

Siphonostomatoid Copepods (Crustacea) Associated with Sponges from the Philippines and Vietnam

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ABSTRACT

Six new species of siphonostomatoid copepods are described from sponges collected in the Philippines and Vietnam. Two new genera of Asterocheridae, *Andapontius* and *Holobinus*, are proposed. The new species are *Andapontius granulatus* n. gen. n. sp., *Holobinus angustus* n. gen. n. sp. and *Dermatomyzon boxshalli* n. sp. in the family Asterocheridae and *Entomopsyllus brevicaudatus* n. sp., *Paralepeopsyllus leei* n. sp. and *P. dambayensis* n. sp. in the family Entomolepididae. *Doropontius denticornis* Thompson and Scott, 1903, is redescribed for the first time since its original record.

Keywords: *Andapontius* n. gen., *Holobinus* n. gen., *Dermatomyzon*, *Paralepeopsyllus*, new species, *Doropontius denticornis*

INTRODUCTION

The internal canals of sponges provide a protected micro-habitat for symbiotic copepods (Boxshall and Halsey, 2004). Siphonostomatoid copepods are frequently associated with sponges and several families are known only from sponge hosts (Boxshall and Huys, 1994).

It is known that the central Philippine Islands are the center of the center of marine biodiversity in the world (Carpenter and Springer, 2005), and sponges in the warm waters of the tropical Indo-Pacific harbor numerous siphonostomatoid copepods (Humes, 1996). For instance, Boxshall (1990) and Malt (1991) recorded respectively six and eight new species of siphonostomatoid copepods associated with sponges collected during a short period of time from Hong Kong. Eighteen of 45 siphonostomatoid species reported by Kim (2010) from tropical waters were sponge-inhabitants. Nevertheless, no sponge-inhabiting copepod has been recorded yet from the Philippines.

In this paper, seven species of siphonostomatoid copepods associated with sponges, including two new genera and six new species, are reported from Bohol Island, the Philippines

and a middle island of Vietnam.

MATERIALS AND METHODS

Sponges were collected in April, 2016 by SCUBA divers of the Korea Institute of Ocean Science & Technology for the purpose of a biochemical research. In the water the collected sponges were all retained together in a net of large mesh size, thus, most of the copepod associates were dislodged. Back on shore the sponges were placed in a large bucket containing sea water for about a couple of hours, then washed. Copepods were obtained as by-catches from the wash water and preserved in 80% ethanol.

Selected copepod specimens were dissected in lactic acid and observed using the reversed slide method (Humes and Gooding, 1964). Type specimens have been deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea. In the descriptions body lengths were measured from the anterior apex of the cephalothorax to the posterior margin of the caudal rami, excluding the caudal setae. In the formula for the armature of legs 1–4 Roman numerals indi-

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cate spines and Arabic numerals represent setae.

SYSTEMATIC ACCOUNTS

Order Siphonostomatoida Thorell, 1859

Family Asterocheridae Giesbrecht, 1899

Genus *Doropontius* Thompson and Scott, 1903

Doropontius denticornis Thompson and Scott, 1903

(Figs. 1–3)

Doropontius denticornis Thompson and Scott, 1903: 291, Pl. 20, figs. 1–5.

Material examined. 3♀, 9♂♂ from washings of a mixture of unidentified sponges, SCUBA, depth 28 m, 09°43' 02"N, 124°32'17"E, Anda, Bohol Island, the Philippines, 4 Apr 2016.

Female. Body (Fig. 1A) circular and extremely flattened dorsoventrally. Total length of dissected specimen 1.08 mm. Prosome 854 µm long, as long as wide, and consisting of cephalothorax and 3 metasomites, but fourth pedigerous somite (= third metasomite) rudimentary and concealed in dorsal view of body by third pedigerous somite. Cephalothorax 624 × 853 µm, with slightly pronounced rostral area and pointed posterolateral corners. Second pedigerous somite 91 × 509 µm, characteristically narrower than third, markedly broadened posteriorly, with acutely pointed posterolateral corners. Third pedigerous somite 121 × 533 µm, with denticle-like point at anterior part of each lateral margin and with pointed posterolateral corners. Urosome (Fig. 1B) 4-segmented. Fifth pedigerous somite (= first urosomite) extended posterolaterally, 198 µm wide across lateral extremities. Genital complex 100 × 176 µm, consisting of broad, posterolaterally extended anterior three quarters and narrower posterior quarter; extended broader part with dentiform anterolateral process and blunt posterolateral process, the latter ornamented about 10 setules bearing swollen base (Fig. 2H); dorsal surface of genital complex with scattered fine spinules; paired genital apertures large and positioned dorsolaterally on broad anterior part of complex. First free abdominal somite 27 × 60 µm, with row of fine spinules along posterior border. Anal somite 36 × 63 µm, broadened distally; anal operculum distinct, extending beyond posterior margin of somite. Caudal ramus (Fig. 1C) quadrangular, 33 × 24 µm, 1.38 times as long as wide, with few spinules on outer margin, 1 short tube at ventrodistal area, and 6 caudal setae (2 dorsal and 4 distal); inner distal seta naked and other 5 setae pinnate.

