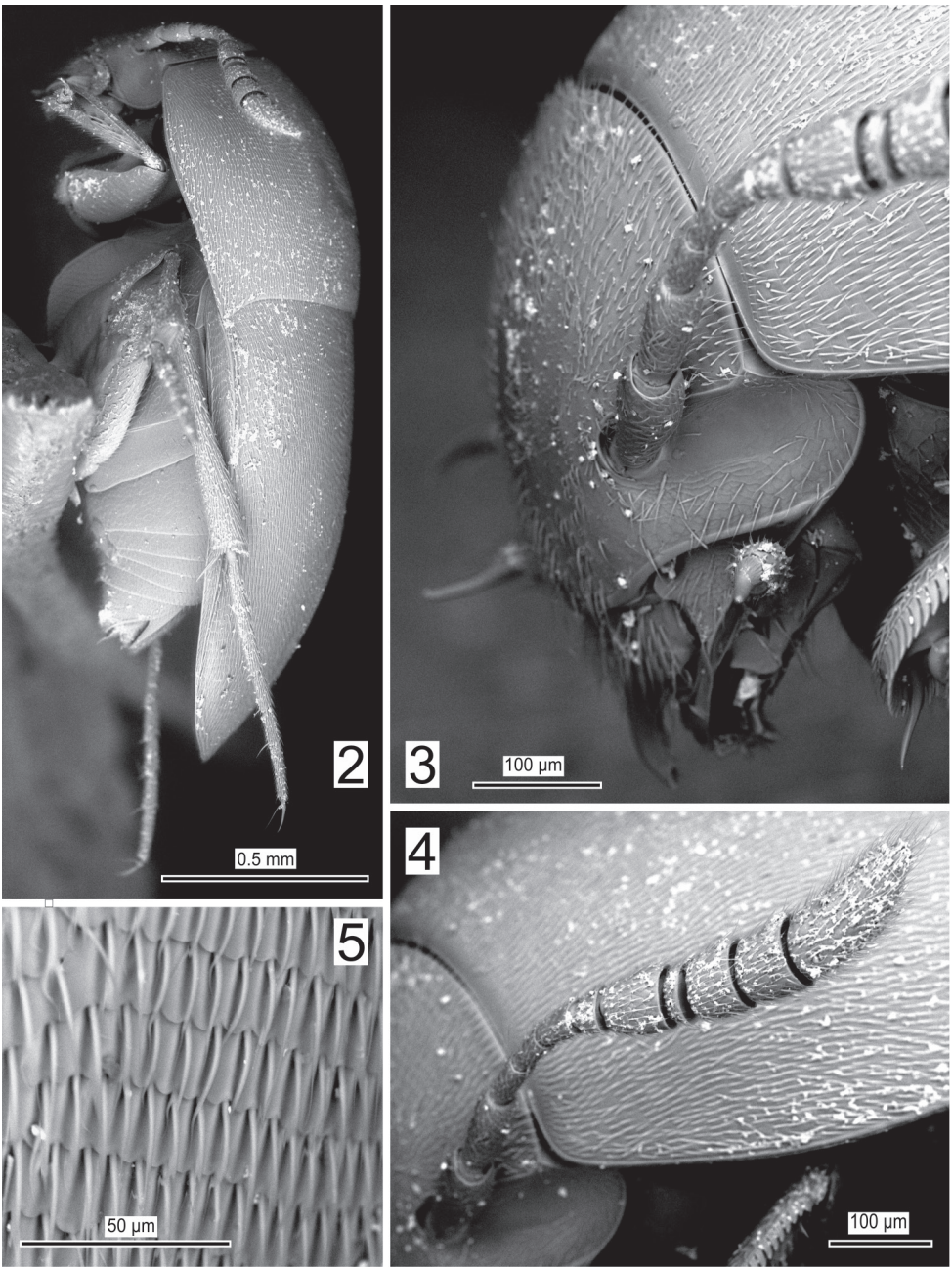
Pronotum transverse, 1.6 times wider than long, the largest width just before the base. Lateral sides arcuate, the posterior angles clearly protruding behind the posterior margin. Pronotal surface with transverse microstrigae.

Elytra short and wide, as long as wide, the greatest width near the base. Surface covered with transverse microstrigae, similar to that of the pronotum (Fig. 5). One incomplete parasutural longitudinal stria, extending over the basal half of the elytral length.

Mesoventral process with a high, widely rounded medial carina (Fig. 6). Metaventrite with lateral metaventral sutures slightly convergent symmetrically toward the central axis of the body. Metatergum long and thick, extending approximately half the length of the elytra (Fig. 18).

