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New Records of Gnathiid and Limnoriid Species (Malacostraca, Peracarida, Isopoda) in Korean Fauna

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ABSTRACT

Two isopods, *Elaphognathia lucanoides* Monod, 1926 and *Limnoria saseboensis* Menzies, 1957, are newly recorded in Korean fauna. *Elaphognathia lucanoides* can be distinguished from its congeners by the following characteristics combined: the cephalon is strongly excavated on the anterior margin; the paraocular ornamentation is forming a ridge distinctly; and the mandible is longer than cephalon. *Limnoria saseboensis* differs from the related species by the following features: pleonite 5 has two parallel longitudinal carinae; the pleotelson has one or two pairs of tubercles and two carinae; and the tubercles are present on the posterior margin of the pleotelson. In this paper, detailed descriptions and figures of these two species are provided.

Keywords: *Elaphognathia*, *Limnoria*, isopods, morphology, Korea

INTRODUCTION

Among the peracarid crustaceans, breeding their offsprings in marsupium, the isopods can be distinguished from others by having dorsoventrally flattened body, seven pairs of uniramous pereopods, and pleotelson always fused with the last pleonite (Poore and Bruce, 2012). They live in various environments including terrestrial, freshwater, and marine as well as parasitic with invertebrate and vertebrate hosts (Poore and Bruce, 2012; Williams and Boyko, 2012). Up to date, over 10,000 isopods are known worldwide, approximately 6,000 species of these are reported from estuarine or marine waters (Poore and Bruce, 2012). In Korea, about 120 isopods including over 80 estuarine or marine species have been reported from various habitats since the first report by Richardson (1909) (Richardson, 1909; Kwon, 1988, 1995; Song and Min, 2017a, 2017b, 2018; Song et al., 2017; Kim and Yoon, 2018a, 2018b, 2019a, 2019b; National Institute of Biological Resources, 2019). Considering the number of species known worldwide, however, it seems that our knowledge for the Korean fauna of isopods is poor and many species still remain to be found. During the survey on the southern coast of Korea from 2017 to 2019, two species new to Korean fauna, *Elaphognathia lucanoides* Monod, 1926 and *Limnoria saseboensis* Menzies, 1957, were found from the intertidal zone. In this paper, these two species are reported with detailed descriptions and figures.

MATERIALS AND METHODS

A sieve (1 mm in pore size) was used to collect the materials of *Elaphognathia lucanoides* from muddy substrate. The materials of *Limnoria saseboensis* were collected from the deadwood on the sandy beach. The collected materials were fixed in 95% ethyl alcohol and then transferred to the laboratory. The stereomicroscope (SMZ 1500; Nikon, Japan) and bright-field microscopy (BX 50; Olympus, Japan) were used to observe and dissect the materials. Measurements and drawings were carried out with the aid of a drawing tube. The drawings were digitized using Adobe Illustrator CS6. The materials of this study were deposited at the National Institute of Biological Resource (NIBR) and Chosun University in Korea.

SYSTEMATIC ACCOUNTS

Order Isopoda Latreille, 1817
Suborder Cymothoida Wägele, 1989

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Family Gnathiidae Leach, 1814
Genus *Elaphognathia* Monod, 1926

[1]***Elaphognathia lucanoides* Monod, 1926 (Figs. 1, 2)**

Elaphognathia lucanoides Monod, 1926: 566, figs. 256, 257; Müller, 1989: 26, fig. 1G, H.

Material examined. Korea: 3♂♂, Jeollanam-do, Wando-gun, Nohwa-eup, Gomak-ri, 34°13′28″N, 126°33′47″E, 26 May 2017, Kim SH, NIBRIV0000869426.

Description of male. Body (Fig. 1A) 5.8 mm, smooth. Cephalon (Fig. 1A–C) oblong, about 0.7 times as long as wide, slightly narrowing posteriorly; frontal border highly excavated mesially, with 1 pair of superior and inferior frontolateral processes, respectively, while latter hardly seems from dorsal side; each superior frontolateral process with several setae distally; dorsal sulcus deep, distinct, V-shaped; paraocular ornamentation distinct, forming ridge; eye large, laterally positioned. Pereonites (Fig. 1A) variously modified; pereonite 1 fused to cephalon, whereas suture line visible dorsally; pereonites 2 and 3 similar to each other, oblong, about 0.22 times as long as wide; pereonite 4 with anterior constriction, 1.7 times longer than pereonite 3; pereonite 5 slightly wider than other pereonites, 1.1 times wider than pereonite 4, with convex lateral margin; pereonite 6 longest, 1.7 times longer than pereonite 5; pereonite 7 reduced, surrounded by pleonite 1. Pleonites (Fig. 1A) oblong, subequal to each other, much narrower than pereonites. Pleotelson (Fig. 1A, D) triangular, tapering posteriorly; apex round, with 2 simple setae.