Rostrum absent. Antennule (Fig. 1D) 16-segmented and 403 µm long; armature formula 2, 4, 8, 2, 7, 2, 2, 2, 2, 2, 2, 2,

2, 2 + aesthetasc, 2, and 11; fourth segment with prominent, dentiform posterodistal process; sixth segment short, obscure; one of 2 setae on first segment small, setule-like; one of setae on terminal segment inserted at basal part of larger distal seta. Antenna (Fig. 1E, F) consisting of coxa, basis, exopod, and endopod. Coxa short, with few setules. Basis unornamented. Exopod small, 1-segmented, about twice as long as wide, with 2 terminal setae and 1 lateral seta. Endopod 3-segmented; first segment ornamented with setules on outer surface and with spinules on inner surface; short second segment armed with 1 spiniform seta; terminal segment setulose, with terminal claw and 3 setae, largest seta spiniform; terminal claw straight, elongated, as long as 3 endopodal segments combined.

Oral siphon (Fig. 1G) flattened, tapering, about 220 µm long, longer than wide, with distal, linguiform extension bearing minute setules along margins. Mandible (Fig. 1H) consisting of stylet and palp. Stylet slender, 197 µm long, with 11 denticles of irregular form. Palp 2-segmented; proximal segment 36 µm long, with spinules on distal region; distal segment 13 µm long, with 1 long, weakly pinnate seta (220 µm long) and 1 small seta (12 µm long). Maxillule (Fig. 1I) bilobed. Inner lobe 82 × 29 µm, widest near proximal third, ornamented with spinules and setules, and distally armed with 1 minute and 4 large setae (lengths of these large setae 115, 116, 109, and 81 µm, respectively, from inner to outer); 3 large inner setae weakly pinnate, outermost one of them naked. Outer lobe small, 26 × 8 µm, about 0.3 times as long as inner lobe, with 4 unequal, naked setae, 3 larger setae 136, 83, and 63 µm, respectively. Maxilla (Fig. 2A) consisting of syncoxa and distal claw; syncoxa with large protrusion and aesthetasc-like tube at proximal region; distal claw strong, longer than syncoxa, distally strongly curved, with 1 denticle near proximal third. Maxilliped (Fig. 2B) consisting of syncoxa, basis and endopod, Syncoxa with 1 small seta distally. Basis ornamented with several minute spinules along outer margin. Endopod 4-segmented; proximal 3 segments armed with 2, 1, and 1 setae, respectively; terminal segment with terminal claw and 1 spine; terminal claw weakly curved, 98 µm long, slightly less than 3 times as long as terminal segment.

Legs 1–3 (Fig. 2C–E) with 3-segmented exopod and endopod. Inner seta on coxa of leg 1 and outer seta on basis of legs 1–3 naked; other setae on legs 1–3 pinnate. Second endopodal segment of legs 1–3 with bicuspid outer distal corner. Inner seta on basis of leg 1 slender and naked. Outer spine on second exopodal segment of leg 1 small, shorter than nearby spines. Leg 3 without inner seta on coxa. Leg 4 (Fig. 2F) vestigial, represented by small lobe bearing 1 apical, and 2 inner distal setae, one of latter setule-like.

