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New Species of the Genus *Pseudanthessius* from Tropical Waters (Copepoda, Cyclopoida, Pseudanthessiidae)

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ABSTRACT

Nine new species of *Pseudanthessius* are described from tropical waters, five of which from the Philippines (*P. boholensis* n. sp., *P. angustus* n. sp., *P. firmus* n. sp., *P. ardius* n. sp., and *P. lativentris* n. sp.), two from Vietnam (*P. remicaudatus* n. sp. and *P. nodosus* n. sp.), and one each from Micronesia (*P. kosraensis* n. sp.) and the Thai coast of the Andaman Sea (*P. fossulicolus* n. sp.). *Pseudanthessius dentatus* Kim, 2000 which was known originally from the Korean coast of the Yellow Sea, and *P. planus* Kim, 2007 originally from the Moluccas, are rediscovered on the Thai coast of the Andaman Sea and the Philippines, respectively.

Keywords: Copepod associates, invertebrate hosts, Micronesia, the Philippines, Vietnam, Thailand

INTRODUCTION

Copepods of the family Pseudanthessiidae consist of six genera, including the most recently described *Tubiporicola* Kim, 2009, of which *Pseudanthessius* Claus, 1880 is the largest genus currently comprising 48 valid species (WoRMS Editorial Board, 2020). Species of the genus are associated with various marine invertebrate hosts belonging to the Echinodermata, Polychaeta, Mollusca, Turbellaria, and Nemertea (Boxshall and Halsey, 2004), but some of them have been found in plankton. More than 70% of the species in the genus have been recorded from tropical waters. In the present paper, nine new species of *Pseudanthessius* are described from tropical regions of the Philippines, Vietnam, Thailand, and Kosrae Island in Micronesia.

MATERIALS AND METHODS

Copepod specimens studied in the present work were extracted from washings of invertebrates or intertidal invertebrate burrows or collected by a light trap. Collected specimens were fixed and preserved in 80% ethanol. Then, the specimens were immersed in lactic acid before microscopic observation and dissection. Dissections were performed using the reverse slide method (Humes and Gooding, 1964). All figures were drawn with the aid of a drawing attachment. Type specimens have been deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea. In the formula for the armature of the antenna and legs 1–4, Roman numerals indicate spines and Arabic numerals represent setae. Terminology for caudal rami and mouthparts of copepods follows Huys and Boxshall (1991) and Humes and Boxshall (1996).

SYSTEMATIC ACCOUNTS

Order Cyclopoida Burmeister, 1834
Family Pseudanthessiidae Humes and Stock, 1972
Genus *Pseudanthessius* Claus, 1889

Pseudanthessius boholensis n. sp. (Figs. 1, 2)

Material examined. 5♀♀ from washings of invertebrates, SCUBA, depth 28 m, 09°43′02″N, 124°32′17″E, Anda, Bohol Island, the Philippines, coll. Lee J & Kim IH, 4 Apr 2016. Holotype (♀, MABIK CR00247462) and paratypes (3♀♀, MABIK CR00247463) have been deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon,

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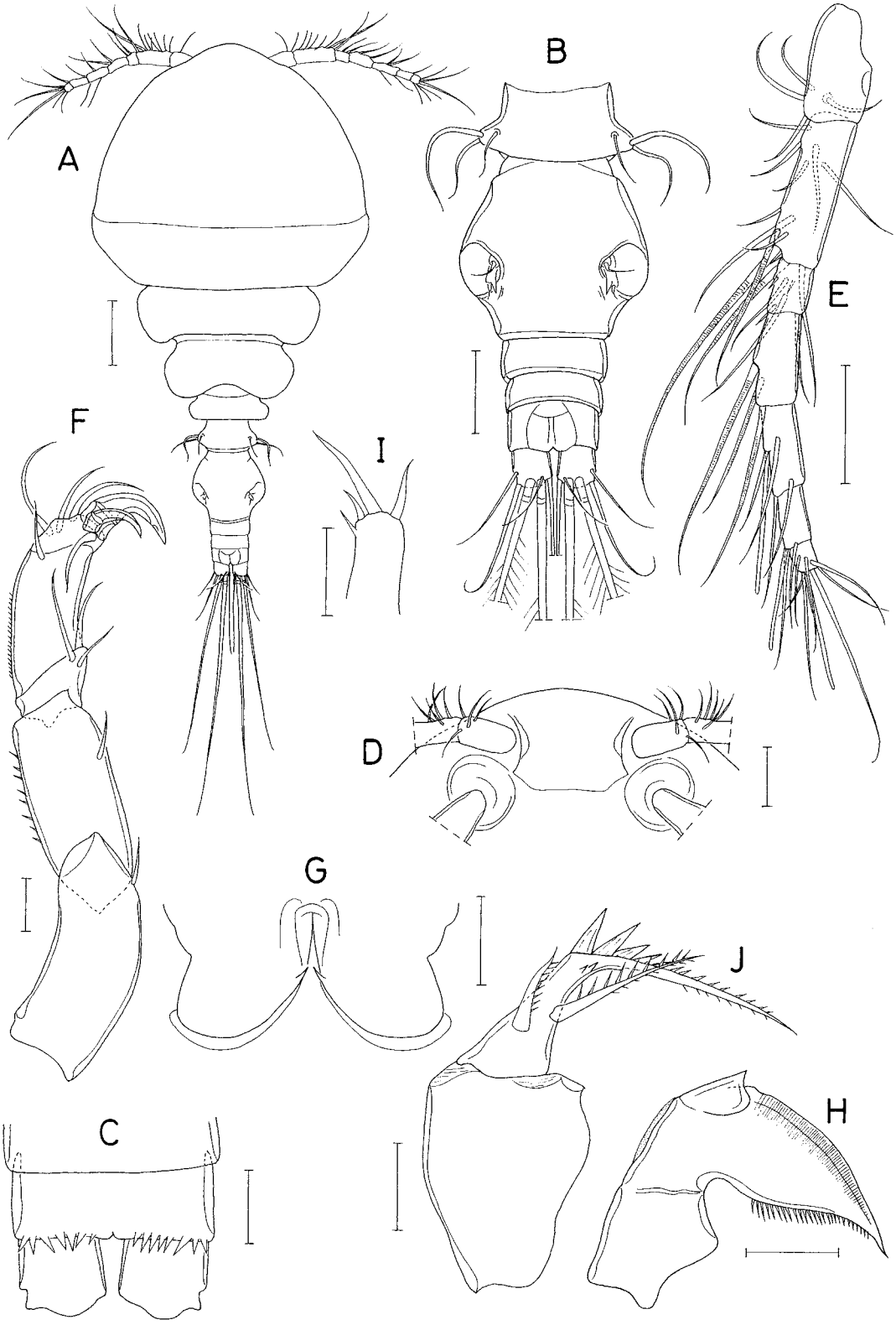

Fig. 1. *Pseudanthessius boholensis* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Anal somite and caudal rami, ventral; D, Rostral area, ventral; E, Antennule; F, Antenna; G, Labrum; H, Mandible; I, Maxillule; J, Maxilla. Scale bars: A=0.1 mm, B, D, E=0.05 mm, C, F–J=0.02 mm.

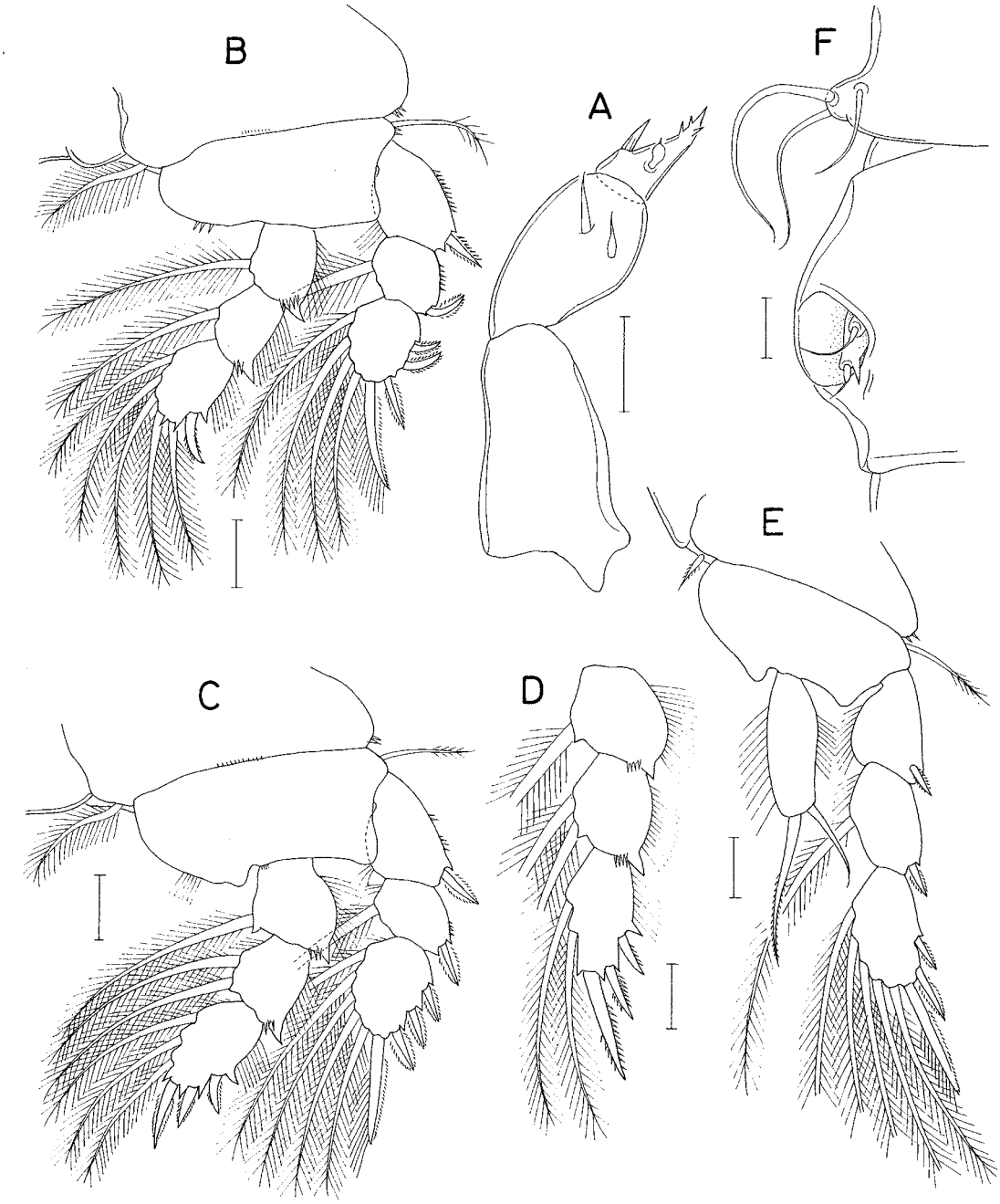

Fig. 2. *Pseudanthessius boholensis* n. sp., female. A, Maxilliped; B, Leg 1; C, Leg 2; D, Endopod of leg 3; E, Leg 4; F, Left leg 5 and genital aperture, dorsal. Scale bars: A–F = 0.02 mm.

Korea. Dissected paratype (♀) is retained in the collection of IHK.

Female. Body (Fig. 1A) with swollen, globular cephalothorax. Body length 836 μm. Prosome 573 μm long, occupying about 69% of body length. All prosomal somites with round lateral corners. Cephalothorax inflated, globular, 389 × 436 μm. Second to fourth pedigerous somites much narrower than cephalothorax. Urosome (Fig. 1B) stout, 5-segmented. Fifth pedigerous somite 95 μm wide, bearing 1 dorsolateral and 2 lateral, naked setae. Genital double-somite slightly wider than long (110 × 117 μm), laterally expanded, with convex lateral margins, widest at 60% region of double-somite length;

genital apertures large, positioning almost dorsally at widest region. Three free abdominal somites much shorter than wide, 23 × 64, 18 × 59, and 26 × 56 μm, respectively. Anal somite (Fig. 1C) ornamented with 7 or 8 dentiform spinules along each side of posteroventral margin. Caudal ramus (Fig. 1C) wider than long (22 × 24 μm), with smooth posteroventral margin.

Rostrum (Fig. 1D) broad; its lateral margin distinct, but posterior margin faint, straight. Antennule (Fig. 1E) 244 μm long, 7-segmented; armature formula 4, 13, 6, 3, 4 + aesthetasc, 2 + aesthetasc, and 7 + aesthetasc; all setae naked; several larger setae wrinkled; terminal segment very short, half as long as penultimate segment. Antenna (Fig. 1F) moderately stout, 4-segmented, consisting of coxobasis and 3-segmented endopod; armature formula 2, 2, 3, and 5 + 2 claws; coxobasis the longest; first and third endopodal segments with spinulose outer margin; third endopodal segment slightly arched, 2.37 times longer than wide (64 × 27 μm); 2 terminal claws very unequal in length and thickness, both strongly curved.

Labrum (Fig. 1G) with deep, narrow posteromedian incision; posterolateral lobes slightly divergent, with membranous fringe along posterior margin and sharp point on inner margin. Mandible (Fig. 1H) with short, tapering distal lash and distinct inner proximal notch; inner margin of gnathobase with raw of small spinules; convex outer margin with membranous fringe and 1 large scale bearing pointed apex; convex margin of gnathobase with numerous fine striations. Maxillule (Fig. 1I) as small lobe bearing 4 naked unequal setae, second outer one of them longest. Maxilla (Fig. 1J) 2-segmented; syncoxa (proximal segment) unarmed; basis (distal segment) with elongate, spinulose distal lash and 2 setae; seta I (inner seta) long, bipinnate; seta II (anterior seta) unilaterally pinnate; seta III absent; distal lash bearing 3 or 4 large teeth (or spines) proximally and 2 small denticles on proximal anterior surface. Maxilliped (Fig. 2A) 3-segmented; syncoxa (first segment) the longest but unarmed; basis (second segment) with 2 subequal, naked setae; endopod (third segment) tapering, with spiniform distal process bearing 3 denticles, 1 small spine, and 1 modified seta bearing droplet-like expansion distally.

Legs 1–3 (Fig. 2B–D) with 3-segmented rami. Leg 4 (Fig. 2E) with 3-segmented exopod and 1-segmented endopod. Outer distal corners of endopodal segments of legs 1–3 with well-developed, pointed process. Leg 4 endopodal segment 2.82 times longer than wide (48 × 17 μm), distally armed with 2 setae, setulose along outer and inner margins, without denticle or notch on outer margin; 2 distal setae 30 μm (outer) and 47 μm (inner), inner seta spiniform, bearing fine spinules along distal half. Armature formula for legs 1–4 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-1	1-0	I-0; I-1; III, I, 4	0-1; 0-1; I, 1, 4
Leg 2	0-1	1-0	I-0; I-1; III, I, 5	0-1; 0-2; I, II, 3
Leg 3	0-1	1-0	I-0; I-1; III, I, 5	0-1; 0-2; I, II, 2
Leg 4	0-1	1-0	I-0; I-1; II, I, 5	0, 2, 0

Leg 5 (Fig. 2F) consisting of 3 naked setae (1 smaller dorsolateral and 2 larger distal) on lateral process of fifth pedigerous somite. Leg 6 (Fig. 2F) on genital operculum represented by 1 denticle and 2 small setae tipped with setule.

Male. Unknown.

Etymology. The geographic name of the type locality is taken for the name of the new species.

Remarks. *Pseudanthessius boholensis* n. sp. most closely resembles *P. madrasensis* Reddiah, 1968, which was redescribed by Humes and Ho (1970). They have in common a swollen cephalothorax, short caudal rami, identical forms of the antenna and mandible (especially a broad outer scale on the convex side of the latter oral appendage), two setiform distal elements on the endopod of leg 4, and two distal setae on leg 5. Nevertheless, a careful comparison of these leads to a determination that they are different in details and not the same species.

The differences in the female are (1) the body length of the female is about 0.84 mm in the new species, compared to 0.63–0.73 mm in *P. madrasensis* measured by Humes and Ho (1970); (2) the caudal ramus is 0.9 times longer than wide (22 × 23 μm) in the new species, compared to 1.14 times longer than wide (25 × 22 μm) in *P. madrasensis*; (3) the anal somite of the new species is ornamented with prominent spinules along the posteroventral margin, but Humes and Ho described that the margin of *P. madrasensis* is naked; (4) the distal segment (basis) of the maxilla bears setae I and II in the new species, but one of these setae absent in *P. madrasensis* according to fig. 11 of Humes and Ho (1970); (5) the spiniform distal process of the maxilliped is spinulose in the new species, but naked in *P. madrasensis*; (6) the endopodal segment of leg 4 is 2.82 times longer than wide (48 × 17 μm) in the new species, compared to 4.43 times longer than wide (62 × 14 μm) in *P. madrasensis*, despite that the latter species is smaller than the new species; and (7) the distal margin of the endopodal segment of leg 4 is smooth in the new species, but ornamented with spinules in *P. madrasensis*. These differences are sufficient to clearly differentiate the two species.

Pseudanthessius angustus n. sp. (Figs. 3, 4)

Material examined. 2♀♀ from the echinoid *Echinometra mathaei* (Blainville, 1825), intertidal, Anda, Bohol, the Philippines, 09°45′N, 124°35′E, coll. Lee J & Kim IH, 1 Apr 2016.

Holotype (♀, MABIK CR00247464) has been deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea. Dissected paratype (♀) is retained in the collection of IHK.

Female. Body (Fig. 3A) narrow. Body length 1.01 mm. Prosome 654 μm long. Greatest width of prosome 373 μm. Prosomal somites with pointed or angular posterolateral corners. Urosome (Fig. 3B) 5-segmented. Fifth pedigerous somite 119 μm wide. Genital double-somite 1.38 times longer than wide (142 × 103 μm), narrower than fifth pedigerous somite, consisting of slightly expanded anterior three-quarters and narrower distal quarter; lateral margins of anterior part curvy, with semicircular lateral expansion just posterior to genital aperture; genital aperture positioning dorsolaterally at 57% region of double-somite length. Three free abdominal somites 40, 26, and 35 μm long, respectively. Anal somite unornamented, without any spinules along posteroventral margin. Caudal ramus (Fig. 3C) 3.04 times longer than wide (73 × 24 μm), with 6 setae; outer lateral seta (seta II) positioning 63% region of ramus length. Outer lateral and dorsal setae naked, other 4 setae pinnate.

Rostrum (Fig. 3D) triangular, slightly wider than long, with blunt distal apex. Antennule (Fig. 3E) 303 μm long, 7-segmented; armature formula 4, 13, 6, 3, 4 + aesthetasc, 2 + aesthetasc, and 7 + aesthetasc; all setae naked and thin, several of them very long; terminal segment short, less than half length of penultimate segment. Antenna (Fig. 3F) slender, consisting of coxobasis and 3-segmented endopod; armature formula 1, 1, 2 + claw, and 3 + 4 claws; first endopodal segment ornamented with fine spinules along outer margin and inner seta on this segment small, not extending over distal margin of segment; third endopodal segment 3.65 times longer than wide (62 × 17 μm); claws on distal endopodal segments slender, setiform, geniculate in middle; 4 claws of third endopodal segment consisting of 2 longer (inner second and fourth ones) and 2 shorter ones.