Antennule (Fig. 1E) consisting of 3 peduncular articles and 5 flagellar articles; peduncular article 1 elongated oblong, with 3 penicillate setae laterally; article 2 oblong, about 0.7 times as long as article 1, with 3 penicillate setae and 3 simple setae distally; article 3 about 1.9 times longer than article 2, with 2 simple setae laterally and 5 simple setae distally; flagellar article 1 without setae, 0.05 times as long as peduncular article 3; article 2 oblong, 5.0 times longer than article 1, without setae; article 3 with 1 aesthetasc and 1 simple seta distally, 0.9 times as long as article 2; article 4 with 1 aesthetasc distally, 0.7 times as long as article 3; article 5 with 1 asthetasc and 3 simple setae distally, 0.4 times as long as article 4. Antenna (Fig. 1F) composed of 4 peduncular and 7 flagellar articles; peduncular article 1 with 1 simple seta distally; article 2 without setae, 0.6 times as long as article 1; article 3 elongated, 3 times longer than article 2, with 1 penicillate seta and 8 simple setae laterally and distally; article 4 subequal to article 3 in length, with 18 simple setae laterally and distally; flagellar articles oblong sequentially shorted posteriorly, with 0–4 simple setae distally.

Mandible (Fig. 1G) slender, elongate, 1.2 times longer than cephalon, with smooth blade; mandibular seta lacking; internal lobe present; basal neck present; distal end curved inwardly. Maxilliped (Fig. 1H), endite absent; palp 4-articled, rolled proximally; palp articles narrowing posteriorly, with plumose setae along with outer margin; fourth article with 1 simple seta distally. Pylopod (Fig. 1I, J) 3-articled; article 1 about 0.9 times as long as total length of pylopod, with plumose setae along with outer margin, 4 simple setae on distal end, and 3 areolae mesially; article 2 oval, 0.14 time as long as article 1, with fine setae laterally, 1 simple seta distally; article 3 minute, semicircular.

Pereopods (Fig. 2A–E) similar to each other; basis elongated oblong, slightly longer than ischium, with 0–3 penicillate setae on superior margin; ischium convex superiorly, with several setae laterally; merus extending to superior distal angle, with 1 tubercle on inferior margin; carpus oblong, 1 or 2 tubercles on inferior margin, with 1 serrate seta on inferior distal angle except for pereopod 7; propodus elongated, about 1.4 times longer than carpus, with short simple setae and 2 robust setae along with inferior margin, distal robust setae serrated, while proximal robust setae smooth in pereopods 2 and 5; dactylus about 0.2 times as long as propodus, with 2 claws. Pereopod 7 (Fig. 2E), merus with 2 serrate setae on superior distal end; carpus with 1 serrate seta on superior distal end.

Penes (Fig. 2L) fused to each other; apex round, slightly concave mesially.

Pleopods (Fig. 2F–J) subsimilar, but pleopod 5 slightly smaller than preceeding pleopods; protopod trapezoid, with 2 coupling hooks on inner margin; rami elongated oval, with plumose setae distally; exopod slightly longer than endopod. Pleopod 2 (Fig. 2G), appendix masculina inserted proximally, longer than endopod, and with rounded distal end. Pleopod 5 (Fig. 2J), protopod oblong, wider than long.

Uropod (Figs. 1A, 2K) not reaching to distal end of pleotelson; protopod triangular; rami elongated oval, with plumose setae on inner margin and simple setae on distal end; endopod wider than exopod, with 4 penicillate setae dorsally; exopod with simple setae along with lateral margin dorsally.

Distribution. Korea (present study), Japan.

Remarks. The Korean materials of *Elaphgnathia lucanoides* are well agreed with the previous reports from Japan by the following characteristics combined: (1) the cephalon is strongly excavated on the anterior margin; (2) the frontal border has a pair of superior and inferior frontolateral processes, respectively; (3) the paraocular ornamentation is distinct and forming a ridge (4) the mandible is longer than the cephalon; and (5) the flagellum of the antennule is 5-articled (Monod, 1926; Müller, 1989).

Korean name: [1]*깊은오목머리큰턱벌레(신칭)