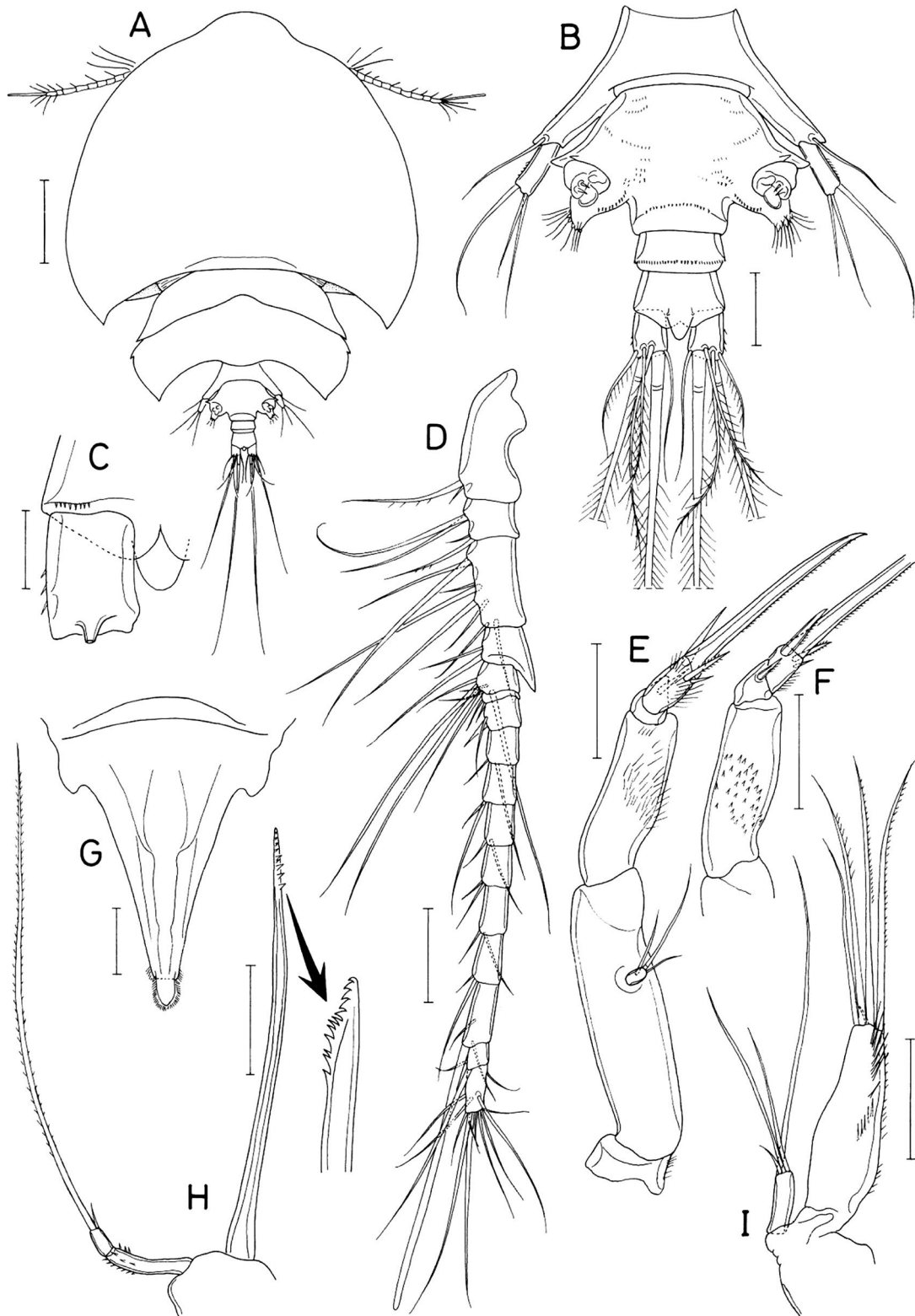


Fig. 1. *Doropontius denticornis* Thompson and Scott, female. A, Habitus, dorsal; B, Urosome, dorsal; C, Right caudal ramus, ventral; D, Antennule; E, Antenna; F, Distal part of antenna; G, Oral cone; H, Mandible; I, Maxillule. Scale bars: A=0.2 mm, B, D-I=0.05 mm, C=0.02 mm.