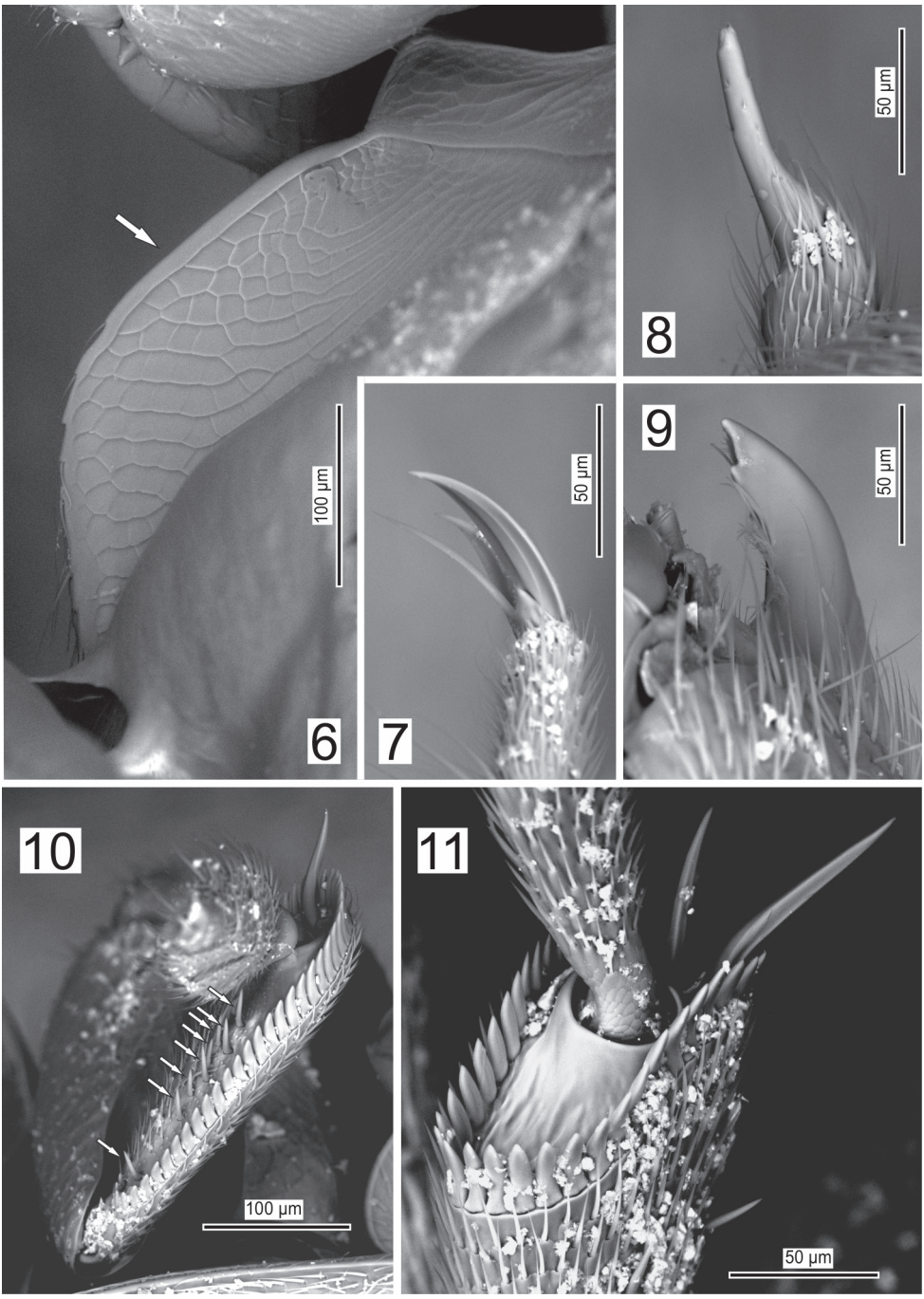
Protibia with a row of regular spines along the external side and with a second internal row on the ventral side, with one spine situated basally and a line of seven spines medially (Fig. 10). Mesotibia and metatibia with a comb of equal-sized spines around their apex (Fig. 11). Tarsal formula 5–5–5 in both sexes. Male protarsi widely dilated, as wide as the apex of the protibia. Female protarsi slightly dilated.

Male genital segment with a spiculum gastrale extending beyond the anterior margin of epipleurites on one third of its length and slightly narrowed on this part (Fig. 17). Latero-posterior margin of the epipleurites with a row of moderately strong setae (Fig. 17).