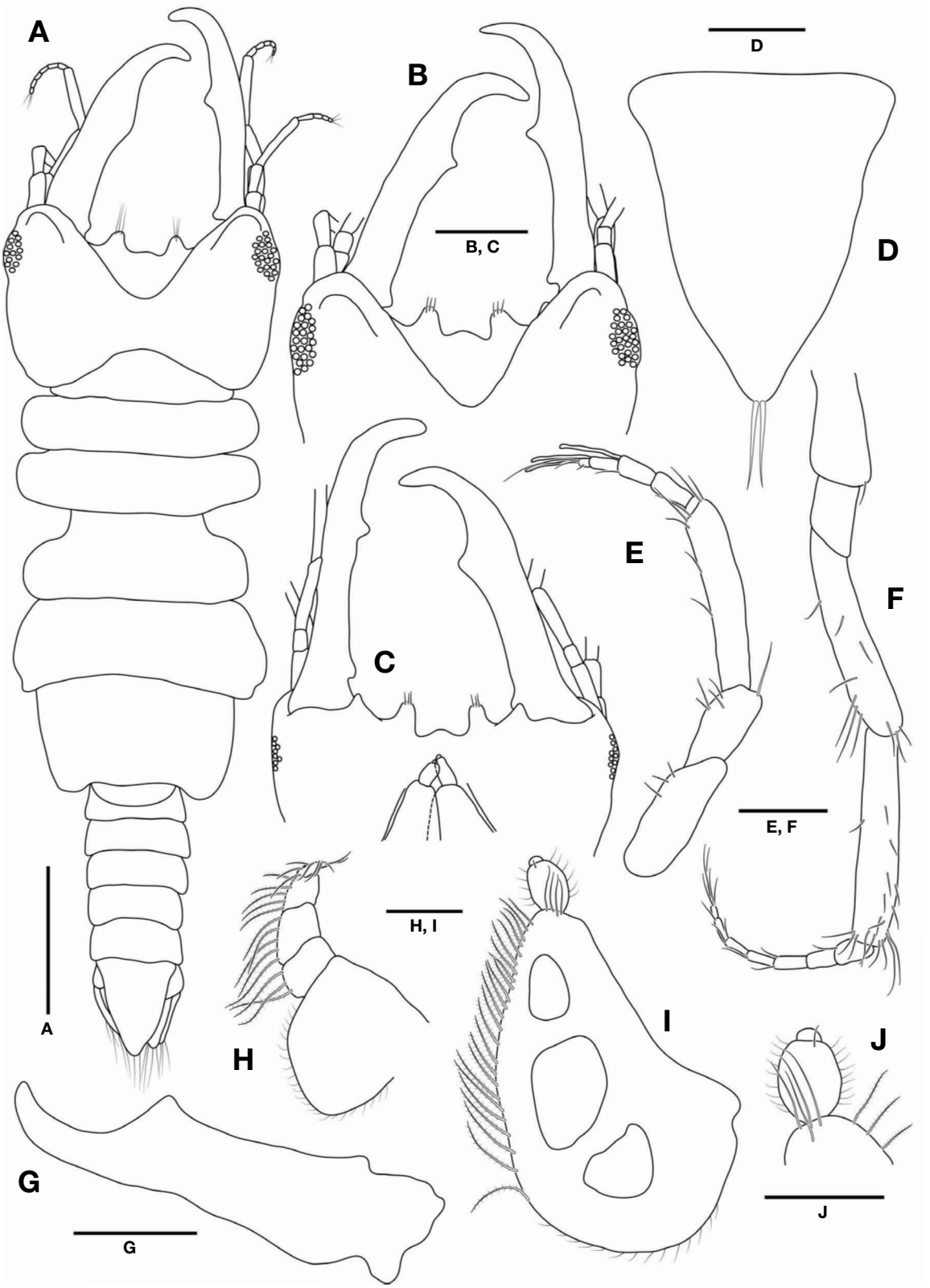

Fig. 1. *Elaphognathia lucanoides*, male. A, Habitus, dorsal view; B, Cephalon, dorsal view; C, Cephalon, ventral view; D, Pleotelson; E, Antennule; F, Antenna; G, Mandible; H, Maxilliped; I, Pylopod; J, Distal end of pylopod. Scale bars: A = 1 mm, B, C, G = 0.5 mm, D–F, H–J = 0.2 mm.