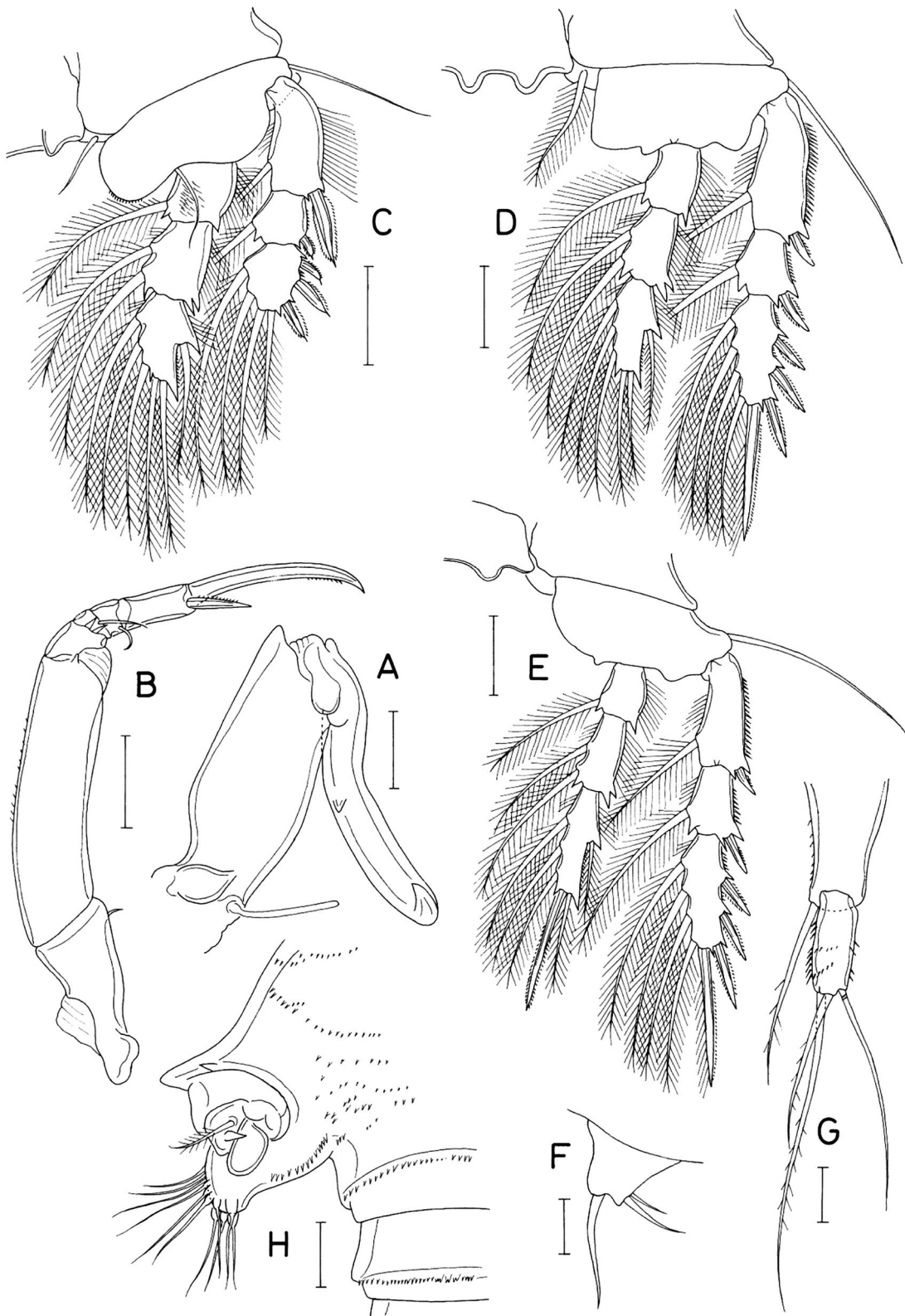


Fig. 2. *Doropontius denticornis* Thompson and Scott, female. A, Maxilla; B, Maxilliped; C, Leg 1; D, Leg 2; E, Leg 3; F, Leg 4; G, Leg 5; H, Genital aperture. Scale bars: A-E=0.05 mm, F=0.01 mm, G, H=0.02 mm.