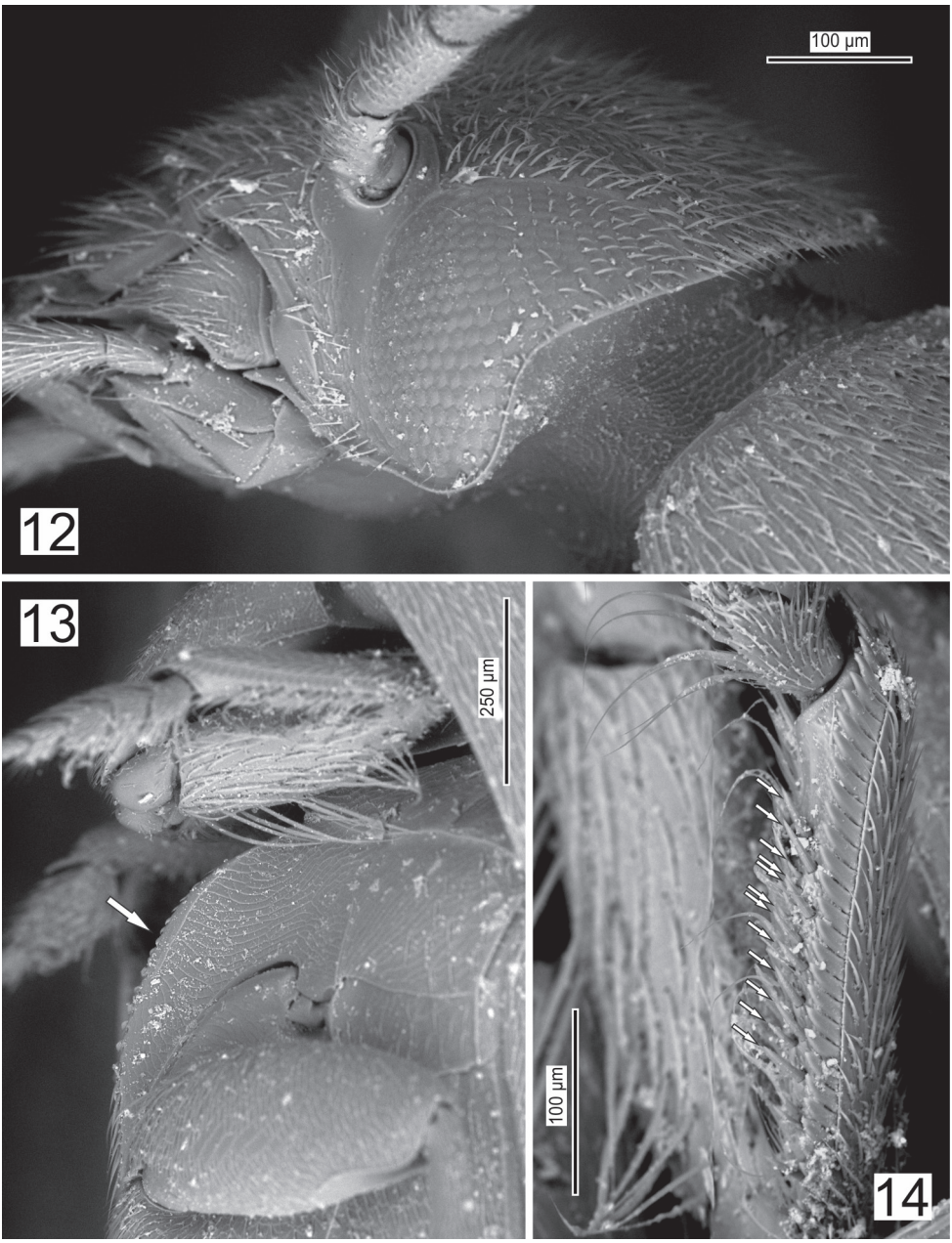


Figures 2–5. *Ptomaphaginus troglodytes* sp. n., male holotype from Shuiboshu Dong cave, SEM. **2** habitus laterally **3** head laterally **4** left antenna **5** surface of left elytron.