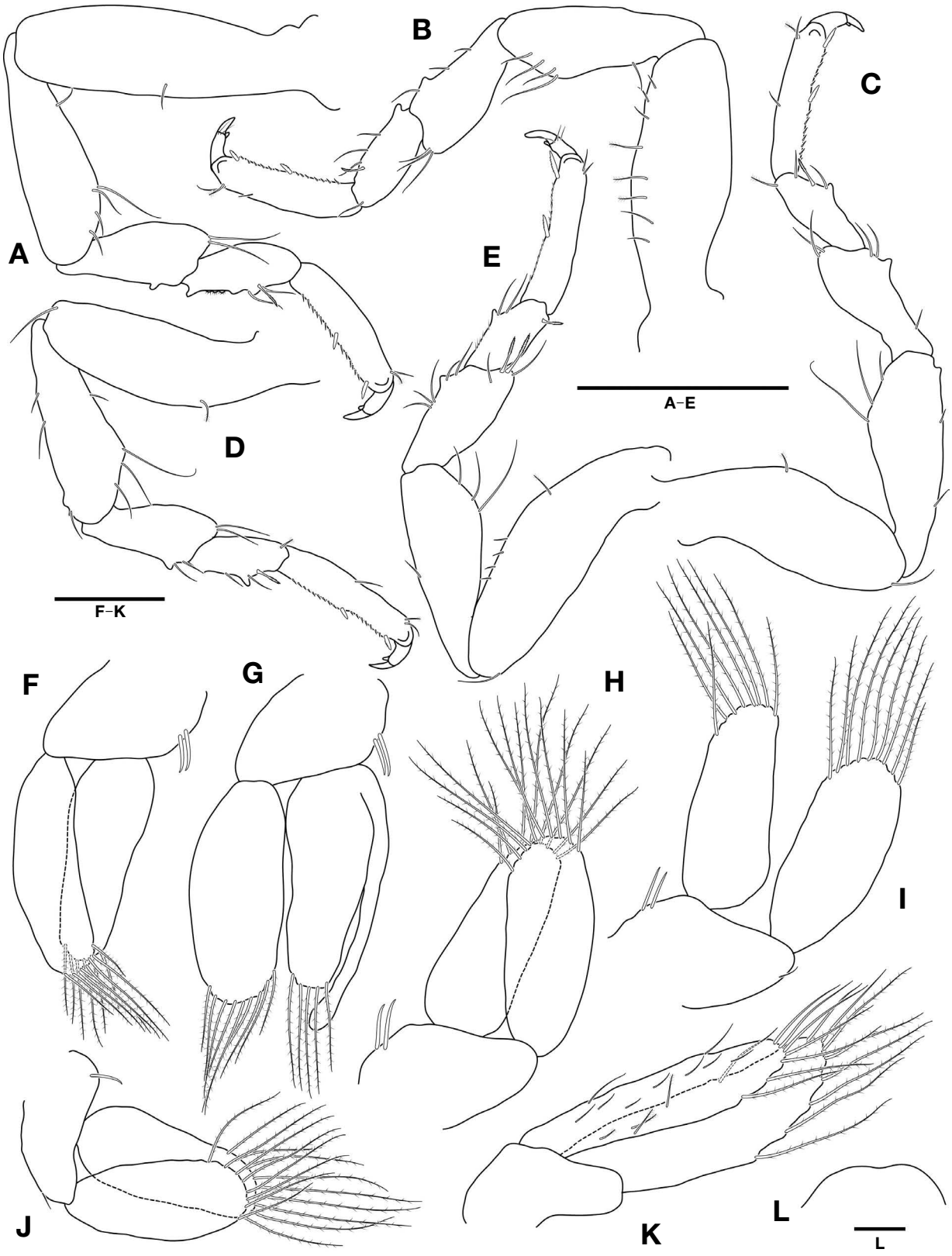

Fig. 2. *Elaphognathia lucanoides*, male. A, Pereopod 2; B, Pereopod 3; C, Pereopod 4; D, Pereopod 5; E, Pereopod 6; F, Pleopod 1; G, Pleopod 2; H, Pleopod 3; I, Pleopod 4; J, Pleopod 5; K, Uropod; L, Penes. Scale bars: A–E = 0.5 mm, F–K = 0.2 mm, L = 0.05 mm.

Within the genus, *Elaphognathia lucanoides* most resembles two species, *Elaphognathia monodi* Gurjanova, 1936 and *Elaphognathia sugashimaensis* (Nunomura, 1981), by having concave frontal border on the cephalon and slender and long mandible, but the former can be distinguishable from the latter two species by having more excavated cephalon, a pair of inferior frontolateral processes (lacking in *E. sugashimaensis*), the paraocular ornamentation forming a ridge (vs. absent in the latter two species), the mandible which is longer than the cephalon (vs. shorter in the latter two species), and the 5-articled flagellum of the antennule (4-articled in *E. sugashimaensis*) (Monod, 1926; Gurjanova, 1936; Nunomura, 1981; Müller, 1989; Song and Min, 2016; Kim and Yoon, 2019b).

Suborder Limnoriidea White, 1850
Family Limnoriidae White, 1850
Genus *Limnoria* Leach, 1814

[1]**Limnoria saseboensis* **Menzies, 1957 (Figs. 3–5)**

Limnoria (*Limnoria*) *saseboensis* Menzies, 1957: 141, fig. 18.
Limnoria saseboensis: Kühne, 1976: 546, fig. 5; Kensley and Schotte, 1989: 198, fig. 87D; Cookson, 1997: 135, figs. 4, 5.
Limnoria indica: Cookson, 1987: 85, figs. 1–8.

Material examined. Korea: 2♂♂, 4♀♀, Gyeongsangnam-do, Tongyeong-si, Hansan-myeon, Yeomho-ri, Hansan-do Island, 34°47′51″N, 128°29′09″E, 31 Aug 2019, NIBR IV0000869427; 2♂♂, 2♀♀, Chubong-ri, Chubongdo Island, 34°45′40″N, 128°30′40″E, 26 Oct 2019; 2♂♂, 2♀♀, Bijin-ri, Bijindo Island, 34°43′01″N, 128°27′36″E, 28 Sep 2019, Kim SH.

Description of female. Body (Fig. 3A) 3.7 mm, 3.2 times longer than wide. Cephalon globular, partly surrounded on posterior margin; eye positioned laterally. Pereonites oblong, wider than long, sequentially shorter posteriorly; pereonite 1 longest, narrowing anteriorly, with groove mesially; pereonite 4 slightly narrower than other pereonites; pereonites 5–7 slightly wider posteriorly. Coxal plates visible on dorsal side; coxal plates 2 and 3 oblong, not expanding posteriorly; coxal plates 4–7 with several setae laterally, expanding posteriorly. Pleonites 1–4 similar in shape, with concave posterior margin; pleonite 5 almost 2.2 times longer than preceeding pleonites, with 2 parallel longitudinal carinae slightly narrowing posteriorly. Pleotelson semicircular, with small tubercles along with posterior margin; 2 tubercles and 2 longitudinal carinae located on dorsomedial surface; 2 short lateral carinae positioned between lateral crest and dorsomedial carina.