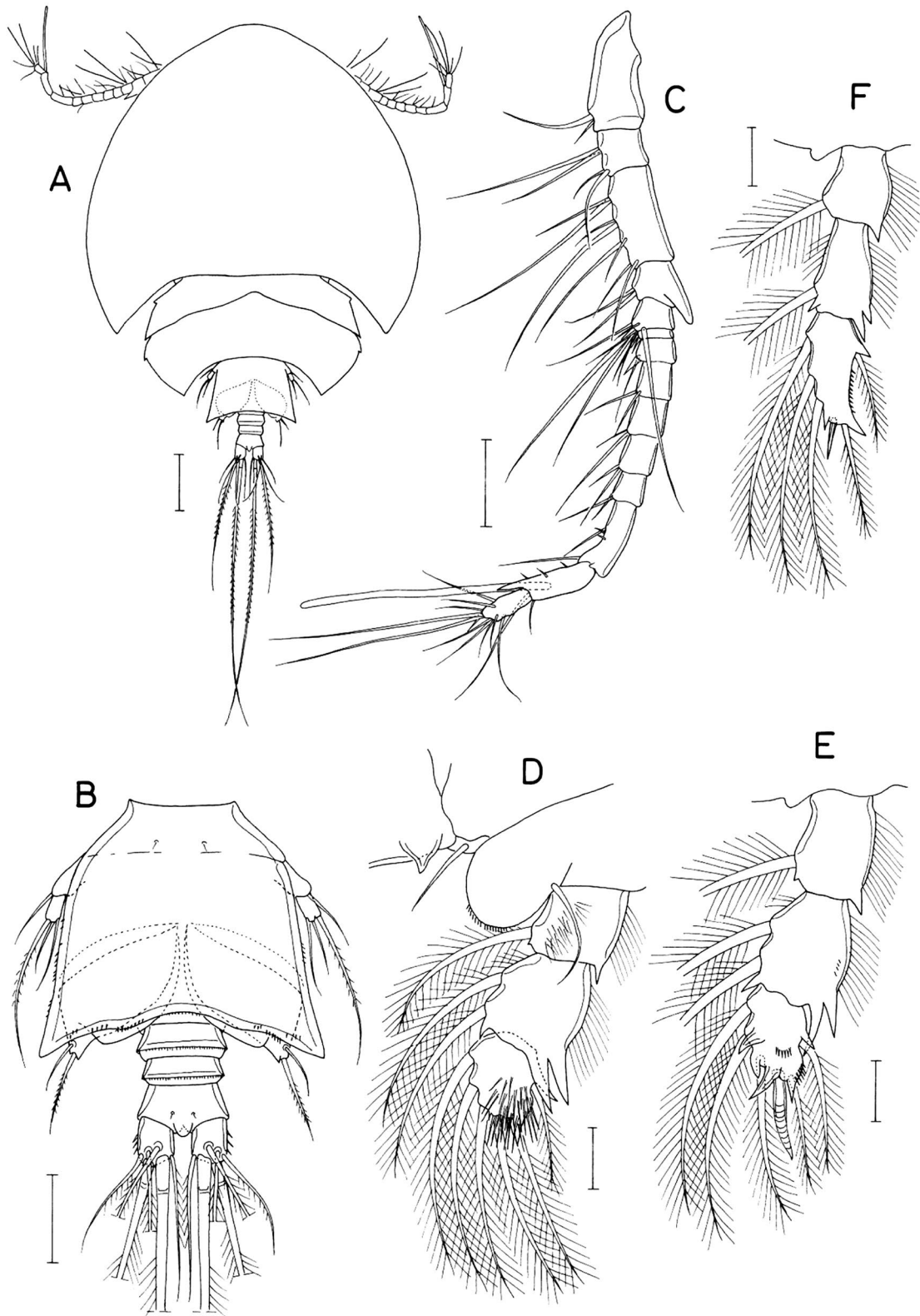


Fig. 3. *Doropontius denticornis* Thompson and Scott, male. A, Habitus, dorsal; B, Urosome, dorsal; C, Antennule; D, Endopod of leg 1; E, Endopod of leg 2; F, Endopod of leg 3. Scale bars: A=0.1 mm, B, C=0.05 mm, D-F=0.02 mm.

	Coxa	Basis	Exopod	Endopod
Leg 1:	0-1	1-1	I-1; I-1; III, 2, 2	0-1; 0-2; 1, 2, 3
Leg 2:	0-1	1-0	I-1; I-1; III, I, 4	0-1; 0-2; 1, 2, 3
Leg 3:	0-0	1-0	I-1; I-1; III, I, 4	0-1; 0-2; 1, 1 + I, 3
Leg 4:	Lobe (with 3 setae).			

Leg 5 (Fig. 2G) consisting of 1 distal seta on posterolateral extension of fifth pedigerous somite and 1-segmented free exopod; exopod spinulose, $41 \times 16 \mu\text{m}$ (L/W ratio 2.56 : 1), with 3 unequal distal setae, innermost one annulated at base. Leg 6 probably represented by 1 small spinule and 1 pinnate seta in genital aperture (Fig. 2H).

Male. Body (Fig. 3A) similar to that of female. Total length $781 \mu\text{m}$, distinctly smaller than female. Second pedigerous somite with small, pointed process on lateral margins. Urosome (Fig. 3B) 4-segmented, consisting of genital complex and 3-segmented abdomen. Genital complex formed by fusion of fifth pedigerous somite and genital somite, $124 \times 161 \mu\text{m}$, gradually broadened posteriorly, with trace of articulation between these somites, pronounced posterolateral angles, and fine spinules scattered on lateral and posterior margins. Three abdominal somites 20×51 , 16×46 , and $27 \times 52 \mu\text{m}$, respectively, much wider than long; first 2 each with fine spinules along posterior margin; anal somite gradually broadened distally, with prominent anal operculum. Caudal ramus $26 \times 21 \mu\text{m}$, 1.24 times as long as wide.