Labrum (Fig. 3G) bearing slightly divergent, rounded posterolateral lobes fringed with membrane flange along posterior and inner margins; posteromedian incision deep. Mandible (Fig. 3H) with curved, elongate distal lash, 1 proximal setiform spine on convex margin of gnathobase, obscure inner proximal notch; concave inner margin with 5 spinules followed by several denticles. Maxillule (Fig. 3I) lobate, with 1 cusp in middle of outer margin, 1 broad, setiform process on inner margin, and distally with 3 setae including vestigial innermost one, other 2 distal ones broad, unilaterally spinulose. Maxilla (Fig. 3J) consisting of syncoxa and basis; syncoxa large, but unarmed; basis with elongate distal lash bearing row of about 14 spines, armed with 3 setae; seta I (inner seta) large, basally broadened, spinulose along both margins; seta II, positioning proximally, about half as long as seta I, finely spinulose along its inner margin; seta III vestigial, obscure. Maxilliped (Fig. 3K) 3-segmented; syncoxa (first segment) unarmed; basis (second segment) armed with 2 large setae, proximal one of them extremely long, directed proximally, about 1.5 times longer than basis, 2.5 times longer than nearby seta; endopod (third segment) small, beak-like, proximally with 1 small spine and 1 small seta.

Legs 1–3 (Fig. 4A–C) with 3-segmented rami. Leg 4 (Fig. 4D) with 3-segmented exopod and 1-segmented endopod. Inner coxal seta pinnate in legs 1–3, but naked, setule-like in leg 4. Outer seta on basis naked in legs 1–4, rudimentary in leg 1, but large in legs 2–4. Leg 4 endopodal segment 3.89 times longer than wide (74 × 19 μm), with 2 distal spines, 1 cusp in middle of outer margin, naked inner margin, and setulose outer margin; 2 distal spines 36 (outer) and 54 (inner) μm long, respectively. Armature formula for legs 1–4 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-1	1-0	I-0; I-1; III, I, 4	0-1; 0-1; I, 1, 4
Leg 2	0-1	1-0	I-0; I-1; III, I, 5	0-1; 0-2; I, II, 3
Leg 3	0-1	1-0	I-0; I-1; III, I, 5	0-1; 0-2; I, II, 2
Leg 4	0-1	1-0	I-0; I-1; II, I, 5	0, II, 0

Leg 5 (Fig. 4E) consisting of 1 dorsolateral seta, 1 lateral spine (37 μm long) and 1 lateral seta (45 μm long); all these 3 elements naked. Leg 6 (Fig. 4E) represented by 2 small setae on genital operculum, proximal longer one of them pinnate.

Male. Unknown.

Etymology. The name of the new species is derived from Latin *angust* (=narrow), depicting its narrow body.

Remarks. The most prominent diagnostic feature of *Pseudanthessius angustus* n. sp. is its possession of a pair of large setae on the basis of the female maxilliped, one of which is longer than the basis. Within the genus *Pseudanthessius*, such a large seta in the same region is evident only in *P. remicaudatus* n. sp. described below and *P. sauvagei* Canu, 1892, which was reported from the North-East Atlantic (Canu, 1892; Sars, 1917). According to illustrations given by Canu (1892) and Sars (1917) for *P. sauvagei*, in the female of this European species (1) the lateral margins of the genital double-somite are smooth, in contrast to the curvy condition in *P. angustus* n. sp., (2) the caudal ramus is about twice as long as wide, while it is 3.04 times as long as wide in *P. angustus* n. sp., (3) the endopodal segment of leg 4 extends beyond the distal margin of the second exopodal segment, while it does not extend beyond the distal margin of the same segment of *P. angustus* n. sp., and (4) the outer distal spine of the endopod of leg 4 is longer than the inner distal spine, whereas the same spine of *P. angustus* n. sp. is shorter than

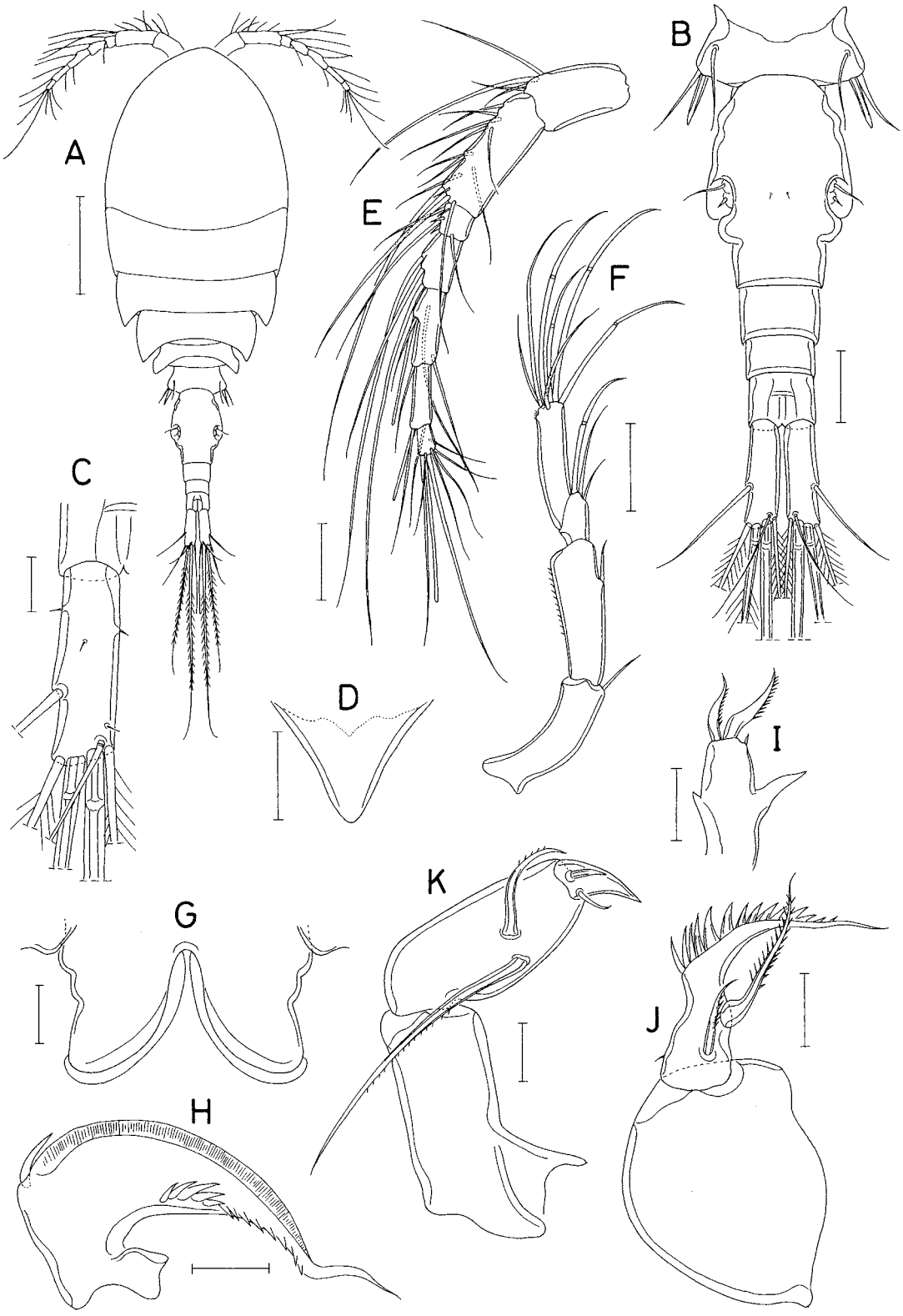

Fig. 3. *Pseudanthessius angustus* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Left caudal ramus, dorsal; D, Rostrum; E, Antennule; F, Antenna; G, Labrum; H, Mandible; I, Maxillule; J, Maxilla; K, Maxilliped. Scale bars: A = 0.2 mm, B, D–F = 0.05 mm, C, G–K = 0.02 mm.

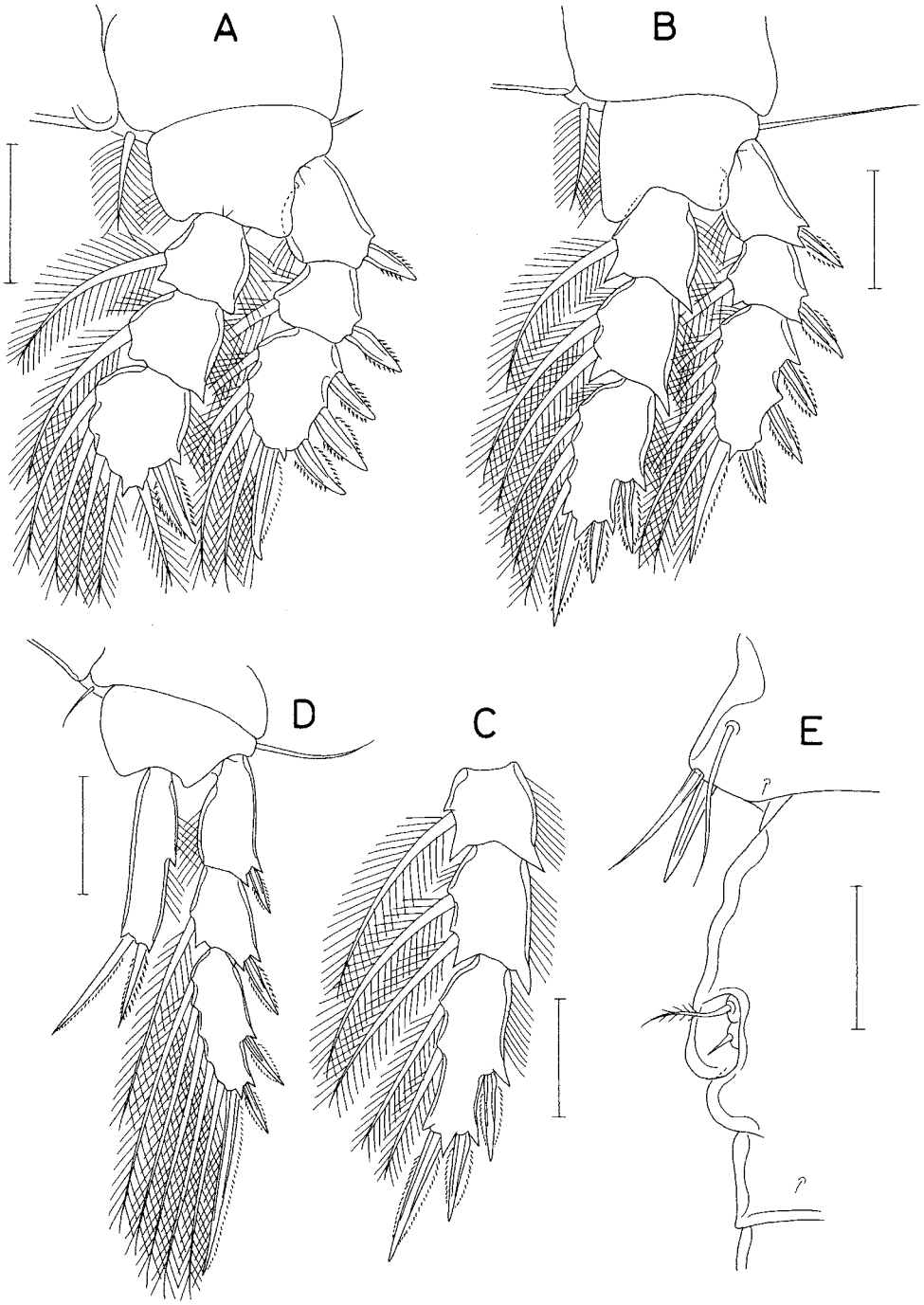

Fig. 4. *Pseudanthessius angustus* n. sp., female. A, Leg 1; B, Leg 2; C, Endopod of leg 3; D, Leg 4; E, Left leg 5 and genital aperture, dorsal. Scale bars: A–E=0.05 mm.

the inner distal spine. These differences indicate that they are not the same species.

A comparison between *P. angustus* n. sp. and *P. remicaudatus* n. sp. will be made in the Remarks section of the latter species.

***Pseudanthessius firmus* n. sp. (Figs. 5, 6)**

Material examined. 2♀♀ from washings of invertebrates, Bohol Island, the Philippines, approximately 09°43′N, 124°32′E, SCUBA, depth 14–26 m, coll. Lee J & Kim IH,

2 Apr 2016. Holotype (♀, MABIK CR00247465) has been deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea. Dissected paratype (♀) is retained in the collection of IHK.

Female. Body (Fig. 5A) stout, with thick, firm exoskeleton. Body length 1.40 mm. Prosome broad, 893 × 653 μm. Prosomal somites with blunt or round posterolateral corners. Cephalothorax divisible into cephalosome and first pedigerous somite by weak dorsal suture line. Urosome (Fig. 5B) 5-segmented, curved dorsally. Fifth pedigerous somite 179 μm wide. Genital double-somite slightly wider than long (147 × 157 μm), narrower than fifth pedigerous somite, consisting of slightly expanded anterior half and narrower posterior half; genital apertures positioning dorsolaterally at 53% region of double-somite length. Three free abdominal somites 45 × 116, 34 × 110, and 68 × 106 μm, respectively. Anal somite unornamented, twice longer than second free abdominal somite. Caudal ramus slightly divergent; each ramus (Fig. 5B) 3.65 times longer than wide (157 × 43 μm), with parallel lateral margins, armed with 7 setae, including vestigial, setule-like seta I; seta II naked, positioning subdistally.

Rostrum (Fig. 5C) semicircular, strong. Antennule (Fig. 5D) 303 μm long, 7-segmented; armature formula 4, 13, 6, 3, 4 + aesthetasc, 2 + aesthetasc, and 7 + aesthetasc; 2 terminal segments short, each wider than long, less than half as long as fifth segment. Antenna (Fig. 5E) 4-segmented; armature formula 1, 1, 3, and 3 + 3 claws; setae on coxobasis and first endopodal segment very small; one of setae on second endopodal segment elongated, extending beyond distal margin of third endopodal segment, peculiarly tipped with adhesion pad (Fig. 5F); third endopodal segment 4.08 times longer than wide (98 × 24 μm), claws unequal, lacking annulation, outermost one of them recurved in distal part, hook-like (Fig. 5F).

Labrum (Fig. 5G) with semicircular, rounded posterolateral lobes bearing fine spinules along their inner margin; posteromedial incision deep. Mandible (Fig. 5H) with elongate, finely spinulose distal lash; convex outer margin of gnathobase toothed, with numerous denticles, proximalmost one of them pale, transparent; inner margin short, densely spinulose, with about 15 spinules; inner proximal notch shallow, indistinct. Maxillule (Fig. 5I) with 4 setae (2 apical, 1 subdistal, and 1 on inner margin); subdistal seta the largest, finely spinulose, other 3 setae naked. Maxilla (Fig. 5J) with unarmed syncoxa; basis with extremely long distal lash bearing 2 rows of spinules along outer margin and fine setules along inner margin and armed with 1 feebly pinnate anterior seta (seta II); setae I and III absent. Maxilliped (Fig. 6A) robust, strongly curved between first and second segments, 3-segmented; syncoxa (first segment) much broader than long, unarmed; basis (second segment) with 2 small setae and spinules on inner margin; endopod (third segment) elongated, tapering, spiniform in distal region bearing densely arranged spinules along inner margin, proximally armed with 1 spine and 1 seta.

Legs 1–3 (Fig. 6B–D) with 3-segmented rami. Leg 4 with 3-segmented exopod and 1-segmented endopod. Inner coxal seta of leg 4 rudimentary. Outer seta on basis naked in all swimming legs. All other setae of these legs pinnate. Endopodal segment of leg 4 about 3 times longer than wide (91 × 30 μm), with smooth inner and outer margins lacking setules or cusp; 2 distal spine 41 (outer) and 83 μm (inner), respectively. Outer spine on first exopodal segment of leg 1 longer than other outer spines on exopods. Armature formula for legs 1–4 as in *P. angustus* n. sp.

Leg 5 (Fig. 6F) consisting of 2 setae and 1 spine; dorsolateral seta pinnate; lateral spine short, 26 μm long, and naked lateral seta 50 μm long. Leg 6 (Fig. 6F) consisting of 1 pinnate seta, 1 small, naked seta, and 1 small cusp on genital operculum.

Male. Unknown.

Etymology. The new species has the thick, firm exoskeleton, hence its name.

Remarks. The peculiar armature condition of the antenna alone may characterize *P. firmus* n. sp., in which one of setae on the second endopodal segment is elongated and tipped with an adhesion pad and one of three distal claws on the third endopodal segment is modified to a hook, as described above. This armature condition of the antenna has not yet been found in *Pseudanthessius*.

As another remarkable morphological feature of *P. firmus* n. sp., its maxilla does not have the inner seta (seta I) on the basis. Within the genus, nine species have been reported to exhibit the same feature: *P. exilicornis* Stock & Humes, 1995; *P. implanus* Humes, 1977; *P. pectinifer* Stock, Humes & Gooding, 1964; *P. pictus* Humes, 1977; *P. procurrens* Humes, 1966; *P. pusillus* Humes, 1969; *P. spinosus* Shin & Kim, 2004; *P. vinnulus* Humes, 1977; and *P. weberi* Scott A., 1909 (A. Scott, 1909; Stock et al, 1964; Humes, 1966, 1969, 1977; Stock and Humes, 1995; Shin and Kim, 2004). Interestingly, most of these nine species are associated with echinoids (except for *P. weberi*, which was found from washings of invertebrates), although another six species associated with echinoids possess the usual maxillary armature. All of the above nine species lack a claw on the second endopodal segment of the antenna and two or three (less than four) terminal claws on the antenna, and a plain, unmodified anterior seta (seta II) on the maxillary basis.

Three of the above nine species, *P. procurrens*, *P. vinnulus*, and *P. weberi*, are comparable with *P. firmus* n. sp., because they have similar length/width ratios (a range between 3.0

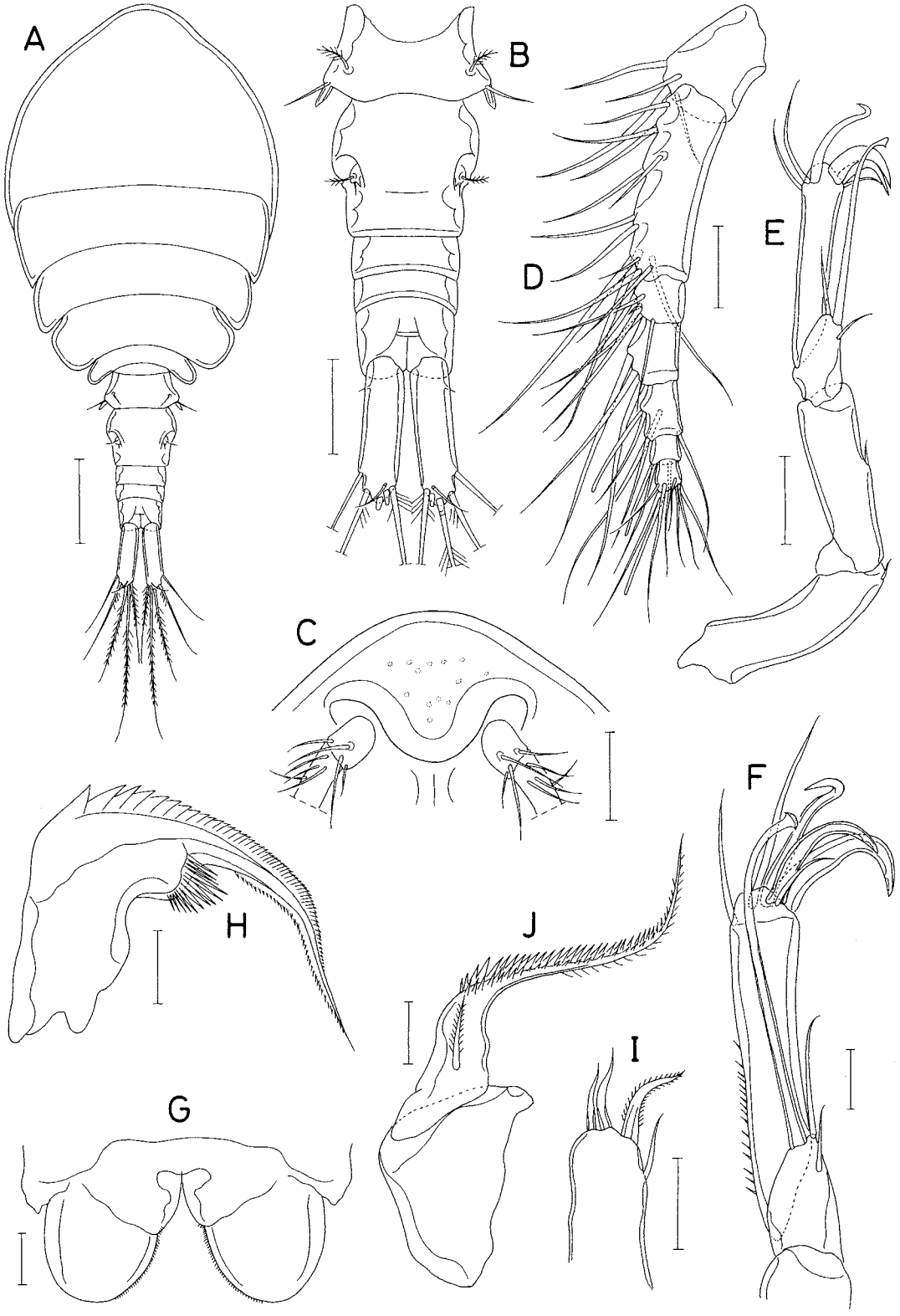

Fig. 5. *Pseudanthessius firmus* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Rostral area, ventral; D, Antennule; E, Antenna; F, Distal part of antenna; G, Labrum; H, Mandible; I, Maxillule; J, Maxilla. Scale bars: A=0.2 mm, B, C=0.1 mm, D, E=0.05 mm, F–J=0.02 mm.