Antennule (Fig. 3B) composed of 3 peduncular articles and 4 flagellar articles; peduncular article 1 with serrated lateral margin; article 2 square with 4 penicillate setae distally, several simple setae laterally, and pectinate scales mesially; article 3 oblong, 1.1 times longer than article 2, with 2 simple setae laterally and 2 simple setae distally, pectinate scales mesially; flagellar article 1 about 0.2 times as long as peduncular article 3, with 2 penicillate setae and 1 simple seta distally; article 2 square, with 12 aesthetascs distally; article 3, oblong, narrower than preceeding articles, with 1 aesthetasc distally; article 4 about 0.9 times as long as article 3, with 5 simple setae distally. Antenna (Fig. 3C) geniculate between peduncular articles 1–3, consisting of 5 peduncular articles and 5 flagellar articles; peduncular article 1 with 1 simple seta distally; article 2 globular to square, with 1 simple seta laterally and 1 robust simple seta distally; article 3 square, with 2 simple setae distally; article 4 about 1.1 times longer than wide, with 2 penicillate setae laterally and 1 simple seta distally; article 5 oblong, 1.4 times longer than article 4, with 4 simple setae and 2 penicillate setae distally; flagellar articles sequentially narrowing and shortened posteriorly; article 1 elongated oblong, 1.1 times longer than peduncular article 5, with 1 simple seta laterally and 4 simple setae distally; articles 2–5 with several simple setae distally.

Mandibles (Fig. 3D, E) asymmetrical; palp 3-articled. Left mandible (Fig. 3D), incisor with files; lacinia mobilis bifurcate; spine row lacking; palp article 1 with 2 simple setae distally; article 2 1.7 times longer than article 1, with 5 serrate setae laterally; article 3 about 0.5 times as long as article 2, with 9 serrate setae along with lateral margin. Right mandible (Fig. 3E), incisor without rasp and files; lacinia mobilis short, not separated; spine row composed of 10 serrate setae sequentially longer posteriorly; palp article 1 with 1 simple seta laterally; article 2 with 5 serrate setae laterally; article 3 with 9 serrate setae along with lateral margin. Maxillule (Fig. 3F) consisting of 2 lobes; inner lobe with 3 plumose setae and 1 simple seta distally; outer lobe with 7 denticulated robust setae and 4 robust setae distally. Maxilla (Fig. 3G) composed of 3 lobes; inner lobe with 9 plumose setae distally; mesial lobe with 3 plumose setae distally; outer lobe with 2 plumose setae distally. Maxilliped (Fig. 3H), endite reaching to distal end of palp article 3, with 1 coupling hook laterally, and 6 plumose setae distally; palp 5-articled; palp article 1 rectangular, 0.5 times as long as wide, with 3 simple setae on distal end; article 2 expanding on inner margin, with several simple setae on inner distal end; article 3 oblong, with several simple setae distally; article 4 square, narrower than article 3, with simple setae distally; article 5 oblong, 1.4 times longer than wide, with simple setae distally; epipod tapering distally, with

Korean name: [1]*두줄용골부삽꼬리벌레 (신칭)