Aedeagus with parameres fused laterally to the median lobe, tegmen without basal blade, the median lobe 2.6 times as long as wide, the apex roughly triangular in dorsal view (Fig. 15), with two lateral rows of eight strong and long setae inserted perpendicularly

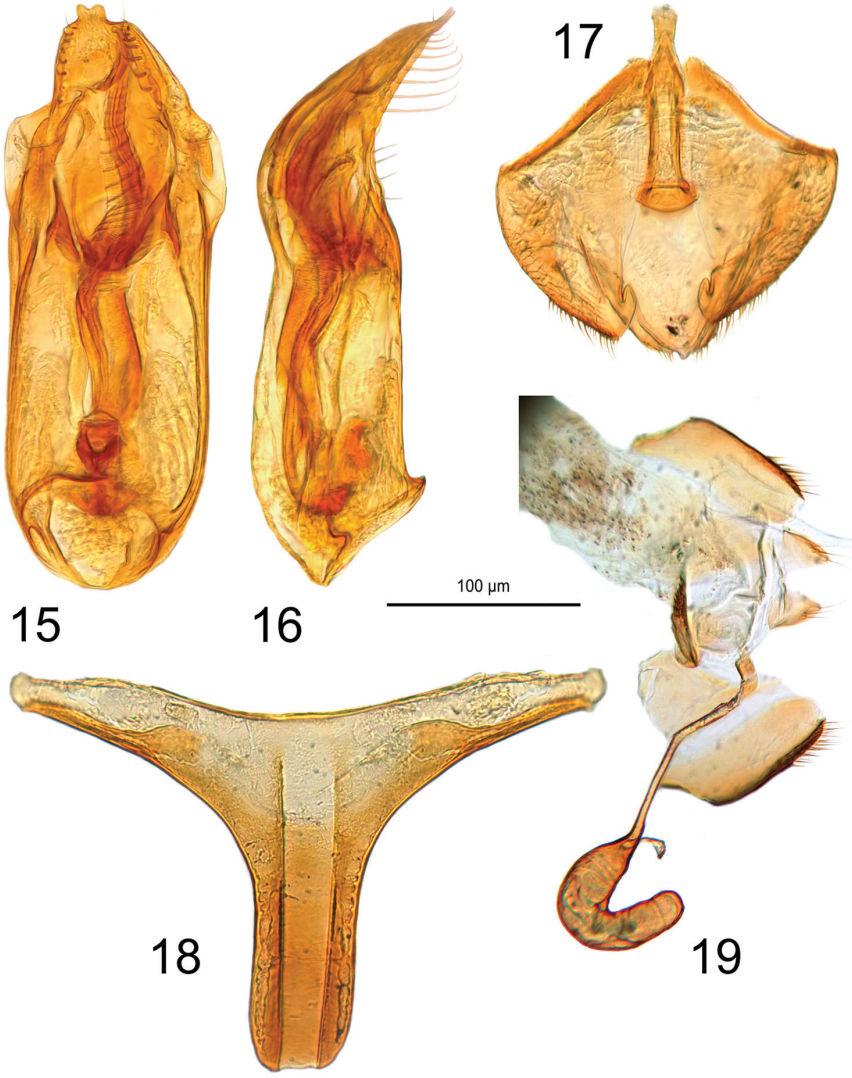


Figures 6–11. *Ptomaphaginus troglodytes* sp. n., male holotype from Shuiboshu Dong cave, SEM. **6** mesoventral process in lateral view **7** apex of mesotarsus in lateral view **8** apex of maxillary palpus in dorsal view **9** right mandibula in dorsal view **10** left protibia in lateral view (arrows indicate position of spines on ventral side) **11** apex of mesotibia in dorso-posterior view.



Figures 12–14. *Ptomaphaginus* sp., male of epigean species (China: Jiangxi province, Jinggang Shan Mts., Baiyinhu env., NMPC). **12** head in lateral view **13** mesoventral process in lateral view **14** left protibia in lateral view (arrows indicate position of spines on ventral side).

to the main plan of the aedeagus, and a preapical lateral row of four tiny setae (Fig. 16). Endophallus with a long, thick stylus, thicker at the base and getting progressively thinner from the base to the apex, with transverse stria in the distal half (Fig. 15).



Figures 15–19. *Ptomaphaginus troglodytes* sp. n., male paratype. **15** aedeagus in dorsal view **16** aedeagus in lateral view **17** male urite IX **18** male metatergum in dorsal view. *Ptomaphaginus troglodytes* sp. n., female paratype **19** female genital segment, with spermatheca.

Female abdominal segment IX with short gonocoxites (Fig. 19). Spermatheca uniformly sclerotized, spermiduct short and straight, spermathecal gland small (Fig. 19).

Diagnosis. Distinct from other *Ptomaphaginus* in the absence of eyes, short, wide body shape, especially the elytra as wide as long (taken together), more developed setation of the aedeagus, and transverse microstrigae of the elytra which are extremely tight and orthogonal to the suture, not oblique as generally in Ptomaphagini.