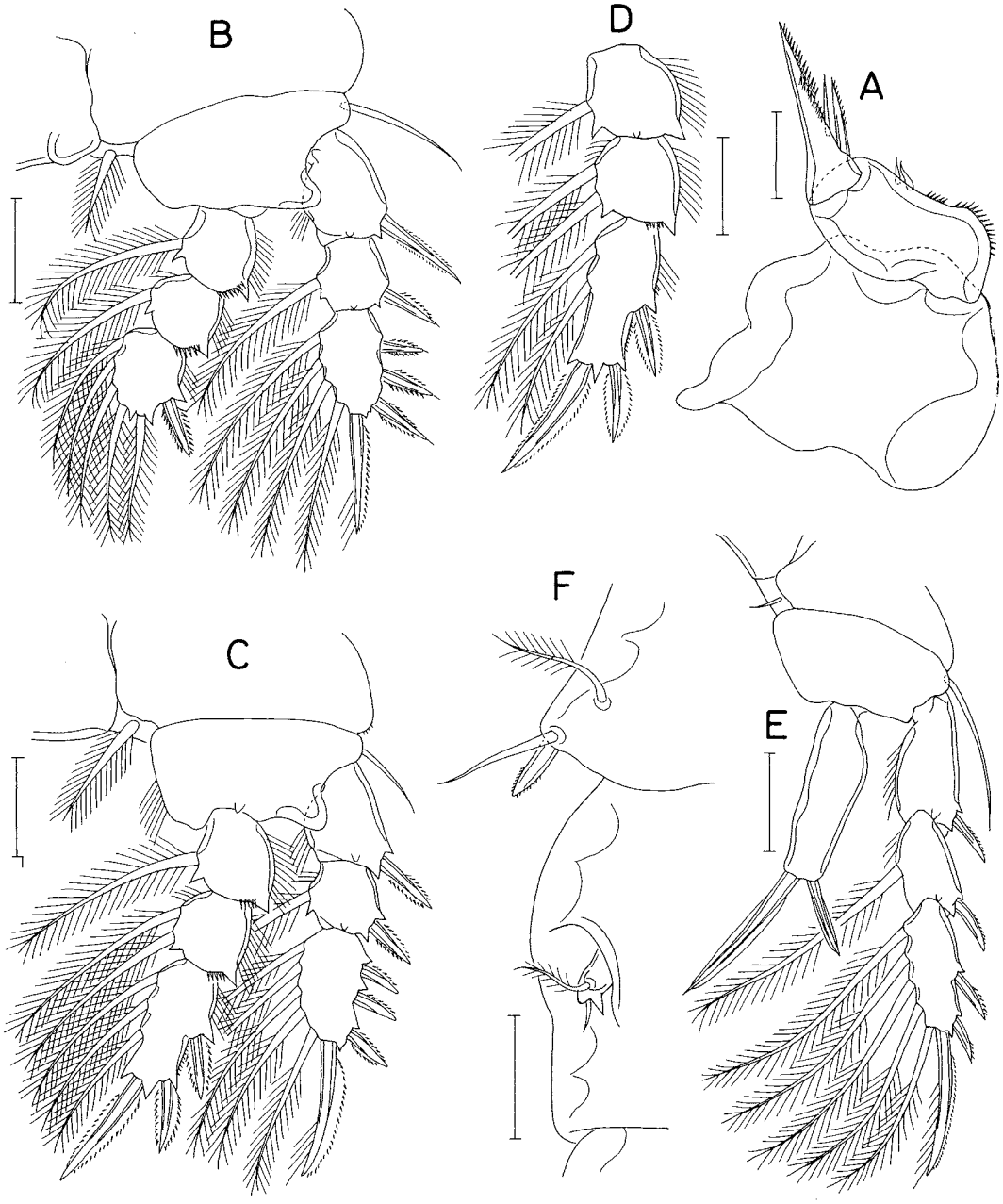

Fig. 6. *Pseudanthessius firmus* n. sp., female. A, Maxilliped; B, Leg 1; C, Leg 2; D, Endopod of leg 3; E, Leg 4; F, Left leg 5 and genital aperture, dorsal. Scale bars: A=0.02 mm, B–F=0.05 mm.

and 5.0) of caudal rami. *Pseudanthessius firmus* n. sp. can be easily distinguished from these three species by its robust female maxilliped and other differences, in addition to the characteristic armature of the antenna.

***Pseudanthessius ardius* n. sp. (Figs. 7, 8)**

Material examined. 1♀ (holotype, MABIK CR00247466) from washings of invertebrates, SCUBA, depth 15–30 m, Anda, Bohol, the Philippines, 09°43′11″N, 124°32′43″E, coll. Lee J & Kim IH, 1 Apr 2016. Holotype (dissected and mounted on a slide) has been deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea.

Female. Body (Fig. 7A) slender. Body length 818 μm. Prosome 488 μm long. Cephalothorax longer than wide (336×258 μm). Posterolateral corners angular in second

pedigerous somite, but blunt or rounded in other prosomal somites. Urosome (Fig. 7B) 5-segmented. Fifth pedigerous somite 85 μm wide. Genital double-somite 1.51 times longer than wide (136 × 90 μm), consisting of broader anterior 70% and narrower posterior 30%, with widest angular region at 60% of double-somite length, another angular region at 72% of double-somite length; genital apertures positioning dorsolaterally at 56% region of double-somite length, slightly anterior to widest region. Three free abdominal somites 29 × 44, 20 × 42, and 35 × 40 μm, respectively. Anal somite with row of fine spinules along posteroventral margin (Fig. 7C); anal aperture large. Caudal ramus (Fig. 7C) 5.25 times longer than wide (84 × 16 μm), slightly broadening distally, armed with 6 setae, ornamented with row of fine spinules along posteroventral margin; outer seta (seta II) spiniform, tipped with seta, positioning 53% region of ramus length.

Rostrum (Fig. 7D) narrow, longer than wide, tapering, with blunt distal apex. Antennule (Fig. 7E) 209 μm long, 7-segmented; armature formula 4, 13, 6, 3, 4 + aesthetasc, 2 + aesthetasc, and 7 + aesthetasc; all setae naked; terminal segment about 0.7 times as long as penultimate segment. Antenna (Fig. 7F) 4-segmented, consisting of coxobasis and 3-segmented endopod; armature formula 1, 1, 2 + claw, and 3 + 4 claws; all claws slender, setiform, geniculate near middle; terminal segment 2.72 times longer than wide (49 × 18 μm), gradually broadening distally.

Labrum (Fig. 7G) with elongate, slightly divergent posterolateral lobes bearing membranous flange along their distal margin. Mandible (Fig. 7H) with arched, tapering gnathobase bearing distally pointed, leaf-like outer scale, smooth convex margin, 8 spinules along concave margin; proximal part with incomplete suture line; inner proximal notch obscurely defined. Maxillule (Fig. 7I) with 4 setae, 1 on inner margin and 3 on distal margin; 2 distal outer ones of them larger than other 2, spinulose along distal half of their inner margin. Maxilla (Fig. 7J) consisting of syncoxa and basis; syncoxa unarmed; basis with 3 setae, 4 distal spines (3 strong ones on convex margin and 1 smaller one on anterior margin), and long, slender distal lash; inner seta (seta I) curved, strong, not flexible, with fine spinules along its distal half; anterior seta (seta II) proximally broadened, with 5 minute spinules; outer proximal seta (seta III) vestigial, thin, needle-like; distal lash, as long as proximal part of basis, spinulose along both margins. Maxilliped (Fig. 8A) 3-segmented; syncoxa (first segment) the longest but unarmed; basis (second segment) slightly expanded near middle, armed with 1 spine and 1 seta; endopod (third segment) claw-like, evenly tapering, spinulose along distal half, proximally armed with 1 spinulose spine and 1 small seta.

Legs 1−3 (Fig. 8B−D) with 3-segmented rami. Leg 4 (Fig. 8E) with 3-segmented exopod and 1-segmented endopod. Inner coxal seta well-developed, pinnate in legs 1−3, but small, naked in leg 4. Outer seta on basis naked in legs 1−4. Leg 3 different from leg 2 in having 3 spines and 2 setae (Fig. 8D) on third endopodal segment and distinctly longer outer seta on basis. Endopodal segment of leg 4 (Fig. 8E) 3.93 times longer than wide (55 × 14 μm), extending to distal margin of second exopodal segment, pinnate along its outer margin bearing 1 small cusp near middle, several spinules on distal margin; 2 distal spines 43 (outer) and 47 μm (inner), respectively. Armature formula for legs 1−4 as in *P. angustus* n. sp.

Leg 5 (Fig. 8F) consisting of 1 dorsolateral seta, and 1 spine (31 μm long) and 1 seta (28 μm long) on lateral apex of fifth pedigerous somite. Leg 6 (Fig. 8F) represented by 1 pinnate seta, 1 small cusp, and 1 modified seta (spiniform, bearing 1 subdistal setule).

Male. Unknown.

Etymology. The name of the new species is derived from the Greek *ard* (=a point), alluding to the presences of a small point on the outer margin of leg 4 endopod.

Remarks. The caudal rami of *P. ardius* n. sp. is 5.25 times longer than wide in the female. Seven congeners are known to have similar length/width ratios (a range of ratios from 4.5 to 6.5) of the caudal rami: *P. gracilioides* Sewell, 1949, *P. gracilis* Claus, 1889, *P. latus* Illg, 1950, *P. nermertophilus* Gallien, 1936, *P. phuketensis* Kim & Hong, 2014, *P. weberi* A. Scott, 1909, and *P. procurrens* Humes, 1966. The first four may be excluded from further comparison with the new species, because they have a stout terminal segment of the antenna, with a length/width ratio less than 2.0 (compared to 2.72 in the new species). The remaining three species can be separated from *P. ardius* n. sp. by their distinguishable features, as follows:

Pseudanthessius phuketensis has numerous spinules along the concave margin of the mandible, three distal spines and distally blunt seta I on the basis of the maxilla, numerous spinules on the inner surface of the basis of the female maxilliped, and one simple, naked spine plus one pinnate seta as the exopod of leg 5 (Kim and Hong, 2014).

Pseudanthessius weberi, which was recorded from a deep water in the depth of 1595 m in the Banda Sea, has three terminal claws on the antenna, a slender, *Lichomolgus*-type mandible bearing an elongate distal lash, and fine spines on the distal margin of the maxilla (A. Scott, 1909).

Pseudanthessius procurrens has an expanded cephalothorax in the female, a broad rostrum, only two terminal claws on the antenna, a characteristic labrum bearing widely divergent posterolateral lobes, a distinctly denticulate convex margin of the mandible, and numerous spines on the distal margin of the basis of the maxilla (Humes, 1966).

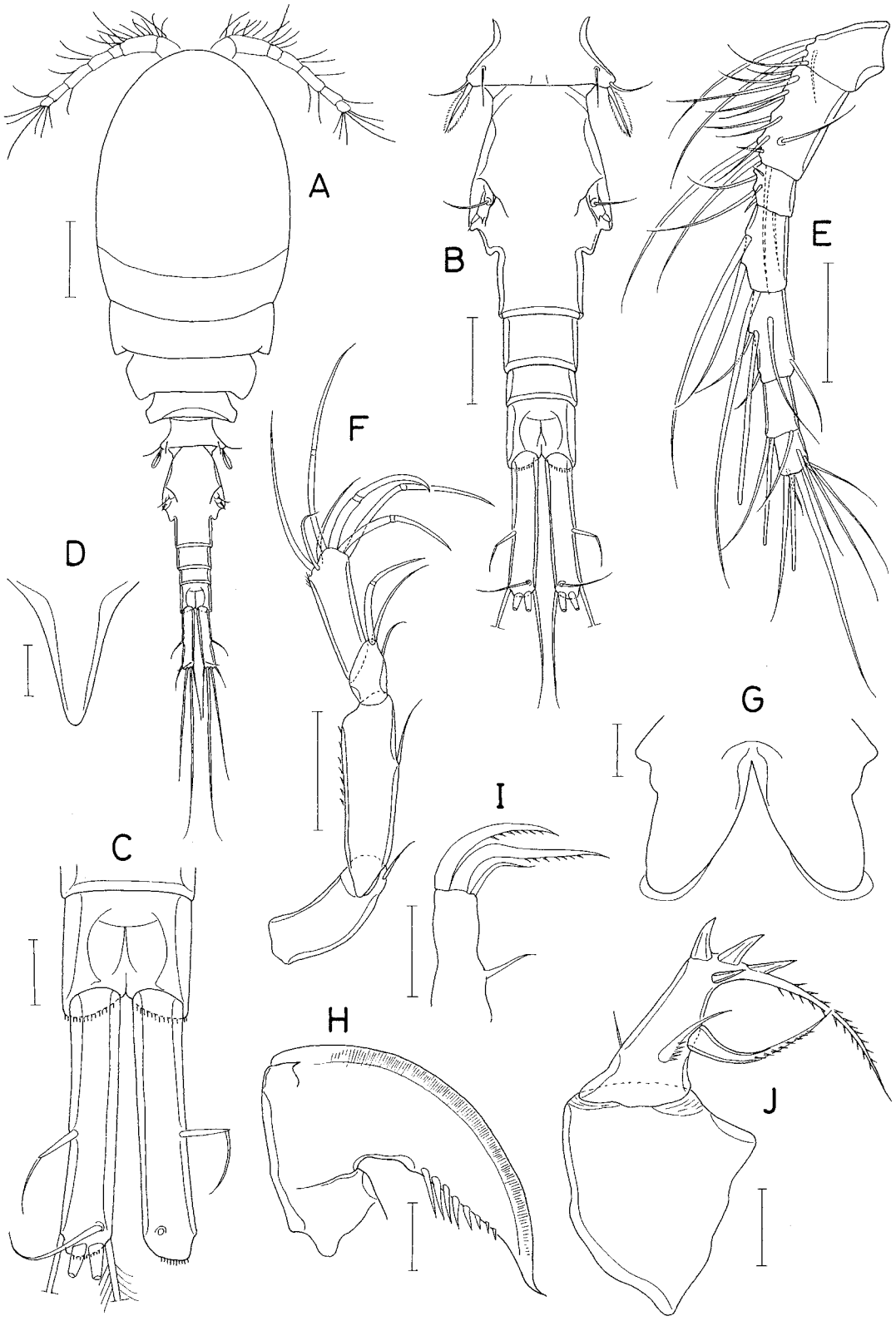

Fig. 7. *Pseudanthessius ardius* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Anal somite and caudal rami, dorsal; D, Rostrum; E, Antennule; F, Antenna; G, Labrum; H, Mandible; I, Maxillule; J, Maxilla. Scale bars: A = 0.1 mm, B, E, F = 0.05 mm, C, D, G–J = 0.02 mm.

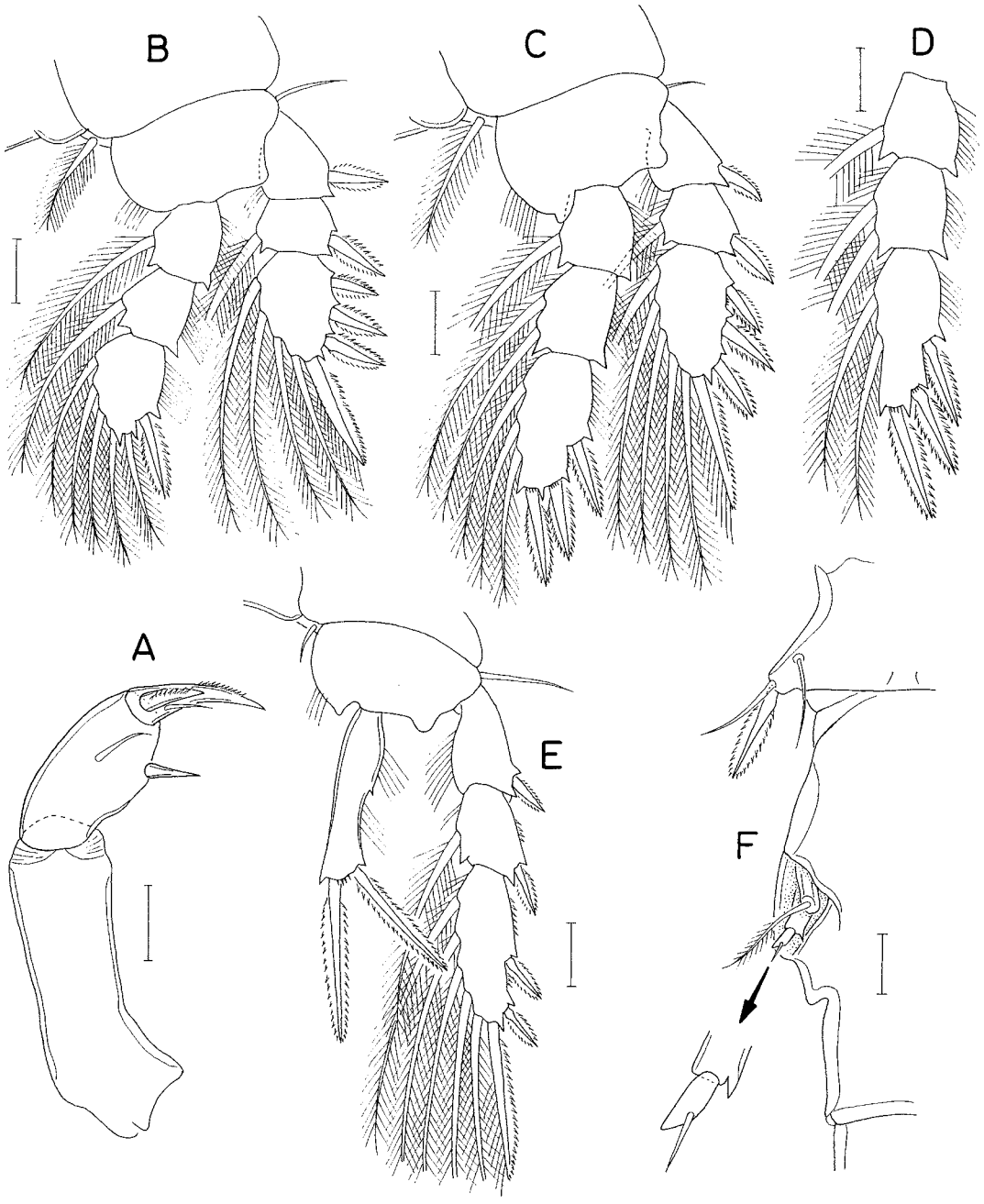

Fig. 8. *Pseudanthessius ardius* n. sp., female. A, Maxilliped; B, Leg 1; C, Leg 2; D, Endopod of leg 3; E, Leg 4; F, Left leg 5 and genital aperture, dorsal. Scale bars: A–F = 0.02 mm.