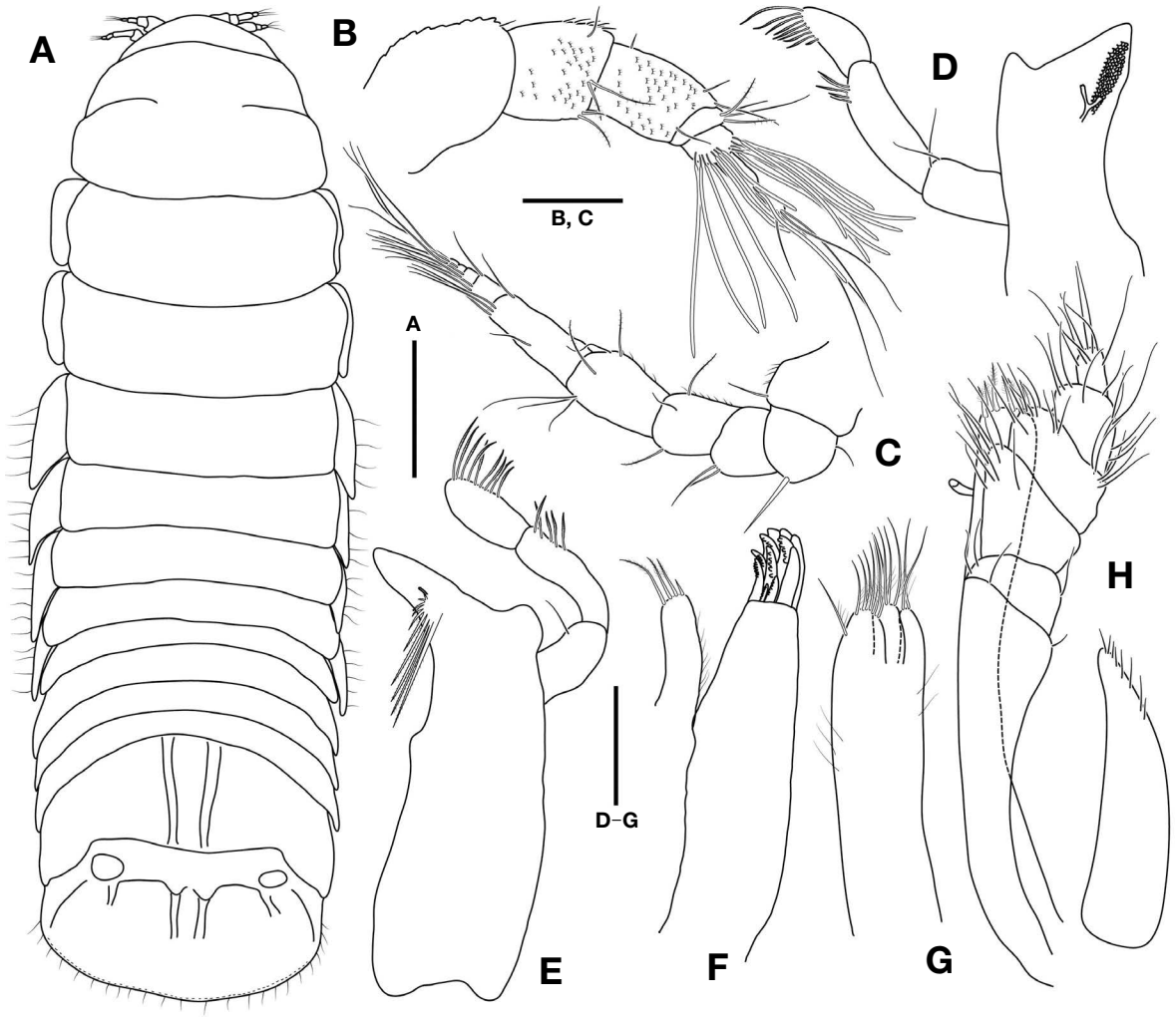

Fig. 3. *Limnoria saseboensis*, female. A, Habitus, dorsal view; B, Antennule; C, Antenna; D, Left mandible; E, Right mandible; F, Maxillule; G, Maxilla; H, Maxilliped. Scale bars: A=0.5 mm, B–H=0.1 mm.

rounded end and several simple setae distally.

Pereopods (Fig. 4A–G) covered with tubercles and pectinate scales those becoming less posteriorly; pereopods 1–4 shortened posteriorly, whereas pereopods 5–7 longer posteriorly; pereopod 4 shortest. Pereopod 1 (Fig. 4A), basis elongated, with serrated superior margin, with 1 simple seta and 1 penicillate seta on distal end; ischium to propodus with tubercles along with inferior margins; ischium 0.6 times as long as basis, with several simple setae on superior margin; merus 0.4 times as long as ischium, with 3 simple setae inferiorly and 2 simple setae superiorly; carpus triangular, with 2 simple setae inferiorly; propodus about 2.1 times longer than merus, with 1 comb seta, 1 serrate seta, and 2 simple setae on inferior margin, dactylus 0.3 times as long as propodus, with 2 claws and 3 simple setae, secondary claw bifid. Pereopod 2–6 (Fig. 4B–F) similar to pereopod 1; each merus with 1 comb seta on superodistal end in pereopods 2 and 3; carpus with 1 serrate seta on inferodistal end; propodus without comb or serrate setae inferodistally. Pereopod 7 (Fig. 4G) longest and slender than preceeding pereopods; merus expanding superodistally, with 1 comb seta inferiorly and 6 comb setae superiorly; carpus almost square, with 1 short seta and 1 robust seta inferiorly, 1 simple seta and 8 comb setae distally; dactylus with bifid secondary claw.

Pleopods (Fig. 4H–L), protopod globular to square; rami with plumose setae except for pleopod 5; endopod slightly longer than exopod; exopod wider than endopod; pleopods 1–4 similar to each other. Pleopod 1 (Fig. 4H), protopod globular, with 3 coupling hooks on inner margin; endopod oblong, with several plumose setae on distal and inner margin. Pleopod 2 (Fig. 4I), protopod with 2 coupling hooks on inner margin; endopod with plumose setae distally. Pleopods