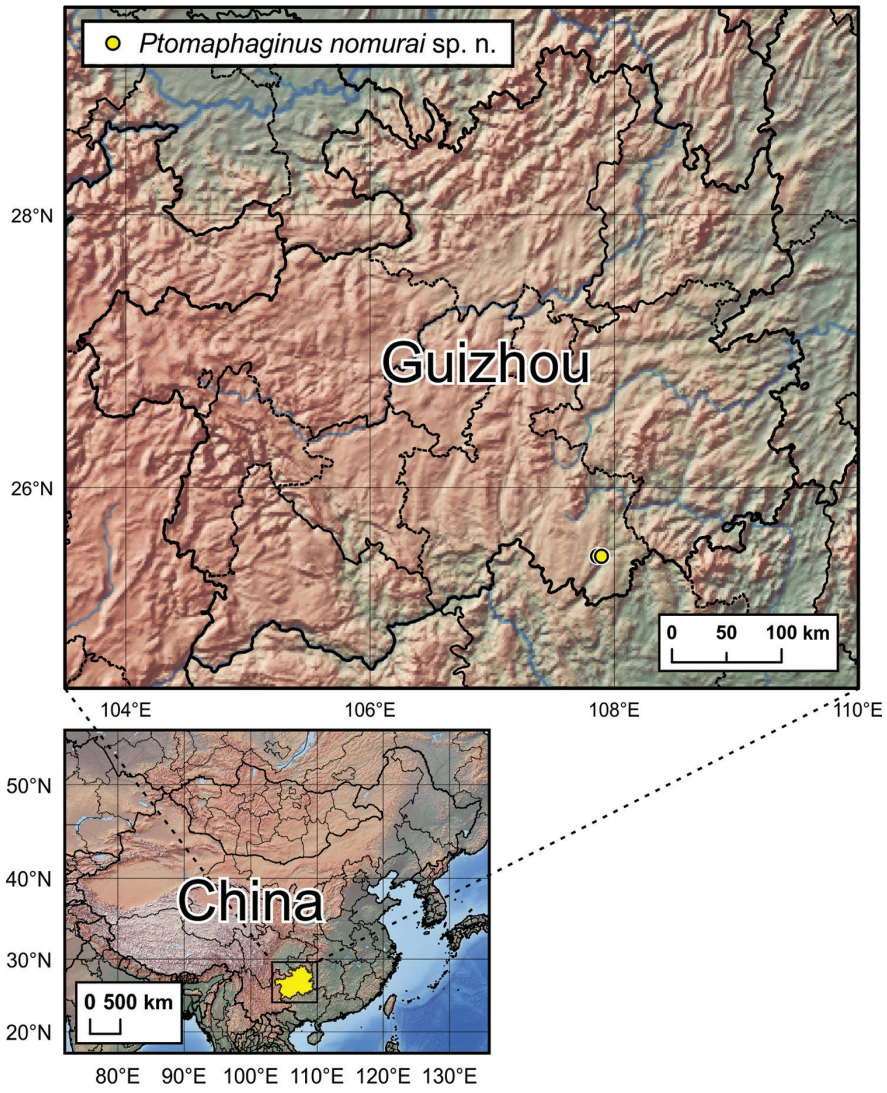


Figure 20. Distribution map of *Ptomaphaginus troglodytes* sp. n. in Guizhou Province, China.

The identification table of Chinese species of *Ptomaphaginus* given in the revision of the genus by Wang and Zhou (2015) should be modified by adding the first couplet before all others:

1 Anophthalmic. Transverse microstrigae of elytra tight and orthogonal to the suture..... ***P. troglodytes* sp. n.**

– Eyes well developed. Transverse microstrigae of elytra more spaced out and oblique ..... **Other species**

Figs 12–14 illustrate some characters of a Chinese epigean species of *Ptomaphaginus* to compare with *P. troglodytes*: Fully developed eyes (Fig. 12), mesoventral process less elevated (Fig. 13) and ventral face of protibia with the second row of spines more regular (Fig. 14).

Etymology. Cave-dweller in Latin, because of the association of the new species with caves; noun in apposition.

Biology and biogeography. No bionomic details are available for the two small series, collected in Shuiboshu Dong and Yamen Dong caves. This is the first species of *Ptomaphaginus* reported from Guizhou Province, most probably as a result of a gap in knowledge of the fauna of the centre of southern China (see Wang and Zhou 2015: 336, figure 20); this may be improved by additional sampling activities.

Distribution. The species is presently known only from two closely situated caves in Libo Karst area, south of Guangxi Province, China (Fig. 20).

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