***Pseudanthessius lativentris* n. sp. (Figs. 9, 10)**

Material examined. 1♀ (holotype, MABIK CR00247467) from washings of invertebrates, SCUBA, depth 15–25 m, Samar Island, the Philippines, 11°15′07.31″N, 125° 34′04.78″E, coll. Park SI, 24 Feb 2017. Holotype (dissected and mounted on a slide) has been deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea.

Female. Body (Fig. 9A) flattened. Body length 1.27 mm. Prosome broad, 770 μm long, occupying about 61% of body length, consisting of cephalosome and well-defined 4 pedigerous somites. Cephalosome 400 × 594 μm. Urosome (Fig. 9B) 5-segmented. Fifth pedigerous somite 209 μm wide, tapering laterally. Genital double-somite markedly

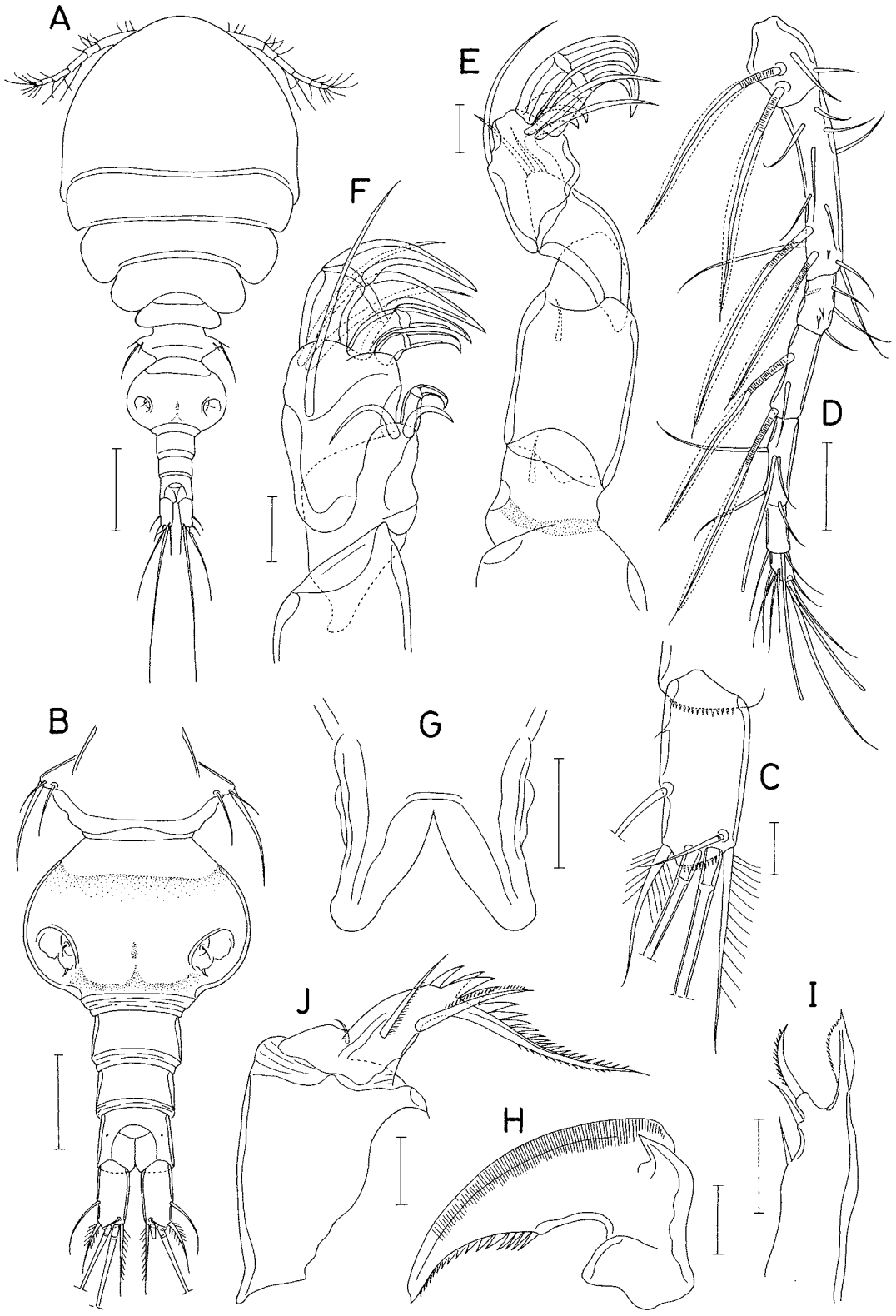

Fig. 9. *Pseudanthessius lativentris* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Left caudal ramus, dorsal; D, Antennule; E, Antenna; F, Distal segments of antenna; G, Labrum; H, Mandible; I, Maxillule; J, Maxilla. Scale bars: A=0.2 mm, B=0.1 mm, C, H–J=0.02 mm, D–G=0.05 mm.

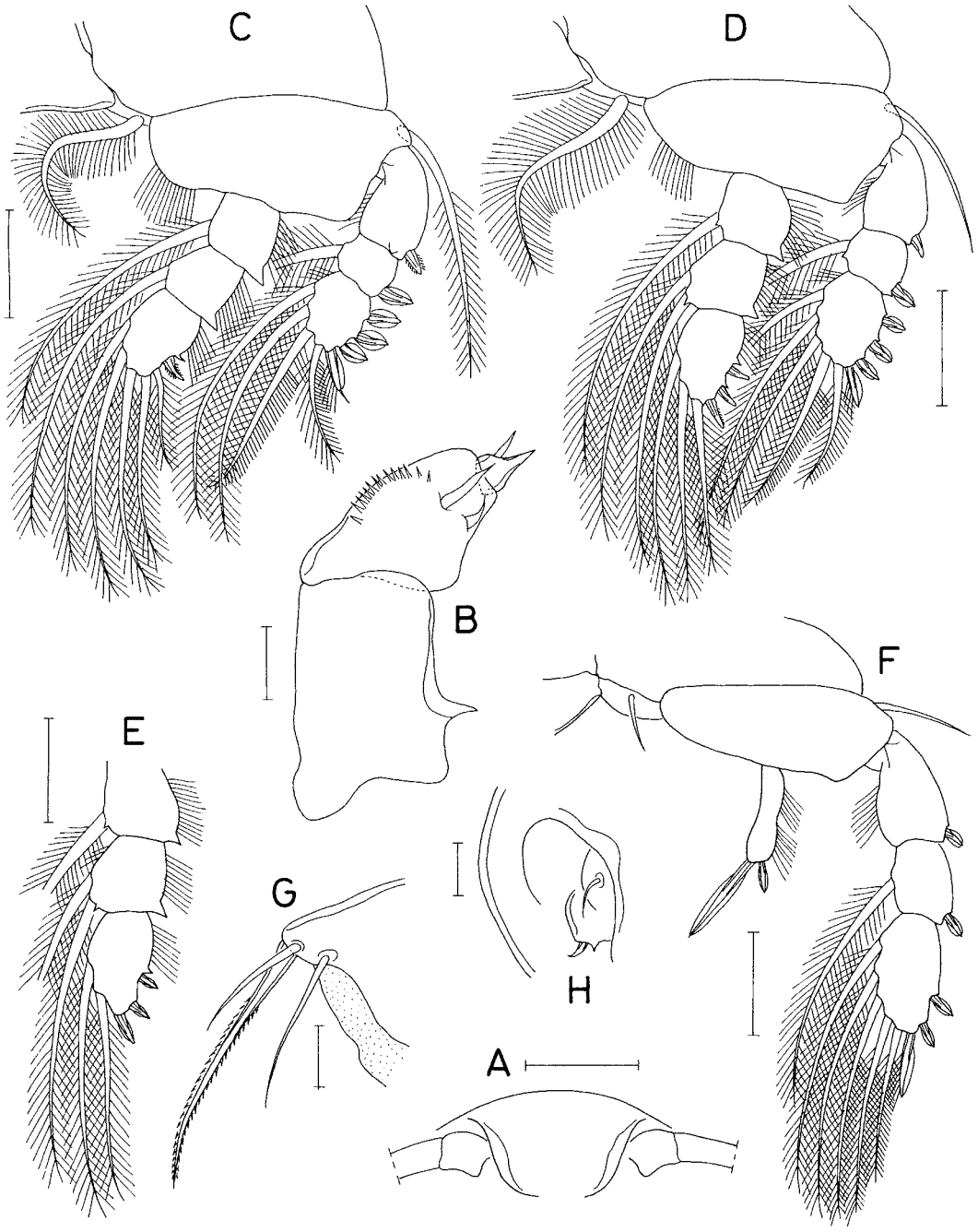

Fig. 10. *Pseudanthessius lativentris* n. sp., female. A, Rostral area, ventral; B, Maxilliped; C, Leg 1; D, Leg 2; E, Endopod of leg 3; F, Leg 4; G, Left leg 5, dorsal; H, Left genital aperture, dorsal. Scale Bars: A, C–G=0.05 mm, B, H=0.02 mm.

expanded, 1.29 times wider than long (190×245 μm), with strongly convex, rounded lateral margins; genital aperture positioning dorsally, at 65% region of double-somite length. Three free abdominal somites 56×95, 48×83, and 57×82 μm, respectively. Anal somite ornamented with row of fine spinules along posteroventral margin (Fig. 9C), Caudal ramus (Fig. 9C) directed straightly backwards, 2.09 times longer than wide (73×35 μm), armed with 6 setae, ornamented with fine spinules along posteroventral margin; outer lateral seta (seta II) positioning at 60% region of ramus length.

Rostrum (Fig. 10A) broad, but its posterior region fused with ventral surface of cephalosome. Antennule (Fig. 9D) slender, 330 μm long, 7-segmented; armature formula 4, 13, 5, 3, 4+aesthertasc, 2+aesthetasc, and 7+aeshtetasc;

all setae naked, 6 of them (2 on each first, second, and fourth segment) characteristically modified into sword-like elements bearing wrinkled proximal one-fifth and tape-like, membrane-fringed distal four-fifths. Antenna (Fig. 9E, F) robust, 4-segmented; armature formula 1, 1, 2 + claw, and 3 + 4 claws; coxobasis (first segment) short, much wider than long, proximally with horizontal stripe; first endopodal segment (second segment) the longest, about twice longer than wide; second endopodal segment wider than long; third endopodal segment with short inner margin and much longer outer margin; 4 distal claws geniculate, comprising 2 strong, massive outer ones (these claws longer than segment) and 2 smaller inner ones.

Labrum (Fig. 9G) strongly sclerotized, with slightly divergent, tapering posterolateral lobes bearing blunt distal apex; posteromedian incision deep. Mandible (Fig. 9H) with 1 tapering, pointed tooth-like outer scale; gnathobase tapering, with smooth convex margin and more than 10 spinules along inner margin. Maxillule (Fig. 9I) with 4 setae; inner and inner subdistal setae small, simple; inner distal seta spinulose along its inner margin, mounted on digitiform process; outer distal seta foliaceous, not articulated at base. Maxilla (Fig. 9J) with unarmed syncoxa; basis with 3 setae and elongate distal lash; outer margin distal lash bearing about 20 spinules, second and third ones of them overlapped; inner seta (seta I) slender, finely spinulose along outer margin; anterior seta (seta II) also slender, finely spinulose along inner margin; seta III rudimentary. Maxilliped (Fig. 10B) 3-segmented; first segment (syncoxa) the longest but unarmed; second segment (basis) narrowing distally, with 2 simple setae of unequal lengths, ornamented with longitudinal row of spinules; third segment (endopod) small, pointed at tip, with 1 simple seta proximally.

Legs 1–3 (Fig. 10C–E) with 3-segmented rami. Leg 4 (Fig. 10F) with 3-segmented exopod and 1-segmented endopod. Inner coxal seta well-developed, pinnate in legs 1–3, but small and naked in leg 4. Outer seta on basis large, pinnate in leg 1, but shorter, naked in legs 2–4. Spines on these legs remarkably small. Endopodal segment of leg 4 small, 47 × 15 μm, setulose along its outer margin; 2 distal spines very unequal, 15 (outer) and 48 μm (inner) long. Armature formula for legs 1–4 as in *P. angustus* n. sp.

Leg 5 (Fig. 10G) represented by 3 lateral setae on fifth pedigerous somite, largest apical one of which spiniform, spinulose, 92 μm long. Leg 6 (Fig. 10H) represented by 1 small seta, 1 small spine, and 1 cusp on genital operculum.

Male. Unknown.

Etymology. The specific name *lativentris* is the combination of Latin words *lat* (=broad) and *vent* (=belly), referring to the broad genital double-somite in the female.

Remarks. Two diagnostic features characterize *P. lativentris* n. sp. The first is the presence of the six modified setae on the antennule, which are large, sword-like, with membrane-fringed margins. Inasmuch as this form of setae has not been reported in the genus thus far, the new species can be easily recognized by this feature alone. As the second diagnostic feature of the new species, its antenna is robust and distally armed with two massive and two smaller claws. About half of existing *Pseudanthessius* species have four distal claws on the antenna. The size combinations of these claws are variable with species and the combination of the two massive (thicker and longer) and two smaller (shorter and narrower) claws appears to be unique to the new species.

Pseudanthessius remicaudatus n. sp. (Figs. 11–13)

Material examined. 4♀♀, 1♂ from washings of echinoids, west coast of Phu Quoc Island, Vietnam, SCUBA, coll. Shin S, 25 Jan 2018. Holotype (♀, MABIK CR00247468) and paratypes (2♀♀, MABIK CR00247469) have been deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea. Dissected paratypes (1♀, 1♂) are retained in the collection of IHK.

Female. Body (Fig. 11A, B) narrow. Length 1.36 mm. Prosome 848 μm long, expanded dorsally. Cephalothorax 630 × 467 μm. Dorsal suture line discernible between cephalosome and first pedigerous somite. Second to fourth pedigerous somites with acutely pointed posterolateral corners. Urosome (Fig. 11C) 5-segmented, slender, curved dorsally (Fig. 11B). Fifth pedigerous somite 79 × 161 μm, much broader than genital double-somite. Genital double-somite 1.77 times longer than wide (205 × 116 μm), with slightly expanded anterior part, widest at 35% region of double-somite length; genital apertures positioning dorsolaterally at widest region of double-somite. Three free abdominal somites 74 × 89, 41 × 93, and 41 × 95 μm, respectively. Anal somite as long as pre-anal somite, unornamented. Caudal ramus (Fig. 11D) broad, flattened, oar-like, 1.60 times longer than wide (85 × 53 μm), about twice longer than anal somite, armed with 6 setae; outer lateral seta (seta II) stiff, naked, positioning subdistally; 4 distal setae pinnate; dorsal seta (seta VII) small, naked.

Rostrum (Fig. 11E) strongly tapering, as long as wide, with rounded distal apex. Antennule (Fig. 11F) 256 μm long, 7-segmented, gradually narrowing distally; armature formula 4, 13, 6, 3, 4 + aesthetasc, 2 + aesthetasc, and 7 + aesthetasc; larger setae bearing numerous horizontal clefts. Antenna (Fig. 11G) 4-segmented; armature formula 1, 1, 2 + claw, and 3 + 4 claws; first endopodal segment (second segment) the longest, gradually broadening distally, with pointed outer distal corner; claw on second endopodal segment strong, extending beyond distal margin of third endopodal segment;

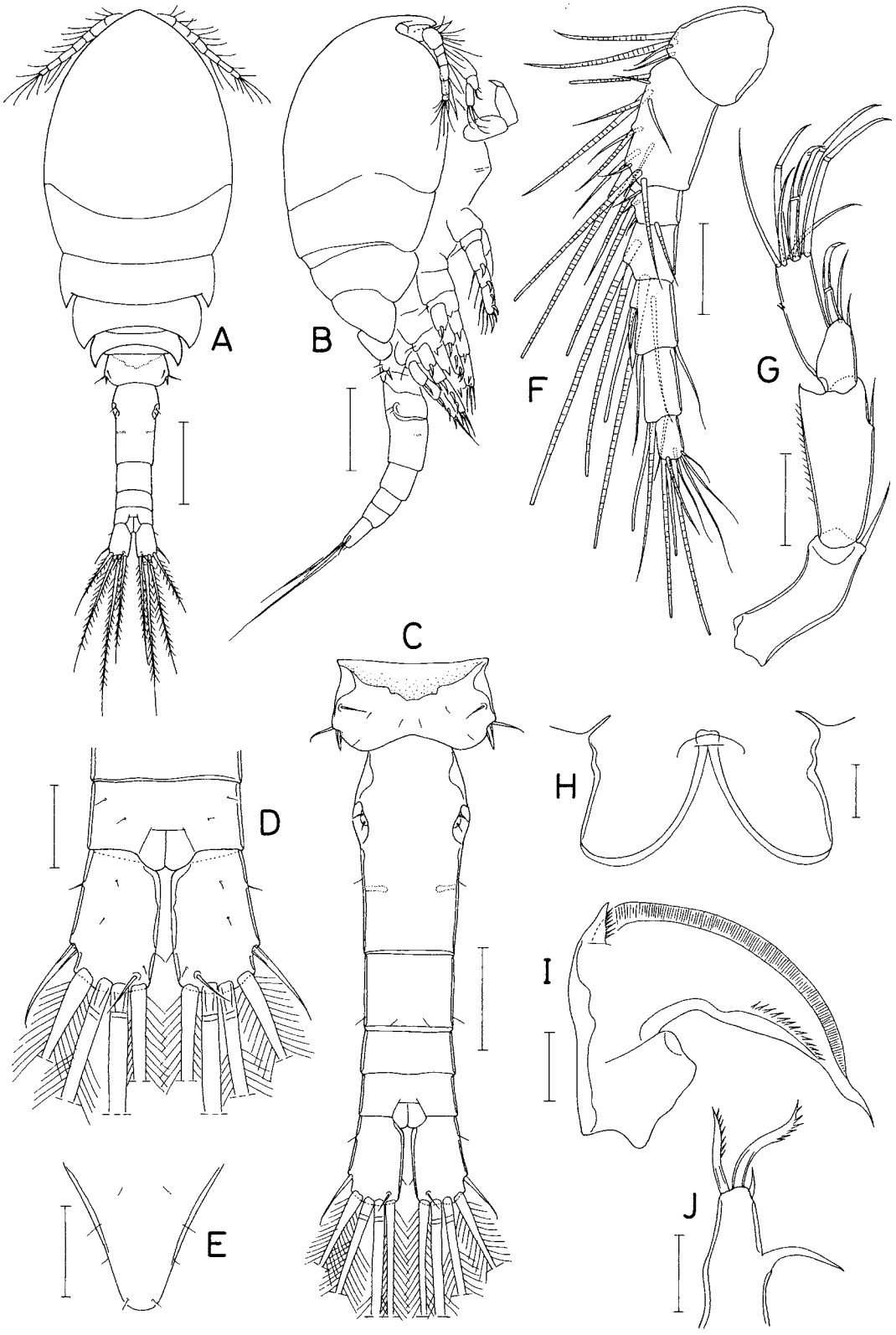

Fig. 11. *Pseudanthessius remicaudatus* n. sp., female. A, Habitus, dorsal; B, Habitus, right; C, Urosome, dorsal; D, Anal somite and caudal rami, dorsal; E, Rostrum; F, Antennule; G, Antenna; H, Labrum; I, Mandible; J, Maxillule. Scale bars: A, B=0.2 mm, C=0.1 mm, D–G=0.05 mm, H–J=0.02 mm.