Rostrum absent. Antennule (Fig. 3C) 14-segmented and geniculate between antepenultimate and penultimate segments; fourth segment with prominent posterolateral process, as in female; penultimate segment with beak-like anterodistal process; armature formula 2, 4, 8, 2, 7, 2, 2, 2, 2, 2, 4, 5 + aesthetasc, and 11. Antenna as in female.

Oral siphon, mandible, maxillule, maxilla, maxilliped as in female.

Leg 1 endopod (Fig. 3D) with enlarged bicuspid outer distal corner of second segment and patch of needle-like spinules on anterodistal surface of terminal segment. Leg 2 endopod (Fig. 3E) with enlarged bicuspid outer distal corner of second segment; terminal segment armed with 1 spine and 5 setae (armature formula 1, 1 + I, 3), 1 spiniform process on inner side, 1 large, spiniform inner distal process; terminal spine with annulations. Leg 3 endopod (Fig. 3F) with same armature as that of female, but terminal spine on terminal segment markedly reduced and naked. Leg 4 as in female.

Leg 5 exopod $17 \times 9 \mu\text{m}$, 1.89 times as long as wide. Leg 6 represented by 1 shorter, naked seta and 1 longer pinnate seta on distal corner of genital operculum (Fig. 3B).

Remarks. *Doropontius denticornis*, the only species of the genus, was incompletely described in the original description and has not been reported again for more than a centu-

ry. Thompson and Scott (1903) provided illustrations of the body form, antennule, maxilla, maxilliped, and leg 1 of *D. denticornis*. Our specimens from the Philippines agree well with the original description in the characteristic form of the body and antennule. In the original description the female had a 17-segmented (16-segmented in our specimens) antennule and the inner coxal seta of leg 1 had a pinnate seta (a naked seta in our specimens). These differences are thought to be artifacts.

Like *Doropontius*, three other genera in the Asterocheridae have 3-segmented rami in legs 1–3 and a rudimentary leg 4. These three genera are *Cholomyzon* Stock and Humes, 1969, *Coralliomyzon* Humes and Stock, 1991 and *Oedomyzon* Stock, 1981 (see Stock and Humes, 1969, Humes and Stock, 1991, and Stock, 1981, respectively). *Doropontius* is differentiated from *Cholomyzon* and *Coralliomyzon* by the possession of the 5-segmented maxilliped (vs. 3-segmented in *Cholomyzon* and *Coralliomyzon*) and an exopod on the antenna (vs. exopod absent in *Cholomyzon* and *Coralliomyzon*), and from *Oedomyzon* by the possession of the 16-segmented antennule in the female (vs. the female antennule is only 7-segmented in *Oedomyzon*) and the 3-segmented endopod of the antenna with a terminal claw (vs. the endopod is 2-segmented, without a terminal claw in *Oedomyzon*).

Andapontius n. gen.

Diagnosis (female). Asterocheridae. Body cycloform, with heavily sclerotized exoskeleton. Prosome 4-segmented. Urosome 4-segmented. Caudal ramus with 6 setae; 2 mid-terminal setae expanded proximally. Rostrum absent. Antennule 18-segmented, with aesthetasc on terminal segment. Antenna with small exopod; endopod 3-segmented, with spiniform terminal claw. Oral cone short, extending to insertions of maxillipeds. Mandible consisting of annulated stylet and 2-segmented palp armed with 2 unequal terminal setae. Maxillule bilobed; inner lobe with 4 large and 1 minute setae; outer lobe shorter than inner lobe, with 3 large and 1 minute setae. Maxilla consisting of syncoxa and claw; syncoxa with proximal, tubular extension of maxillary gland. Maxilliped consisting of syncoxa, basis, and 3-segmented endopod. Legs 1 and 2 biramous, with 3-segmented rami. Armature formula of leg 1: I-0; I-1; II, 2, 2 for exopod; 0-1; 0-1; 1, 2, 3 for endopod. Armature formula of leg 2: I-0; 0-1; II, I, 4 for exopod; 0-1; 0-1; 1, 2, 2 for endopod. Legs 3 and 4 uniramous, consisting of unarmed coxa, basis bearing outer seta, and 1-segmented exopod bearing 2 distal setae; endopod absent. Leg 5 consisting of protopod bearing 1 dorsodistal seta and exopod bearing 3 distal setae. Leg 6 represented by 1 long and 1 short setae on genital operculum.

Type species. *Andapontius granulatus* n. sp.