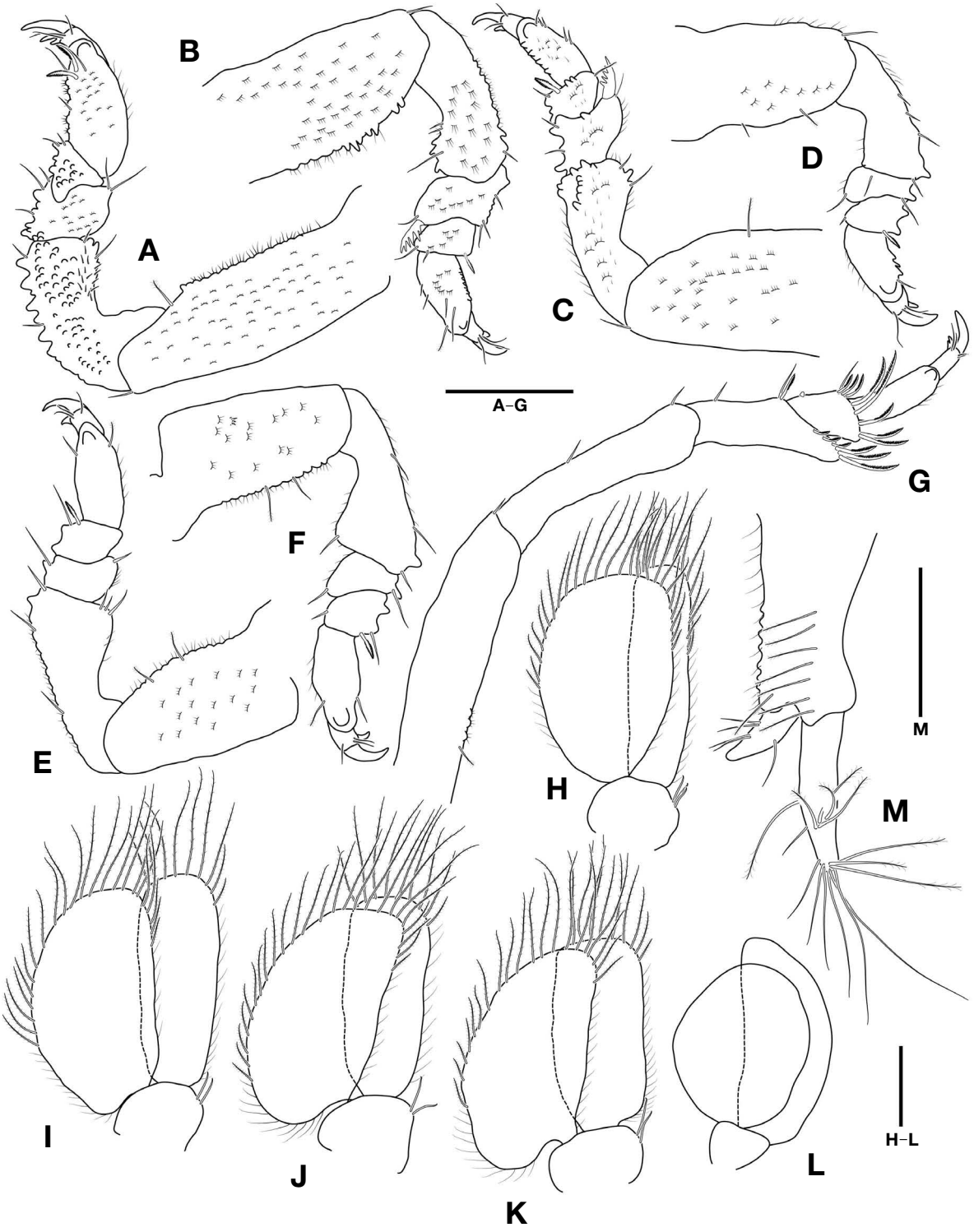

Fig. 4. *Limnoria saseboensis*, female. A, Pereopod 1; B, Pereopod 2; C, Pereopod 3; D, Pereopod 4; E, Pereopod 5; F, Pereopod 6; G, Pereopod 7; H, Pleopod 1; I, Pleopod 2; J, Pleopod 3; K, Pleopod 4; L, Pleopod 5; M, Uropod. Scale bars: A–M = 0.2 mm.

3 and 4 (Fig. 4J, K), protopod with 2 coupling hooks on inner margin; endopod truncated distally; exopod expanding proximally. Pleopod 5 (Fig. 4L), protopod lacking coupling hooks; rami without plumose setae; endopod semicircular, tapering