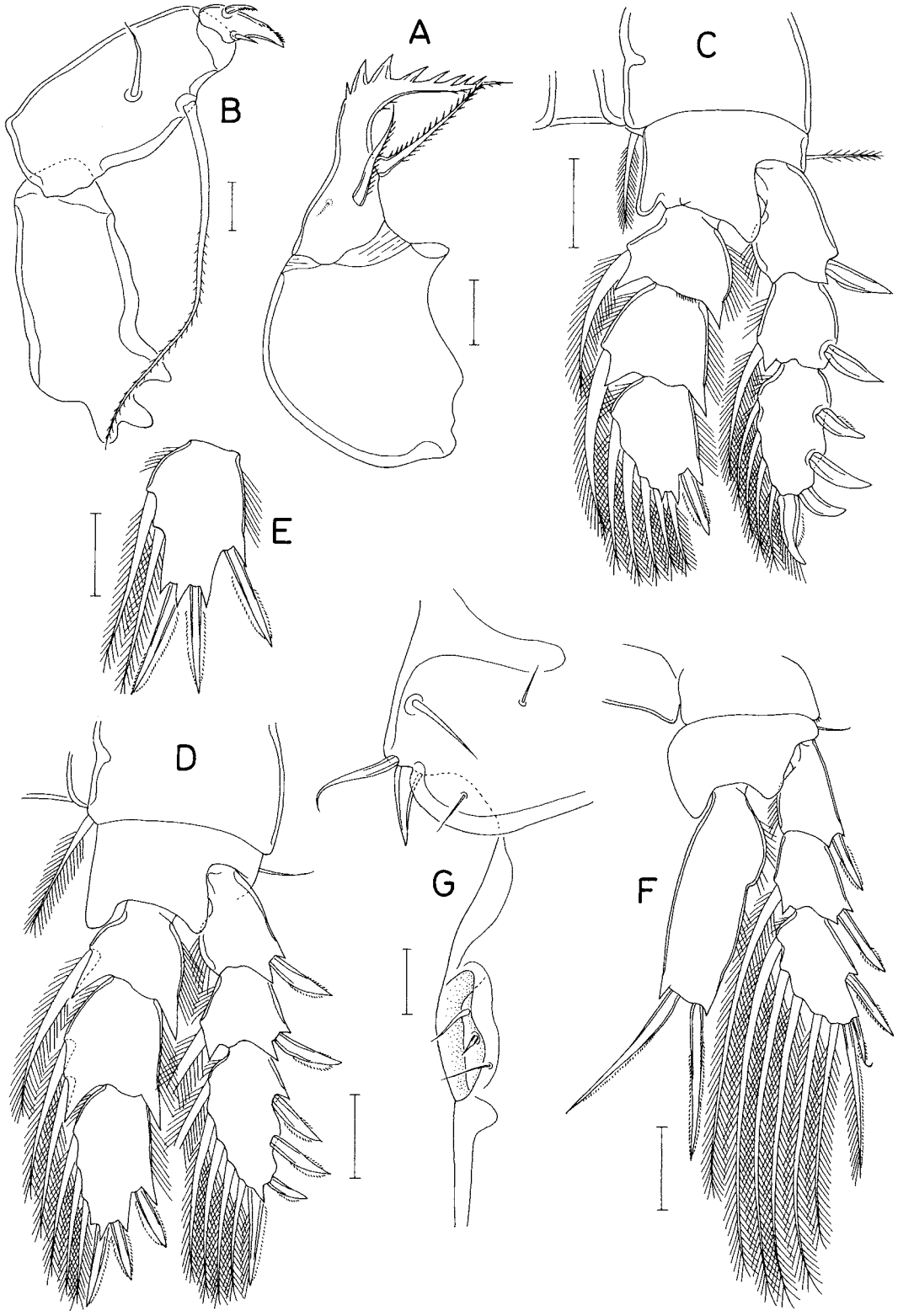

Fig. 12. *Pseudanthessius remicaudatus* n. sp., female. A, Maxilla; B, Maxilliped; C, Leg 1; D, Leg 2; E, Third endopodal segment of leg 3; F, Leg 4; G, Left leg 5 and genital aperture, dorsal. Scale bars: A, B = 0.02 mm, C–G = 0.05 mm.

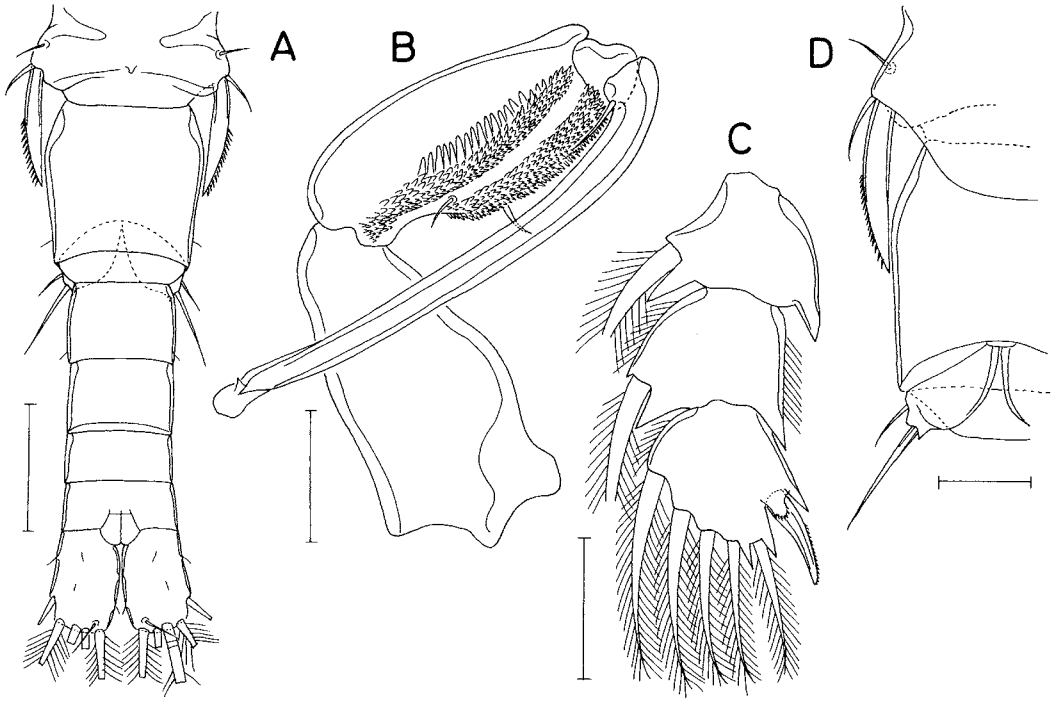

Fig. 13. *Pseudanthessius remicaudatus* n. sp., male. A, Urosome, dorsal; B, Maxilliped; C, Endopod of leg 1; D, Right leg 5 and genital operculum, ventral. Scale bars: A=0.1 mm, B–D=0.05 mm.

third endopodal segment 2.45 times longer than wide (54×22 μm); 4 distal claws slender, consisting of 2 longer, setiform inner ones and 2 shorter outer ones.

Labrum (Fig. 11H) with slightly divergent, moderately elongated posterolateral lobes. Mandible (Fig. 11I) with tapering gnathobase bearing short distal lash, 1 triangular, lamellate outer scale bearing several spinules along its inner margin, row of more than 10 minute spinules along subdistal part of inner margin. Maxillule (Fig. 11J) with 1 setiform process on inner margin and 3 unequal setae distally; inner distal seta small, naked; 2 outer distal setae spinulose along their inner margin. Maxilla (Fig. 12A) with unarmed syncoxa; basis (second segment) with 3 setae and short distal lash; inner seta (seta I) thin, spinulose along both margins; anterior seta (seta II) also thin, pinnate along inner margin; outer proximal seta (seta III) vestigial; outer margin of distal lash with 7 or 8 teeth, proximal 1 or 2 of them smaller than next tooth. Maxilliped (Fig. 12B) 3-segmented; syncoxa (first segment) unarmed; basis (second segment) slightly inflated in middle, with 2 extremely unequal setae, shorter one 34 μm long, naked, and longer one 160 μm long, about 4.7 times longer than shorter seta, about 1.4 times longer than basis; endopod (third segment) small, tapering, proximally with 1 small spine and 1 small seta, ornamented with row of minute spinules along distal third.

Legs 1–3 with 3-segmented rami. Leg 4 (Fig. 12F) with 3-segmented exopod and 1-segmented endopod. Endopods broader than exopods (Fig. 12C, D, F). Inner coxal seta lacking in leg 4. Leg 3 similar to leg 2, except bearing 3 spines and 2 setae on third endopodal segment (Fig. 12E). Endopodal segment of leg 4 large, 2.89 times longer than wide (133×46 μm), extending to subdistal region of third exopodal segment, slightly expanded along proximal third; 2 distal spines slender, subequal in length 94 (outer) and 98 (inner) μm, respectively. Second outer spine on third exopodal segment of leg 4 much shorter than the first. Armature formula for legs 1–4 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-1	1-0	I-0; I-1; III, I, 4	0-1; 0-1; I, 1, 4
Leg 2	0-1	1-0	I-0; I-1; III, I, 5	0-1; 0-2; I, II, 3
Leg 3	0-1	1-0	I-0; I-1; III, I, 5	0-1; 0-2; I, II, 2
Leg 4	0-0	1-0	I-0; I-1; II, I, 5	0, II, 0

Leg 5 (Fig. 12G) consisting of dorsolateral seta and apical spine (25 μm long) and seta (32 μm long) on fifth pedigerous somite; apical spine stout, unornamented. Leg 6 (Fig. 12G) represented by 1 small seta and 1 minute spine on genital operculum.

Male. Body resembling that of female. Length 1.05 mm. Urosome (Fig. 13A) 6-segmented. Fifth pedigerous somite

162 μm wide. Genital somite longer than wide (141 × 127 μm), nearly quadrangular. Four abdominal somites 61 × 85, 56 × 83, 40 × 88, and 38 × 91 μm, respectively. Caudal ramus 1.49 times longer than wide (79 × 53 μm).

Rostrum, antennule, antenna, and mouthparts as in female, except for maxilliped. Maxilliped (Fig. 13B) consisting of 3 segments and terminal claw; syncoxa (first segment) tapering distally, unarmed; basis (second segment) as long as syncoxa, with 2 small, simple setae, ornamented with numerous spinules on inner surface; small endopod (third segment) unarmed; terminal claw elongate, bearing 1 small seta proximally.

Leg 1 slightly different from that of female; its third endopodal segment with small serrate lobe near base of outer distal spine (Fig. 13C); latter spine slightly curved. Legs 2–4 as in female.

Leg 5 (Fig. 13D) as in female, but distal spine enlarged, broad, 91 μm long, spinulose along distal half of its outer margin; apical seta 39 μm long. Leg 6 (Fig. 13D) represented by 2 very unequal setae on genital operculum.

Etymology. The name of the new species is derived from Latin words *remus* (=an oar) and *caud* (=the tail). It indicates to the broad, oar-like caudal rami of the new species.

Remarks. As a striking feature of *P. remicaudatus* n. sp., one of two setae on the basis of the female maxilliped is markedly enlarged, longer than the basis. Because this feature is shared only by two congeners, *P. sauvagei* and the above described *P. angustus* n. sp., *P. remicaudatus* n. sp. can be compared only with these two species. These three species are all associated with echinoids and have in common a narrow body, a claw on the second endopodal segment of the antenna, and four slender setiform distal claws on the same appendage. *Pseudanthessius sauvagei* and *P. angustus* n. sp. can be differentiated from *P. remicaudatus* n. sp. by the following features:

In *P. sauvagei*, the posterolateral corners of the second to fourth pedigerous somites are blunt (Sars, 1917), the mandible appears to have no outer scale, as illustrated by Canu (1892) and Sars (1917), the maxillule is armed only with three distal setae, as illustrated by the both authors, leg 4 has an inner coxal seta (Sars, 1917), and the fifth pedigerous somite is not broader than the genital double-somite, as illustrated by the both authors.

In *P. angustus* n. sp., the caudal ramus of the female is not broadened, 3.04 times longer than wide, the genital apertures are positioned slightly posterior to midlength of the genital double-somite, the outer scale of the mandible is setiform, and the exopodal segment of leg 4 is slender and shorter, extending only to the distal margin of the second exopodal segment.

***Pseudanthessius nodosus* n. sp. (Figs. 14–16)**

Material examined. 1♀ (holotype, MABIK CR00247470) and 1♂ (paratype, MABIK CR00247471) from washings of invertebrates, SCUBA, Phu Quoc Island, Vietnam, 10°18′10.64″N, 103°51′20.18″E, coll. Park SI, 13 Dec 2016. Holotype and paratype (both dissected, each mounted on a slide) have been deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea.

Female. Body (Fig. 14A) with broad prosome and slender urosome. Body length 1.53 mm. Prosome 873 × 698 μm. Dorsal suture line between cephalosome and first pedigerous somite faint. Posterolateral corners of prosomal somites rounded. Urosome (Fig. 14B) 5-segmented. Fifth pedigerous somite 203 μm wide. Genital double-somite slightly longer than wide (227 × 206 μm), consisting of laterally expanded anterior two-thirds and narrower posterior one-third (112 μm wide across this narrower region); genital apertures positioning dorsolaterally at midlength of double-somite. Anterior part of genital double-somite bearing 1 stout, posteriorly directed spine posterolaterally just posterior to genital aperture (Figs. 14B, 15F). Three free abdominal somites 67 × 100, 52 × 94, 76 × 85 μm, respectively. Posterior margin of anal somite fringed with row of small spinules (Fig. 14C). Caudal rami (Fig. 14C) slightly divergent, 5.97 times longer than wide (197 × 33 μm), with 6 setae; outer lateral seta naked, positioning at 58% region of ramus length, outer distal seta (seta III) pinnate along inner margin tipped with setule.

Rostrum (Fig. 14D) triangular, wider than long. Antennule (Fig. 14E) slender, 7-segmented; first 2 segments distinctly broader than distal 5 segments; armature formula 4, 13, 6, 3, 4 + aesthetasc, 2 + aesthetasc, and 7 + aesthetasc; all setae naked and thin, several of them markedly long. Antenna (Fig. 14F) slender, 4-segmented; armature formula 1, 1, 2 + claw, and 3 + 4 claws; third endopodal segment 2.93 times longer than wide (82 × 28 μm); 4 distal claws comprising 3 slender setiform claws (including longest outermost one) and 1 thicker but shortest third inner claw.

Labrum (Fig. 14G) with widely divergent, posteriorly extended posterolateral lobes bearing membranous flange along its inner and distal margins. Mandible (Fig. 14H) with 1 cleft at outer corner, short distal lash, tapering gnathobase bearing naked margins. Maxillule (Fig. 14I) with 4 unequal setae, including small inner margin seta, small inner distal seta, and 2 flattened outer distal setae. Maxilla (Fig. 14J) with unarmed syncoxa; basis terminating in arched distal lash bearing numerous denticles along outer margin and longitudinal row of minute spinules on its anterior surface, and armed with 2 setae; inner seta (seta I) large, strong, spinulose on all surfaces, bluntly tipped; anterior seta (seta II) modified to large, blunt tubercle covered with numerous

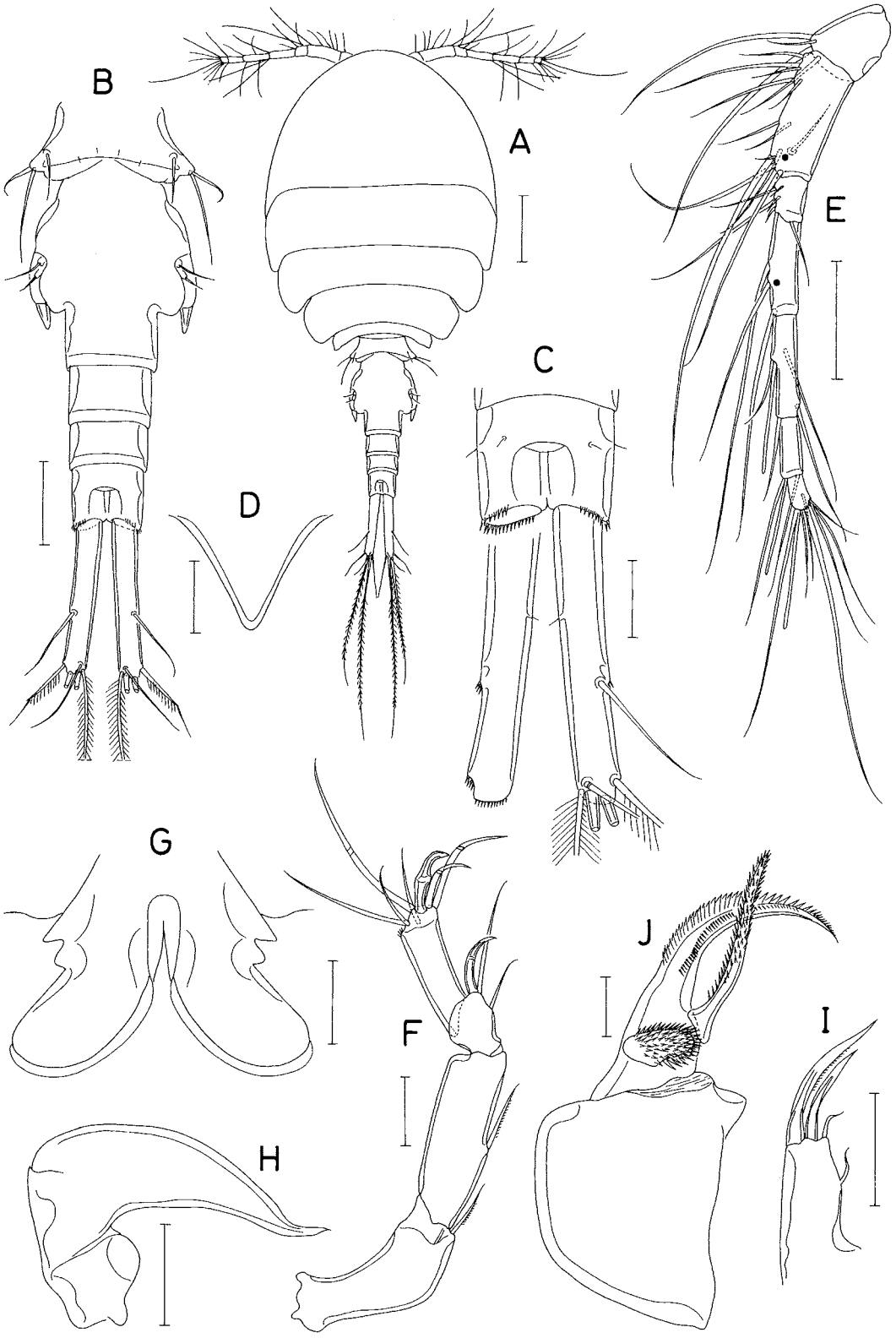

Fig. 14. *Pseudanthessius nodosus* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Anal somite and caudal rami, dorsal; D, Rostrum; E, Antennule; F, Antenna; G, Labrum; H, Mandible; I, Maxillule; J, Maxilla. Scale bars: A=0.2 mm, B, E=0.1 mm, C, D, F–I=0.05 mm, J=0.02 mm.