Table 1. Comparison of genera of the Asterocheridae in which leg 4 is uniramous or represented by a lobe or a seta

Genera	Segments of rami of legs 1–4								Other major features	Host taxa
	Leg 1		Leg 2		Leg 3		Leg 4			
	Exp	Enp	Exp	Enp	Exp	Enp	Exp	Enp		
<i>Cleopontius</i> Thompson & Scott, 1903	3	3	3	3	3	3	3	X	A2 with 2-segmented exp	Porifera
<i>Temanus</i> Humes 1997	3	3	3	3	3	3	3	X	A2 without exp; maxilliped enp 1-segmented	Cnidaria
<i>Cyclocheres</i> Kim 2010	3	3	3	3	3	3	3	X	Caudal ramus with an aesthetasc	Porifera
<i>Humesimyzon</i> Kim 2010	3	3	3	3	3	3	3	X	A2 exp as a seta; maxilliped enp 1-segmented	Cnidaria
<i>Cholomyzon</i> Stock & Humes, 1969	3	3	3	3	3	3	X or as a seta		♀ A1 11-segmented; A2 without exp; maxilliped enp 1-segmented	Cnidaria
<i>Coralliomyzon</i> Humes & Stock, 1991	3	3	3	3	3	3	X or as a seta		♀ A1 11-segmented; A2 without exp; maxilliped enp 1-segmented	Cnidaria
<i>Oedomyzon</i> Stock 1981	3	3	3	3	3	3	A lobe		♀ A1 7-segmented; A2 without terminal claw	Cnidaria
<i>Doropontius</i> Thompson & Scott, 1903	3	3	3	3	3	3	A lobe		Body discoid	Porifera
<i>Tupacheres</i> Stock 1965	2	3	2	3	2	2	2	X	♀ body vermiform	Porifera
<i>Cystomyzon</i> Stock 1981	2	2	3	2	3	2	A lobe		♀ A1 7-segmented; A2 without terminal claw	Cnidaria
<i>Andapontius</i> n. gen.	3	3	3	3	2	X	2	X		Porifera
<i>Holobius</i> n. gen.	3	2	3	2	2	X	A lobe			Porifera

X, absent; A1, antennule; A2, antenna; Exp, exopod; Enp, endopod.

Etymology. The generic name is formed from *Anda*, the geographical name of the southeastern area of Bohol Island, in which the type locality is located, and the Greek word *pontios* (= in the sea) frequently used in generic names of siphonostomatoid copepods. The gender is masculine.

Remarks. In the Asterocheridae leg segmentation is an important character in classifying its genera. Ten nominal genera in this family lack an endopod in leg 4, as in *Andapontius* n. gen. (Table 1). Most of these genera have 3-segmented rami in legs 1–3 and only two genera, *Tupacheres* Stock, 1965 and *Cystomyzon* Stock, 1981, have reduced segmen-

tation in the rami of legs 1–3. The patterns of segmental reductions in the two genera are, however, quite different from that of *Andapontius* n. gen. In *Andapontius* n. gen. legs 1 and 2 have 3-segmented rami, and legs 3 and 4 have a 2-segmented exopod, without an endopod. In contrast, in *Tupacheres* exopods of legs 1–4 and the endopod of leg 3 are 2-segmented and in *Cystomyzon* the exopod of leg 1 and endopods of legs 1–3 are 2-segmented. *Tupacheres* is associated with a sponge in the Mediterranean Sea (Stock, 1965) and *Cystomyzon* was found in galls of a hydrocoral in Papua New Guinea (Stock, 1981).

The possession of the annulated mandibular stylet by *Andapontius* n. gen. is remarkable, because in the Asterocheridae this feature is shared only with the genus *Stockmyzon* Bandera and Huys, 2008. Bandera and Huys (2008) regarded this feature as an autapomorphy of *Stockmyzon*. *Andapontius* n. gen. has another remarkable feature that the antennule has the aesthetasc on the last segment. This feature has been known as a distinguishing character of the family Artotrogidae, but it is shared with four genera in the Asterocheridae: *Asterocheroides* Malt, 1991, *Cephalocheres* Kim, 2010, *Cholomyzon* and *Onychocheres* Stock and Gooding, 1986. The sharing of this feature by the genera of the two different families may reflect the close relationship between these families, as Boxshall and Halsey (2004) mentioned.

A combination of the features that the characteristic leg morphology, the annulated mandibular stylet, and the presence of the aesthetasc on the last antennular segment justify the establishment of the new genus.

Andapontius granulatus n. sp. (Figs. 4, 5)

Material examined. 3 ♀♀ from washings of a mixture of unidentified sponges, SCUBA, 09°43'11"N, 124°32'43"E, Anda, Bohol Island, the Philippines, 3 Apr 2016. Holotype (♀, MABIK Lot No. 8801) and paratype (1 ♀, MABIK Lot No. 8802) have been deposited in the Marine Biodiversity Institute of Korea. Dissected paratype (1 ♀) is retained in the collection of the junior author.