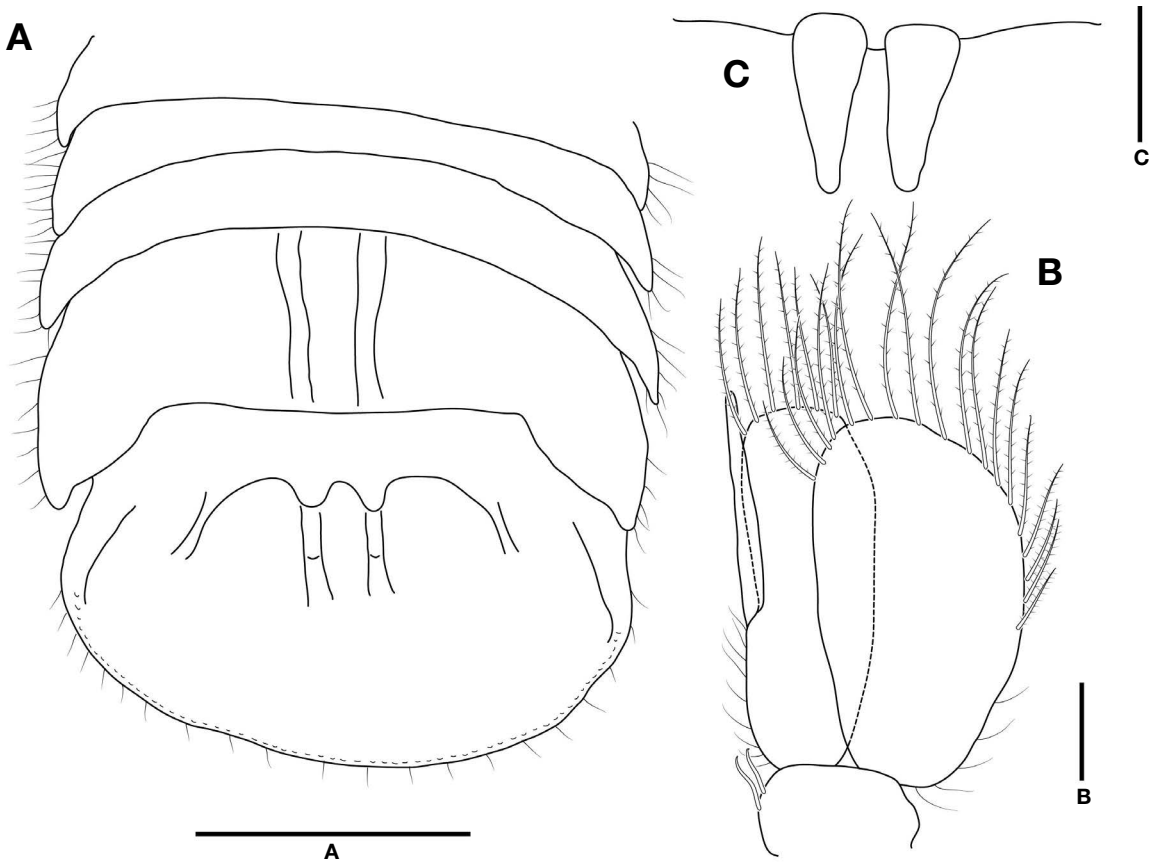

Fig. 5. *Limnoria saseboensis*, male. A, Plonite 2 to pleotelson; B, Penes; C, Pleopod 2. Scale bars: A, B=0.5 mm, C=0.1 mm.

posteriorly.

Uropod (Fig. 4M), protopod rectangular, serrated on lateral margin, 1.6 times longer than wide, with 8 penicillate setae laterally; endopod elongated oblong, about 0.9 times as long as protopod, with 1 simple seta and 5 penicillate setae mesially, 6 simple and 3 penicillate setae distally; exopod claw-like, 0.5 times as long as endopod, with 5 simple setae mesially.

Description of male. Male similar to female except for several characters. Pleotelson (Fig. 5A) with 4 tubercles along with 2 parallel carinae; 2 anterior tubercles distinct, but 2 posterior tubercles indistinct. Penes (Fig. 5B) separated each other, but positioned closely; tapering posteriorly; apex round. Pleopod 2 (Fig. 5C), protopod oblong, with 2 coupling hooks on inner margin; endopod slightly longer than endopod, with plumose setae distally; appendix masculine inserted medially; slightly longer than endopod; with rounded apex; exopod wider than endopod, with plumose setae distally.

Distribution. Korea (Present study), Australia, Japan, USA (Florida).

Variation. According to Cookson (1997), *Limnoria saseboensis* has some variations in the shape of the pleotelson. The Korean materials of *Limnoria saseboensis* are also highly variable to individuals in the shape of the pleotelson. Although some specimens have tubercles on the lateral crest of the pleotelson, the tubercles rarely observed in the Korean materials. The short lateral carina, known as a characteristic feature of the species, is lacking in some specimens. In the male specimens, the two posterior tubercles on the pleotelson are often lacking or indistinct.

Remarks. *Limnoria saseboensis* differs from almost other limnoriids by the following characteristics combined: pleonite 5 has two parallel longitudinal carinae those are narrowing posteriorly; the pleotelson has one or two pairs of tubercles and two carinae dorsomedially; the pleotelson has tubercles between lateral crest and posterior margin (Menzies, 1957; Cookson, 1997). The Korean materials well correspond with the previous reports of the species in terms of the characteristic features mentioned above.

Limnoria saseboensis is most similar to *Limnoria foveolata* Menzies, 1957 by having parallel longitudinal carinae in pleonite 5, two tubercles and a pair of carinae dorsomedially, and a pair of carinae anterolaterally in the pleotelson. However, the former can be distinguished from the latter in terms of the presence of tubercles between lateral crest and poste-

rior margin of the pleotelson (vs. absence in the latter), the absence of a rasp in the right mandible (vs. presence in the latter), the serrated lateral margin of the uropodal protopod (vs. smooth lateral margin in the latter) (Menzies, 1957; Cookson, 1997). This species also resembles *Limnoria indica* Becker & Kampf, 1958 in that both species have two carinae and two pairs of tubercles in the pleotelson. However, the former is distinguishable from the latter in having anterolateral carinae (vs. absence in the latter) and two carinae dorsomedially in both sex in the pleotelson (vs. absence in male in the latter) (Cookson, 1991).

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CONFLICTS OF INTEREST

Seong Myeong Yoon, a contributing editor of the Animal Systematics, Evolution and Diversity, was not involved in the editorial evaluation or decision to publish this article. The remaining author has declared no conflicts of interest.

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