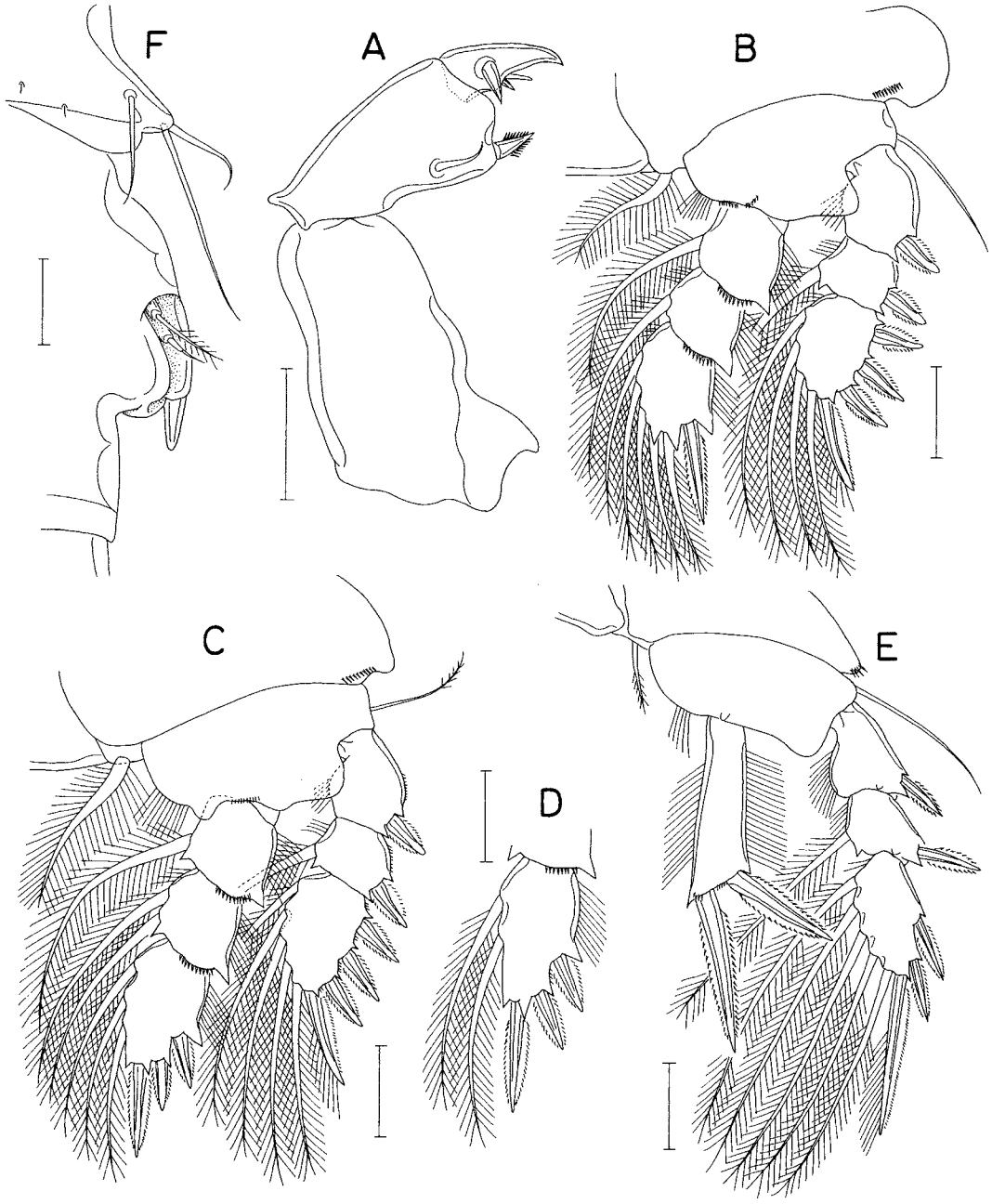

Fig. 15. *Pseudanthessius nodosus* n. sp., female. A, Maxilliped; B, Leg 1; C, Leg 2; D, Third endopodal segment of leg 3; E, Leg 4; F, Right leg 5 and genital aperture, dorsal. Scale bars: A–F = 0.05 mm.

spinules; seta III absent. Maxilliped (Fig. 15A) 3-segmented; syncoxa (first segment) the longest but unarmed; basis (second segment) with 1 distinct process proximally on outer margin and armed with 1 stout spinulose spine and 1 simple seta; small endopod (third segment) tapering, claw-like, proximally with 1 stout spine, 1 small spine, and 1 small, transparent seta.

Legs 1–3 with 3-segmented rami (Fig. 15B, C). Leg 4 (Fig. 15E) with 3-segmented exopod and 1-segmented endopod. Outer margin of coxa of leg 1 strongly produced (Fig. 14B). Inner coxal seta pinnate in legs 1–4 but smaller in leg 4. Leg 3 resembling leg 2 except its third endopodal segment armed with 3 spines and 2 setae (Fig. 15D). Endopodal segment of leg 4 gradually broadening distally, 2.71 times longer than wide, with oblique distal margin, pointed inner and outer distal corners, setulose inner and outer margins; 2 distal

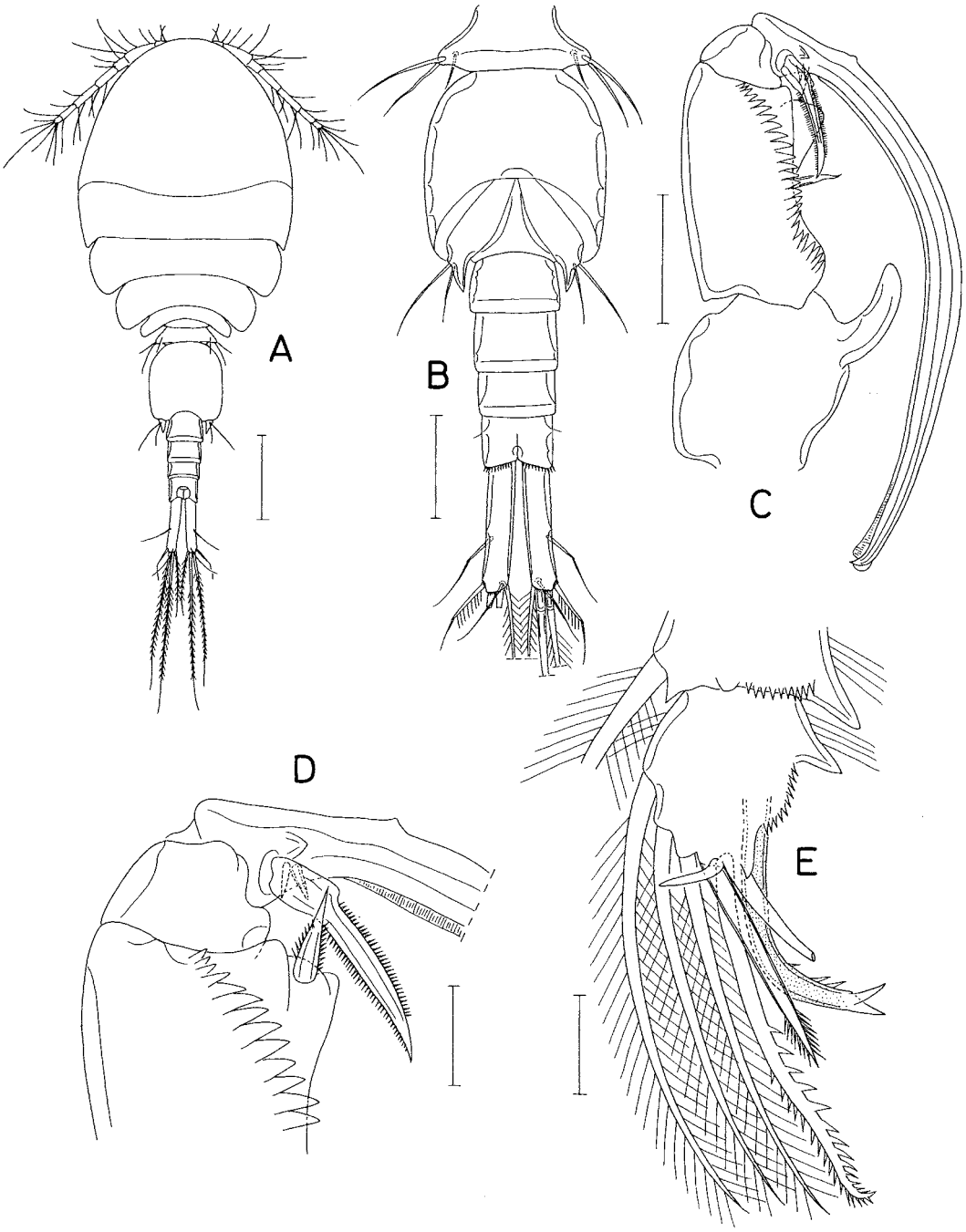

Fig. 16. *Pseudanthessius nodosus* n. sp., male. A, Habitus, dorsal; B, Urosome, ventral; C, Maxilliped; D, Distal part of maxilliped; E, Third endopodal segment of leg 1. Scale bars: A=0.2 mm, B=0.1 mm, C=0.05 mm, D, E=0.02 mm.

spines large 68 (outer) and 95 μm (inner) long. Armature formula for legs 1–4 as in *P. angustus* n. sp.

Leg 5 (Fig. 15F) represented by 3 naked setae on lateral region of fifth pedigerous somite. Leg 6 (Fig. 15F) represented by 1 pinnate and 1 shorter, naked setae on genital operculum.

Male. Body (Fig. 16A) narrower than that of female. Length 1.23 mm. Prosome 697 μm long. Urosome (Fig. 16B) 6-segmented. Fifth pedigerous somite narrower than genital somite. Genital somite longer than wide; genital operculum apically bearing 1 claw-like process and 2 setae. Caudal ramus 5.0 times longer than wide (130 × 26 μm); outer lateral seta positioning at 56% region of ramus length.

Rostrum as in female. Antennule with 2 additional aesthetascs, 1 on second and another one on fourth segments at places of dark circles in Fig. 14E. Antenna, mandible, maxillule, maxilla as in female. Maxilliped (Fig. 16C) comprising 3 segments and terminal claw; syncoxa (first segment) wider than long, with large digitiform process subdistally on inner margin; basis with longitudinal row of spinules (or scales) on inner surface, 1 seta in middle, and 1 spine on expanded inner distal region (Fig. 16D); small endopod unarmed; terminal claw large, longer than proximal segments combined, arched, proximally bearing 1 large, spinulose spine and 1 small cusp, and 2 small setiform elements (Fig. 16D).

Leg 1 sexually dimorphic; its third endopodal segment (Fig. 16E) armed with 6 elements: outer element large, curved, bifurcate at tip, with few spinules on its outer margin; outer distal element naked bearing pore at tip; inner distal element straight, spinulose at distal region; distalmost inner seta saw-like, with denticulate margins; other 3 inner seta pinnate, as usual; one slender digitiform process present distally near base inner distal seta. Legs 2–4 as in female. Leg 5 (Fig. 16B) also as in female, but 2 apical setae almost equal in length. Leg 6 (Fig. 16B) represented by 1 strong, claw-like process and 2 naked setae on genital operculum.

Etymology. The name of the new species is from the Greek *nod* (=toothless), depicting the smooth, toothless mandible.

Remarks. *Pseudanthessius nodosus* n. sp. is easily recognized by two distinct morphological features, i.e., the modified seta II of the maxilla and the presence of a post-genital spine in the female.

In *Pseudanthessius*, seta II (anterior seta) on the basis of the maxilla is generally thin, frequently with a spinulose or setulose inner margin. In some species, however, the seta is markedly inflated proximally with several spinules and tipped with a setule, as in *P. aestheticus* Stock, Humes & Gooding, 1964, *P. deficiens* Stock, Humes & Gooding, 1964, and *P. dentatus* Kim, 2000 (Stock et al., 1964; Kim, 2000). But in none of species of *Pseudanthessius* this seta of the maxilla is modified into a large, spinulose tubercle as in *P. nodosus* n. sp.

In four species of *Pseudanthessius*, *P. acutus* Kim, 2009, *P. angularis* Humes & Ho, 1970, *P. limatus* Humes, 1978, and *P. spinifer* Lindberg, 1946, the female genital double-somite has processes on its lateral margins. But these processes are not articulated at base, therefore, different in nature from the spine of *P. nodosus* n. sp. Moreover, the caudal rami of *P. acutus*, *P. angularis*, and *P. spinifer* are relatively shorter, less than four times as long as wide (compared to 5.97 times in *P. nodosus* n. sp.), and the antenna of *P. limatus* extraordinarily has no claw on the terminal segment.

Pseudanthessius kosraensis n. sp. (Figs. 17, 18)

Material examined. 1♀ (holotype, MABIK CR00247472) collected with light trap, shallow subtidal, Kosrae, 05°21′ 27.17″N, 162°57′51.23″E, coll. Park SI, 2 Jul 2016, Holotype (dissected and mounted on a slide) has been deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea.

Female. Body (Fig. 17A) narrow. Length 1.13 mm. Prosome 709 × 405 μm. Cephalothorax 500 μm long, 1.23 times longer than wide. Second pedigerous somite with angular posterolateral corners. Other prosomal somites with blunt or rounded posterolateral corners. Urosome (Fig. 17B) 5-segmented. Fifth pedigerous somite 127 μm wide. Genital double-somite 1.32 times longer than wide (158 × 120 μm), slightly narrower than fifth pedigerous somite, consisting of circular, expanded anterior two-thirds and narrower posterior third (62 μm wide across this region); genital apertures positioning laterally in middle of double-somite. Three free abdominal somites 40 × 53, 25 × 49, and 53 × 48 μm, respectively. Anal somite with row of fine spinules along posteroventral margin (Fig. 17C). Caudal rami (Fig. 17C) directed posteriorly, 4.09 times longer than wide (90 × 22 μm), with 6 setae and small pore plus fine spinules on distal margin; outer lateral seta (seta II) naked, positioning at 66% region of ramus length; other 5 setae pinnate.

Rostrum (Fig. 17D) as long as wide, tapering with round distal apex. Antennule (Fig. 17E) 330 μm long, 7-segmented; armature formula 4, 13, 6, 3, 4 + aesthetasc, 2 + aesthetasc, and 7 + aesthetasc; all setae naked; terminal segment short, half as long as penultimate segment. Antenna (Fig. 17F) slender, 4-segmented; armature formula 1, 1, 2 + claw, and 3 + 4 claws; third endopodal segment (fourth segment) 3.10 times longer than wide, its distal claws geniculate, consisting of 3 slender, setiform ones and 1 stronger one (third inner claw).

Labrum (Fig. 17G) with elongated, divergent, tapering posterolateral lobes bearing membranous flange along its distal margin; posteromedian incision deep. Mandible (Fig. 17H) incompletely articulated proximally; gnathobase broad, tapering, with short distal lash, 1 distinct, acutely pointed outer scale, and numerous fine setules along inner margin. Maxillule (Fig. 17I) with 1 small process on outer margin, 1 setiform process on inner margin, and 3 setae apically; middle of 3 apical setae large, spinulose along its inner margin, other 2 setae very small, naked. Maxilla (Fig. 18A) 2-segmented; syncoxa (proximal segment) unarmed; basis (distal segment) with elongate distal lash and 3 setae; seta I (inner seta) 46 μm long, spinulose along both margins; seta II (anterior seta) spiniform, not flexible, unornamented; seta III vestigial; distal lash 105 μm long, bearing 4 large spines proximally on distal margin followed by minute spinules along both margins. Maxilliped (Fig. 18B) 3-segmented; syncoxa (first segment)

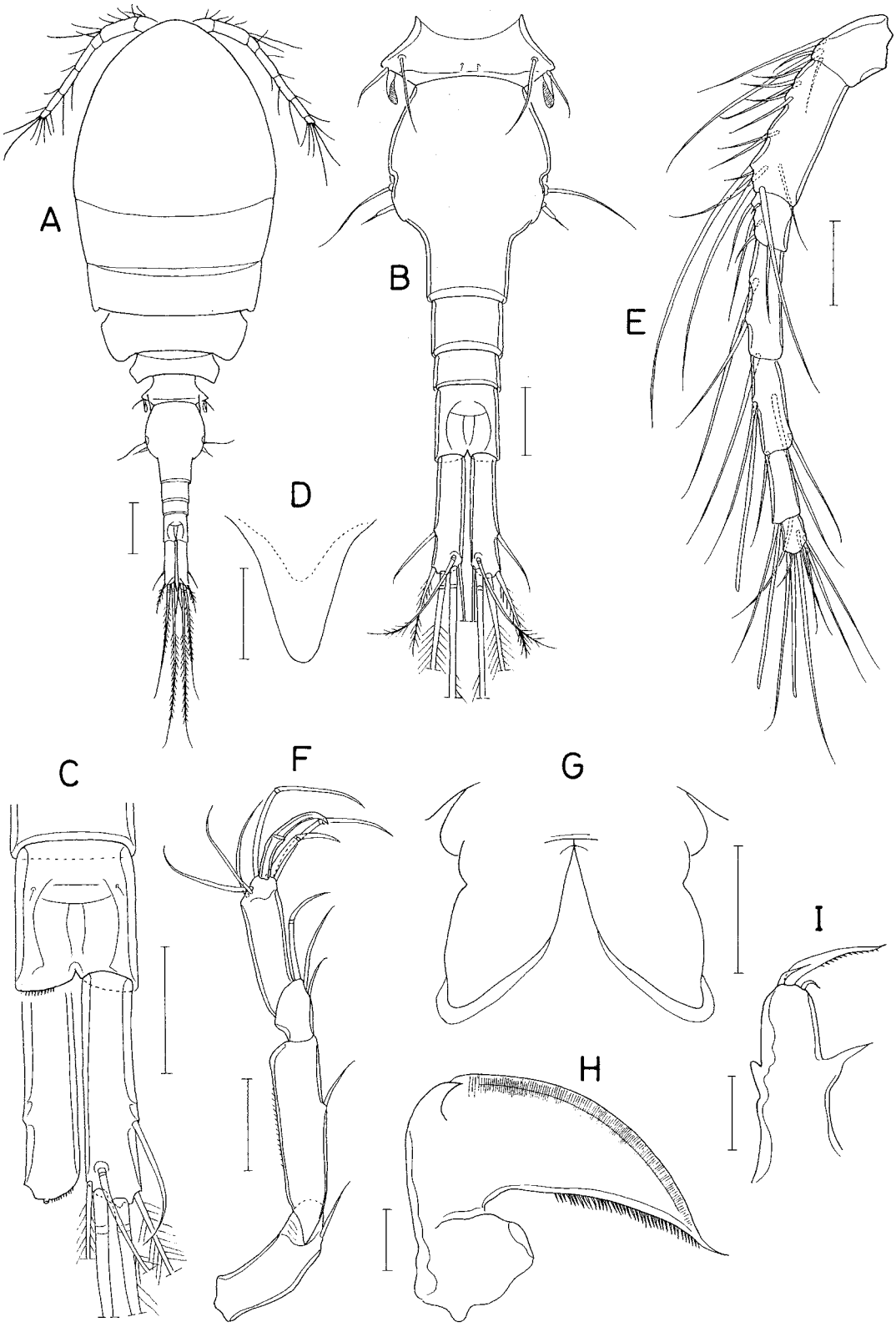

Fig. 17. *Pseudanthessius kosraensis* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Anal somite and caudal rami, dorsal; D, Rostrum; E, Antennule; F, Antenna; G, Labrum; H, Mandible; I, Maxillule. Scale bars: A=0.1 mm, B–G=0.05 mm, H, I=0.02 mm.

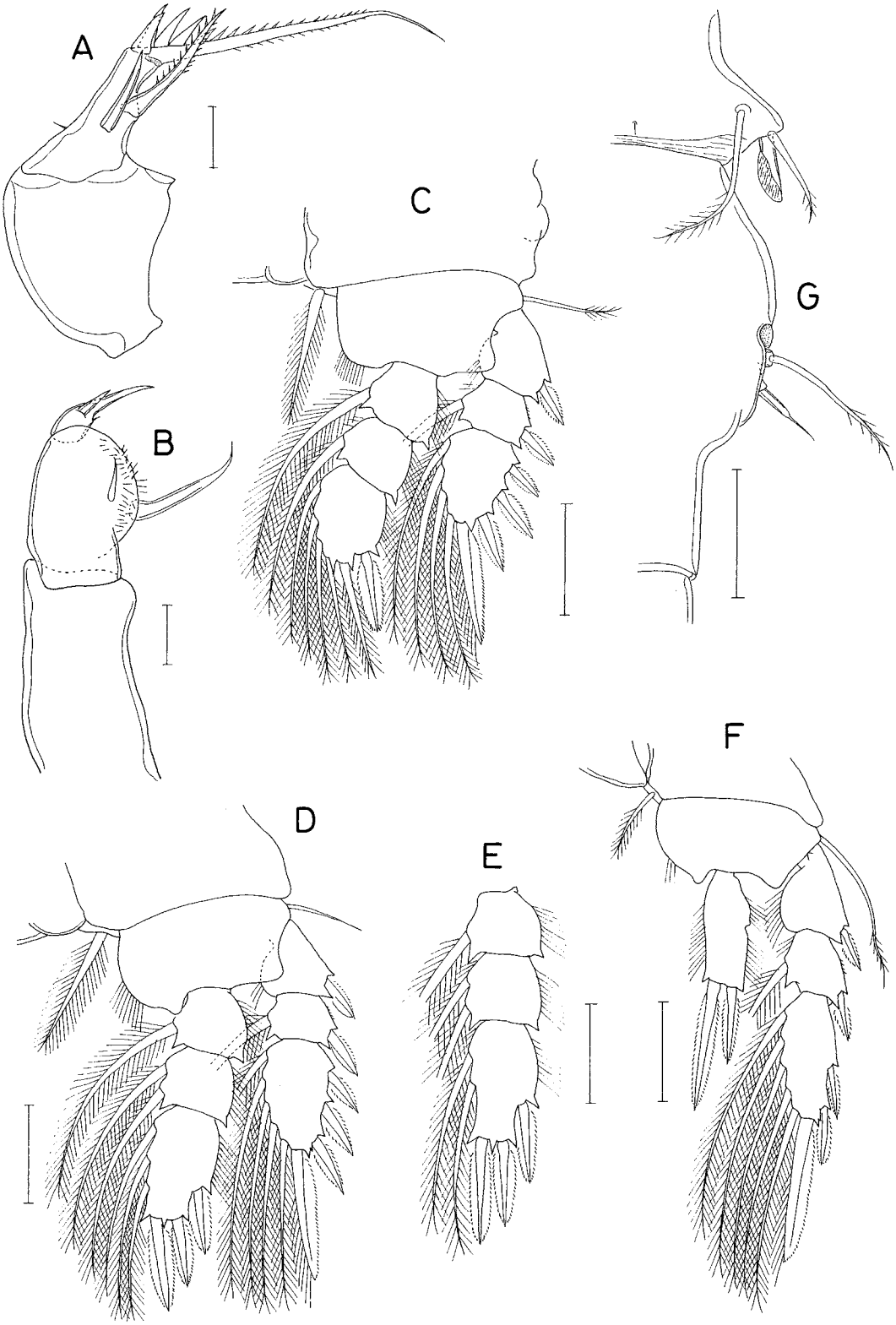

Fig. 18. *Pseudanthessius kosraensis* n. sp., female. A, Maxilla; B, Maxilliped; C, Leg 1; D, Leg 2; E, Endopod of leg 3; F, Leg 4; G, Right leg 5 and genital aperture, dorsal. Scale bars: A, B = 0.02 mm, C–G = 0.05 mm.

unarmed; second segment (basis) inflated along distal two-thirds, with 1 large (45 μm long) and 1 small (15 μm long) setae and numerous fine setules on convex inner surface. Third segment (endopod) small, terminating in slender, spiniform process, with 1 small spine and 1 minute seta proximally.

Legs 1−3 with 3-segmented rami (Fig. 18C−E). Leg 4 (Fig. 18F) with 3-segmented exopod and 1-segmented endopod. Inner coxal seta pinnate in these legs. Outer seta on leg 4 longer than those of legs 1−3. Leg 3 different from leg 2 in having 3 spines and 2 setae on third endopodal segment (Fig. 18E). Endopodal segment of leg 4 2.48 times longer than wide (57 × 23 μm), setulose along inner and outer margins, with 1 notch near middle of outer margin; 2 distal spines 39 (outer) and 66 (inner) μm, respectively. Armature formula for legs 1−4 as in *P. angustus* n. sp.

Leg 5 (Fig. 18G) consisting of 1 dorsolateral seta and apical spine and seta; apical spine 26 μm long, fringed with membrane along its inner margin; apical seta 40 μm long. Leg 6 (Fig. 18G) represented by 1 long, pinnate seta (68 μm long) and 1 small, setule-tipped spine in genital area.

Male. Unknown.

Etymology. The new species is named after its type locality, Kosrae.

Remarks. *Pseudanthessius kosraensis* n. sp. may be differentiated from its congeners by the following ways. The caudal ramus of this new species is 4.09 times longer than wide in the female. Eleven species of *Pseudanthessius* are described or illustrated to have similar ratios (a range of about 3.0 to 5.0: 1) of the length to the width of the caudal rami. They are *P. vinnulus* Humes, 1977, *P. mucronatus* Gurney, 1927, *P. tortuosus* Stock, Humes & Gooding, 1964, *P. nermertophilus* Gallien, 1936, *P. weberi* A. Scott, 1909, *P. procurrens* Humes, 1966, *P. firmus* n. sp., *P. asper* Kim, 2009, *P. angustus* n. sp., *P. assimilis* Sars, 1917, and *P. spinifer* Lindberg, 1946. The first three of these species can be excluded from a comparison with *P. kosraensis* n. sp., because their leg 5 consists of three setae (rather than two setae plus one spine as in *P. kosraensis* n. sp.). *Pseudanthessius spinifer*, *P. firmus* n. sp., and *P. asper* are not necessary either to compare with *P. kosraensis* n. sp., because the genital double-somite of *P. spinifer* bears a spiniform process on its lateral margins, the basis of the maxilla of *P. firmus* n. sp. lacks seta I, and the third exopodal segment of leg 3 of *P. asper* is armed with three spines and five setae (formula II, I, 5, rather than III, I, 5). *Pseudanthessius nermertophilus*, *P. weberi*, *P. procurrens*, and *P. assimilis* can be differentiated from *P. kosraensis* n. sp. by having only two or three distal claws on the antenna and a smooth outer margin of the exopodal segment of leg 4 (without any notch or point). In the remaining species, *P. angustus* n. sp., all four distal claws of the antenna are slender, setiform, the outer scale of the mandible is setiform, and one of two setae on the basis of the female maxilliped is extremely long (longer than the basis). Therefore, this species cannot be confused with *P. kosraensis* n. sp.

Pseudanthessius fossulicolus n. sp. (Figs. 19, 20)

Material examined. 1♀ (holotype, MABIK CR00247473) collected from invertebrate burrows, intertidal, Ko Sireh, Phuket, Thailand, 07°52′26″N, 98°25′35″E, coll. Kim IH, 12 Jul 2015. Holotype (dissected and mounted on a slide) has been deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea.

Female. Body (Fig. 19A) slender. Length 815 μm. Prosome 458 μm long, fusiform. Cephalothorax distinctly longer than wide (316 × 269 μm). Dorsal suture line between cephalosome and first pedigerous somite indistinct. Posterolateral corners bluntly produced distally in first pedigerous somite. Urosome (Fig. 19B) 5-segmented. Fifth pedigerous somite 86 μm wide, distinctly narrower than genital double-somite. Genital double-somite 124 × 106 μm, consisting of laterally strongly expanded anterior three quarters and narrower posterior quarter; genital apertures large, positioning dorsally at widest 55% region of double-somite length. Three free abdominal somites 32 × 42, 28 × 39, and 45 × 36 μm, respectively. Anal somite (Fig. 19C) unornamented. Caudal rami (Fig. 19C) elongate, 7.27 times longer than wide (109 × 15 μm), bearing 6 setae; outer lateral seta (seta II) positioning at 60% region of ramus length; this and outer distal seta (seta III) spiniform, tipped with setule; setae IV−VI pinnate, other setae naked.

Rostrum (Fig. 19D) tapering, distinctly longer than wide, with blunt distal apex. Antennule (Fig. 19E) 230 μm long, 7-segmented; armature formula 4, 13, 6, 3, 4 + aesthetasc, 2 + aesthetasc, and 7 + aesthetasc; third to terminal segment distinctly narrower than proximal 2 segments; terminal segment short, less than half as long as penultimate segment; all setae naked. Antenna (Fig. 19F) slender, 4-segmented; armature formula 1, 1, 3, and 7; terminal segment 4.0 times longer than wide (48 × 12 μm); inner 3 of 7 distal setae equal in length and thickness, spiniform, but not geniculate.

Labrum (Fig. 19G) with deep posteromedian incision, narrow, widely divergent posterolateral lobe bearing membranous flange along its distal margin. Mandible (Fig. 19H) incompletely articulated proximally, with short distal lash, cleft at outer corner (lacking scale), and 7 small setules in mid-region of inner margin of gnathobase. Maxillule (Fig. 19I) lobate, with 4 setae: 1 on inner margin, 3 on distal margin; 3 distal setae unequal in length, outermost one the longest, and innermost one the shortest. Maxilla (Fig. 19J)

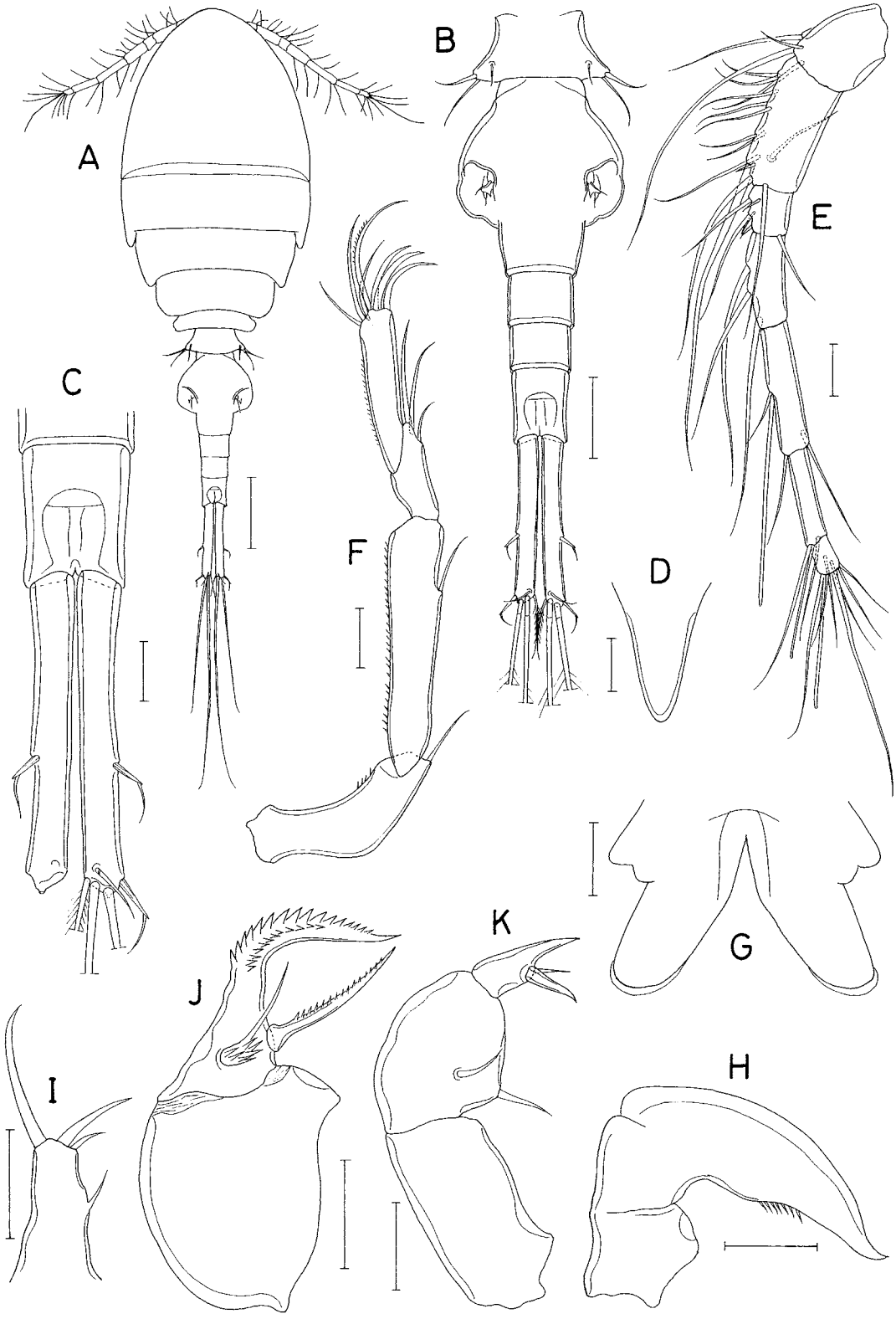

Fig. 19. *Pseudanthessius fossulicolus* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Anal somite, and caudal rami, dorsal; D, Rostrum; E, Antennule; F, Antenna; G, Labrum; H, Mandible; I, Maxillule; J, Maxilla; K, Maxilliped. Scale bars: A=0.1 mm, B=0.05 mm, C–K=0.02 mm.

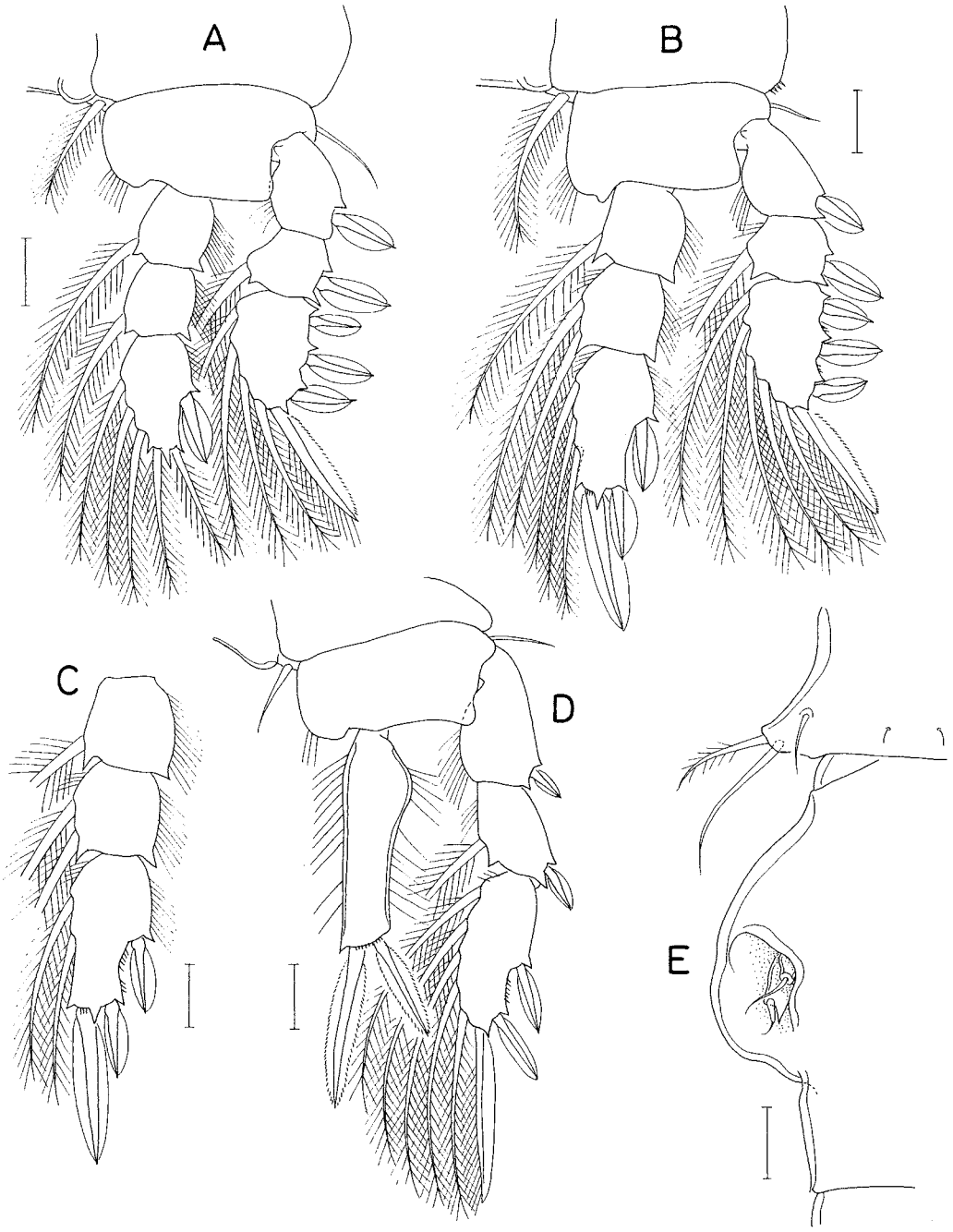

Fig. 20. *Pseudanthessius fossulicolus* n. sp., female. A, Leg 1; B, Leg 2; C, Endopod of leg 3; D, Leg 4; E, Left leg 5 and genital aperture, dorsal. Scale bars: A–E = 0.02 mm.

consisting of syncoxa and basis; syncoxa unarmed; basis with 2 setae and relatively short distal lash; inner seta (seta I) spiniform, spinulose along its outer margin; anterior seta (seta II) consisting of inflated proximal part and distal seta; proximal part bearing patch of 7 spinules, distal seta naked; seta III absent. Maxilliped (Fig. 19K) 3-segmented; first segment unarmed; second segment (basis) expanded, with 2 equal, naked setae at proximal third of segment length; third segment (endopod) terminating in spiniform process, with 1 spine and 1 seta.

Legs 1–3 with 3-segmented rami (Fig. 20A–C). Leg 4 (Fig. 20D) with 3-segmented exopod and 1-segmented

endopod. Leg 3 different from leg 2 in having 3 spines and 2 setae on third endopodal segment (Fig. 20C). Inner coxal seta small, naked in leg 4, but well-developed, pinnate in legs 1–3. Outer seta on basis small and naked in legs 1–4. Endopod of leg 4 extending over distal margin of second exopodal segment, 3.09 times longer than wide (68 × 22 μm), inflated in proximal third, setulose along outer and inner margins; 2 distal spines 34 (outer) and 50 (inner) μm long, respectively. Armature formula for legs 1–4 as in *P. angustus* n. sp.

Leg 5 (Fig. 20E) represented by 3 lateral setae (1 dorsolateral and 2 apical) on fifth pedigerous somite; 2 apical setae 29 and 45 μm long, respectively, shorter one pinnate. Leg 6 (Fig. 20E) represented by 2 small setae and 1 cusp on genital operculum.

Male. Unknown.

Etymology. From Latin *fossul* (=burrow) and *col* (dwell), referring to the finding of the new species in burrows.

Remarks. As diagnostic features of *P. fossulicolus* n. sp., the antenna lacks any claw distally and leg 5 of the female is represented only by setae (without a spine). This set of features is shared by two congeners, *P. limatus*, Humes, 1978 and *P. mucronatus* Gurney, 1927. In other morphological points the latter two species are not similar to *P. fossulicolus* n. sp. *Pseudanthessius limatus* has a pair of acuminate processes on the genital double-somite, a well-developed outer scale on the mandible, and a very slender distal lash of the maxilla (Humes, 1978). *Pseudanthessius mucronatus* has pointed posterolateral corners of the second pedigerous somite, a short terminal segment of the antenna, and only a single distal seta on the endopod of leg 4, as illustrated by Gurney (1927). Therefore, these two species are easily distinguishable from *P. fossulicolus* n. sp.

As mentioned in the Remarks section of *P. nodosus* n. sp., seta II on the basis of the maxilla of *P. aestheticus*, *P. deficiens*, and *P. dentatus* is specialized, with the inflated, spinulose proximal part, as in *P. fossulicolus* n. sp. Of these, *P. aestheticus* is very similar to *P. fossulicolus* n. sp., although the former species was discovered in the West Indies. The body, mandible, and maxilla in particular are very alike in forms between the two species. Noticed differences between them are in morphological details, as follows: (1) the female genital double-somite is less expanded in *P. aestheticus*; (2) the posterior margin of the anal somite is fringed with spinules in *P. aestheticus* but smooth in *P. fossulicolus* n. sp.; (3) the antenna of *P. aestheticus* is armed with claws, in addition to setae (cf. armed only with setae in *P. fossulicolus* n. sp.), as mentioned above; (4) the basis of the female maxilliped is ornamented with spinules on inner margin (unornamented in *P. fossulicolus* n. sp.), as figured by Stock et al. (1964); and (5) the maxillule of *P. aestheticus* is armed with three setae (cf. with four setae in *P. fossulicolus* n. sp.), although the inner margin seta was presumably overlooked by Stock et al. (1964).

Pseudanthessius dentatus Kim, 2000 (Fig. 21)

Material examined. 1♀ (dissected) collected from invertebrate burrows, intertidal, Ko Sireh, Phuket, Thailand, 07° 52′26″N, 98°25′35″E, coll. Kim IH, 12 Jul 2015.

Supplementary description of female. Body form (Fig. 21A) as figured in the original description. Body length 824 μm. Pre-anal somite short, less than half as long as first free abdominal somite, Caudal ramus (Fig. 21B) 7.33 times longer than wide (110 × 15 μm), gradually broadening distally; outer lateral seta (seta II) positioning at 80% region of ramus length.

Rostrum, antennule, antenna, labrum, mandible (Fig. 21C), maxillule (Fig. 21D), and maxilliped (Fig. 21F) as in original description. Maxilla (Fig. 21E) also as in original description, but seta II on basis bearing 2 spiniform processes (instead of 4 in type specimens). Legs 1–3 as in original description. Endopodal segment of leg 4 (Fig. 21G) with setulose inner margin and finely spinulose outer margin. Legs 5 and 6 (Fig. 21H) characteristic, basically as in original description.

Remarks. It is interesting to find that this well-defined species was also found in the Andaman Sea. *Pseudanthessius dentatus* was originally discovered on the Korean coast of the Yellow Sea (Kim, 2000). The type specimens and a female from Phuket consistently reveal the characteristic morphological features of this species, such as the presence of three dentiform spines on the concave margin of the mandible, four large distal spines on the basis of the maxilla, a posterolateral membranous flap on each side of the fifth pedigerous somite, and the outstanding form of the apical spine on the lateral margin of the fifth pedigerous somite. The only noticeable difference between the type specimens from Korea and the female from Phuket is the number of dentiform distal processes (four in the types vs. two in the female from Phuket) of seta II on the basis of the maxilla, but this difference is considered to be an infraspecific variation.

Pseudanthessius planus Kim, 2007 (Figs. 22, 23)

Material examined. 2♀♀ from washings of invertebrates, SCUBA, depth 28 m, 09°43′02″N, 124°32′17″E, Anda, Bohol Island, the Philippines, coll. Lee J & Kim IH, 4 Apr 2016.

Supplementary description of female. Body (Fig. 22A) 825 μm long. Prosome flattened, subcircular, 542 × 450 μm. Genital double-somite (Fig. 22B) wider than long (110 × 136 μm), slightly wider than fifth pedigerous somite. Genital double-somite, first abdominal and anal somites with row of spinules

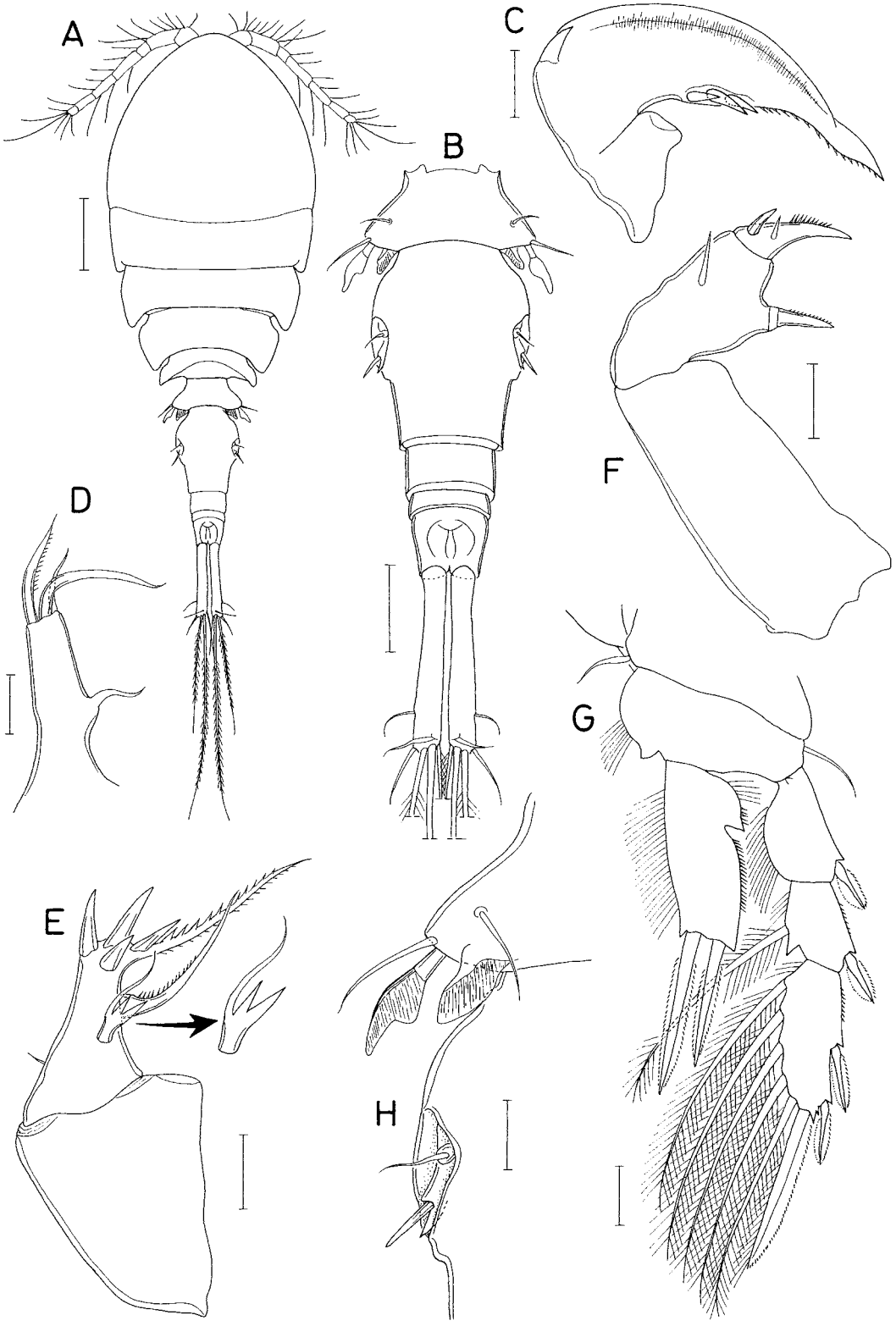

Fig. 21. *Pseudanthessius dentatus* Kim, 2000, female. A, Habitus, dorsal; B, Urosome, dorsal; C, Mandible; D, Maxillule; E, Maxilla; F, Maxilliped; G, Leg 4; H, Left leg 5 and genital aperture, dorsal. Scale bars: A=0.1 mm, B=0.05 mm, C–H=0.02 mm.

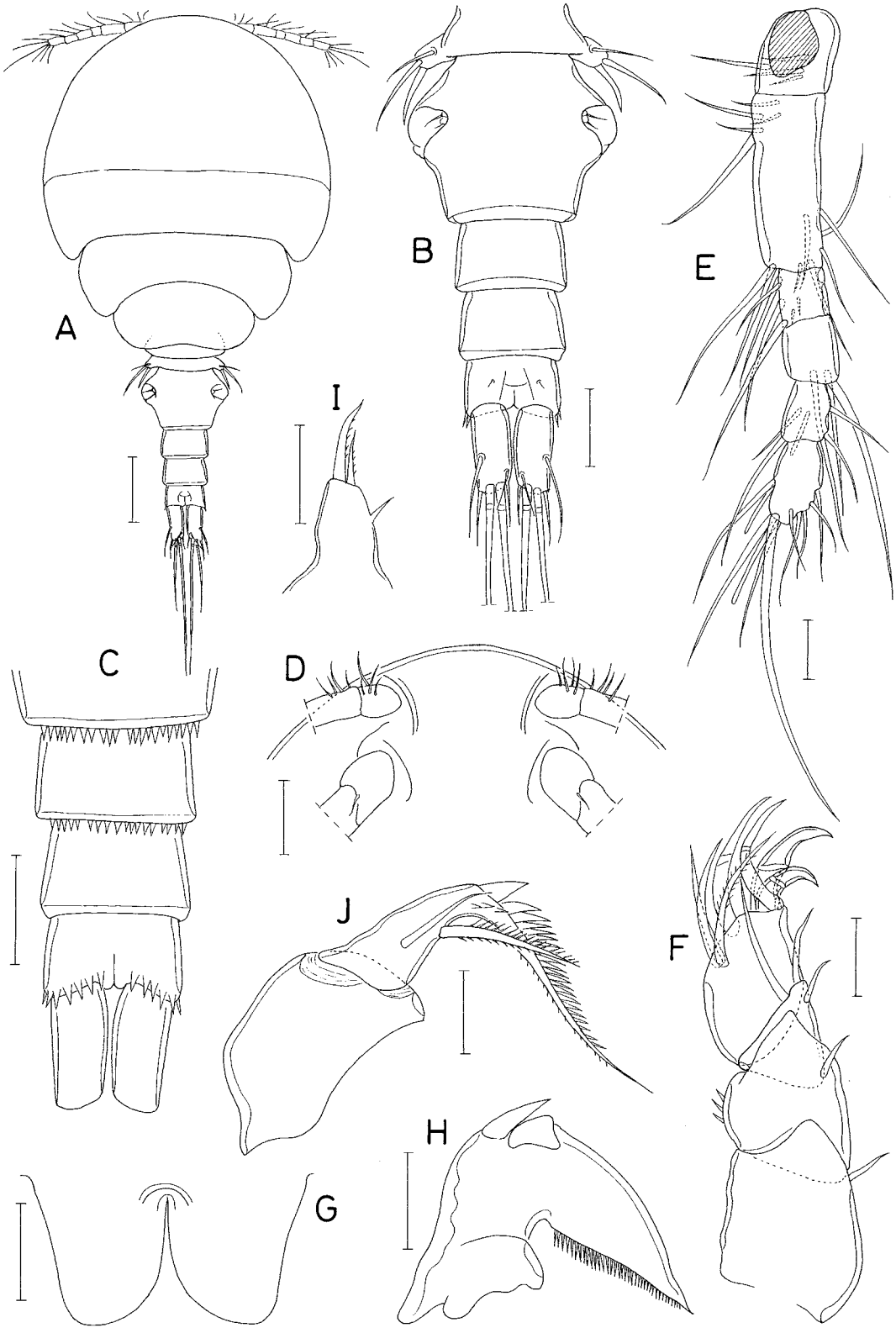

Fig. 22. *Pseudanthessius planus* Kim, 2007, female. A, Habitus, dorsal; B, Urosome, dorsal; C, Abdomen, ventral; D, Rostral area, ventral; E, Antennule; F, Antenna; G, Labrum; H, Mandible; I, Maxillule; J, Maxilla. Scale bars: A=0.1 mm, B–D=0.05 mm, E–J=0.02 mm.

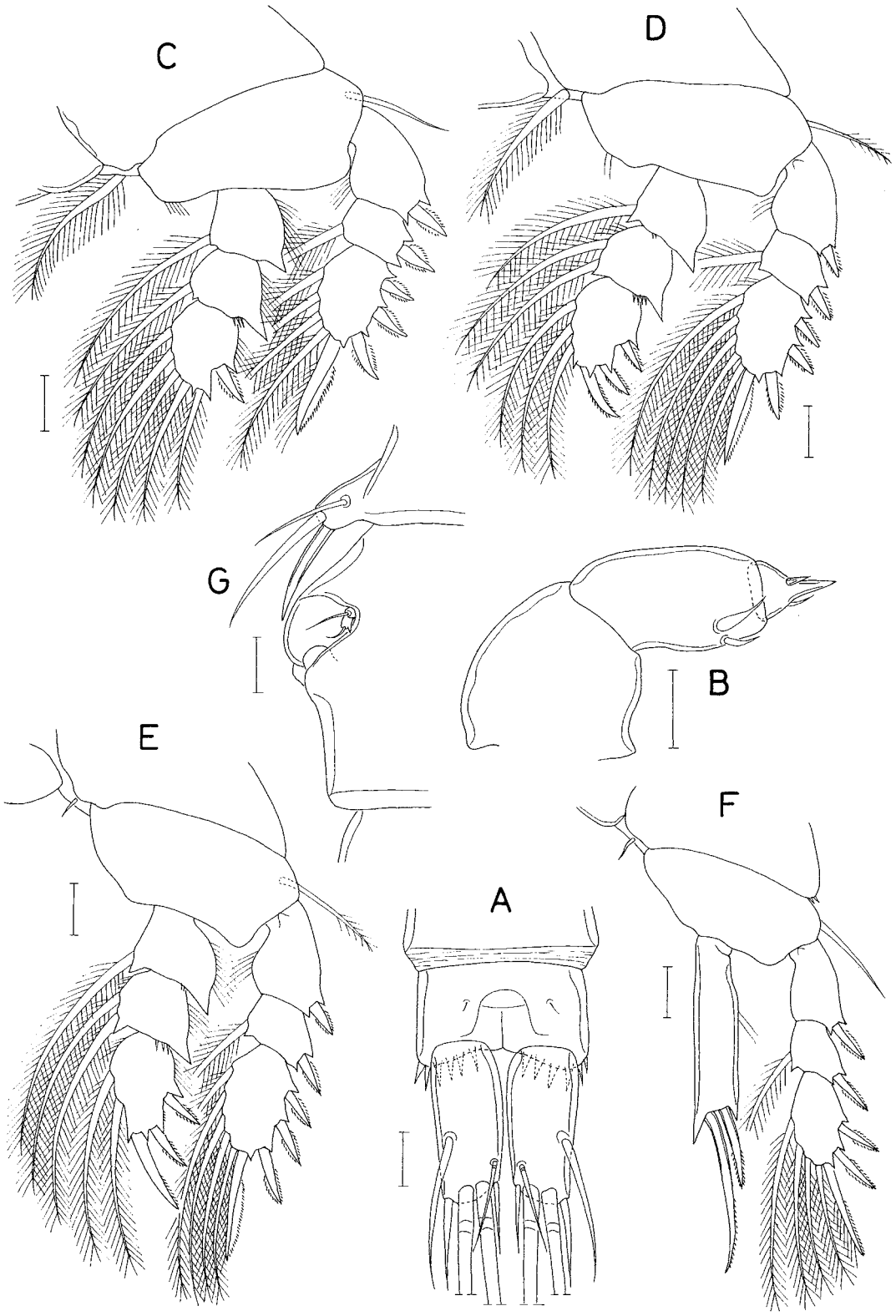

Fig. 23. *Pseudanthessius planus* Kim, 2007, female. A, Anal somite and caudal rami, dorsal; B, Maxilliped; C, Leg 1; D, Leg 2; E, Leg 3; F, Leg 4; G, Left leg 5 and genital aperture, dorsal. Scale bars: A–G = 0.02 mm.

along posteroventral margin (Fig. 22C). Anal somite shorter than other abdominal somites, Caudal ramus (Fig. 23A) 2.27 times longer than wide (59 × 26 μm), with 6 naked setae; outer lateral seta positioning at 58% region of ramus length.

Rostrum (Fig. 22D) broad, without posterior margin. Antennule (Fig. 22E) 178 μm long; 6-segmented; armature formula 4, 13, 6, 3, 4 + aesthetasc, and 9 + 2 aesthetascs; all setae naked; aesthetascs small. Antenna (Fig. 22F) robust, 4-segmented; armature formula 1, 1, 3, and 3 + 4 claws; 4 distal claws comprising 2 thicker, shorter and 2 slender, longer ones, all these claws geniculate.

Labrum (Fig. 22G) with broad posterior lobes and narrow posteromedian incision. Mandible (Fig. 22H) with 2 scales at outer corner, proximal one of them spiniform, and distal one nearly rectangular. Maxillule (Fig. 22I) and maxilliped (Fig. 23D) as described in original description. Maxilla (Fig. 22J) with proximalmost tooth on distal margin of basis of maxilla much larger than following distal teeth; seta I spinulose along both margins.

Legs 1–3 (Fig. 23C–E) segmented and armed as in type specimens. Leg 4 (Fig. 23F) with 3-segmented exopod and 1-segmented endopod. Inner coxal seta well-developed in legs 1 and 2, but rudimentary in legs 3 and 4. Third exopodal segment of leg 4 armed with 3 spines and 4 setae (formula II, I, 4); endopod elongate, 4.0 times longer than wide (68 × 17 μm), with 2 distal setiform spines of 32 (outer) and 65 μm (inner) long, respectively.

Leg 5 (Fig. 23G) as lateral lobe of fifth pedigerous somite, bearing dorsal seta and apical spine (38 μm long) and seta (55 μm long). Leg 6 (Fig. 23G) represented by 2 small setae and 1 minute cusp on genital operculum.

Male. Unknown.

Remarks. *Pseudanthessius planus* was described on the basis of two females associated with the echinoid *Himerometra robustipinna (*Carpenter) from Marsegoe Island, Indonesia (Kim, 2007). As the most significant diagnostic features of this copepod species, the antennule is 6-segmented and the third exopodal segment of leg 4 is armed with three spines and four setae (not five setae, as erroneously described in the original description).

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CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

ACKNOWLDGMENTS

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