Female. Body (Fig. 4A) with broad prosome and heavily sclerotized exoskeleton. Total length 955 µm. Prosome 623 µm long, circular in dorsal view, and consisting of cephalothorax and 3 metasomites, with granular papillae mainly on lateral sides of prosomal somites. Cephalothorax 426 × 568 µm, wider than long, with blunt posterolateral corners; surface papillae on cephalothorax grouped roughly in 3 patches: anterolateral, mid-lateral and posterolateral. Second and fourth pedigerous somites (first and third metasomites) with angular posterolateral corners, but second pedigerous somite with rounded posterolateral corners. Urosome (Fig. 4B) 4-segmented. Fifth pedigerous somite (first urosomal somite) much narrower than genital complex. Genital complex 127 × 164 µm, distinctly wider than long, with convex lateral margins; genital aperture located dorsolaterally at mid-length of genital complex. Two free abdominal somites, longer than wide, 82 × 64 and 64 × 53 µm, respectively, both unornamented. Caudal rami close to each other. Each ramus (Fig. 4C) 38 × 26 µm, 1.46 times as long as wide, with 6 setae located in distal region; 2 mid-terminal setae (setae IV and V) markedly expanded along proximal third and weakly pinnate along distal half, other setae naked; inner distal seta (seta VI) fused with nearby seta (seta V) at base.

Rostrum absent. Antennule (Fig. 4D) gradually narrowed from proximal to distal, 300 µm long, and 18-segmented; armature formula 2, 2, 2, 2, 2, 2, 2, 2, 7, 2, 2, 2, 2, 2, 2, 2, 15 + 2 aesthetascs; most of setae small; first to fourth segments each with 1 pinnate seta, other setae naked; terminal segment with trace of articulation; one of setae on terminal segment minute and inserted on basal part of one of terminal setae. Antenna (Fig. 4E) consisting of coxa, basis, exopod, and endopod. Coxa short and unornamented. Basis with few minute spinules in subdistal region. Exopod small, about twice as long as wide, with 2 terminal and 1 lateral setae. Endopod 3-segmented; first segment with longitudinal row of fine spinules along distal third; short second segment with 1 small seta subdistally; terminal segment with few setules and armed with spiniform terminal claw (43 µm long) and 3 unequal setae (largest one pinnate along distal half; outermost one minute, hardly visible).

Oral cone (Fig. 4F, G) stout, about 159 × 77 µm in anterior (ventral) view, antero-posteriorly deeper than maximum width, extending to anterior margin of maxilliped insertions, with fine lateral setules at distal region. Mandible (Fig. 4H) consisting of stylet and palp. Stylet 136 µm long, annulated near proximal fourth, with 12 teeth at distal region. Palp 2-segmented; proximal segment 50 µm long; distal segment 18 µm long, ornamented with few setules distally and armed with 2 unequal, pinnate terminal setae (202 µm and 77 µm long). Maxillule (Fig. 4I) bilobed. Inner lobe 53 × 23 µm, with setules along proximal half, few spinules subdistally, and 5 terminal setae, one minute, other 4 setae 75, 65, 65, and 50 µm long, respectively, 3 of these setae weakly pinnate along mid-region. Outer lobe 50 × 12 µm, unornamented, but armed with 4 terminal setae; one minute; other 3 setae 93, 91, and 67 µm long, respectively. Maxilla (Fig. 4J) consisting of syncoxa and distal claw (basis); syncoxa with flexible, aesthetasc-like tubular extension of maxillary gland proximally and row of fine spinules at proximal region; distal claw slender, with few minute setules and spinules in distal half. Maxilliped (Fig. 5A) 5-segmented; first segment (syncoxa) with 1 small seta at distal area of inner margin; second segment (basis) with 1 minute seta slightly distal to middle of inner margin; three distal segments (endopod) with 2, 1, and 1 setae, respectively; terminal claw straight, 45 µm long, longer than terminal segment (31 µm long), with fine spinules on inner margin.

Legs 1 and 2 (Fig. 5B, C) with 3-segmented rami; both legs without inner coxal seta; outer seta on basis naked, other setae pinnate. Legs 3 and 4 (Fig. 5D, E) consisting of unarmed coxa, basis with naked outer seta, and 1-segmented exopod bearing 2 naked distal setae; intercoxal plate and endopod absent. Leg 3 smaller than leg 4. Armature formula for legs 1 and 2 as follows:

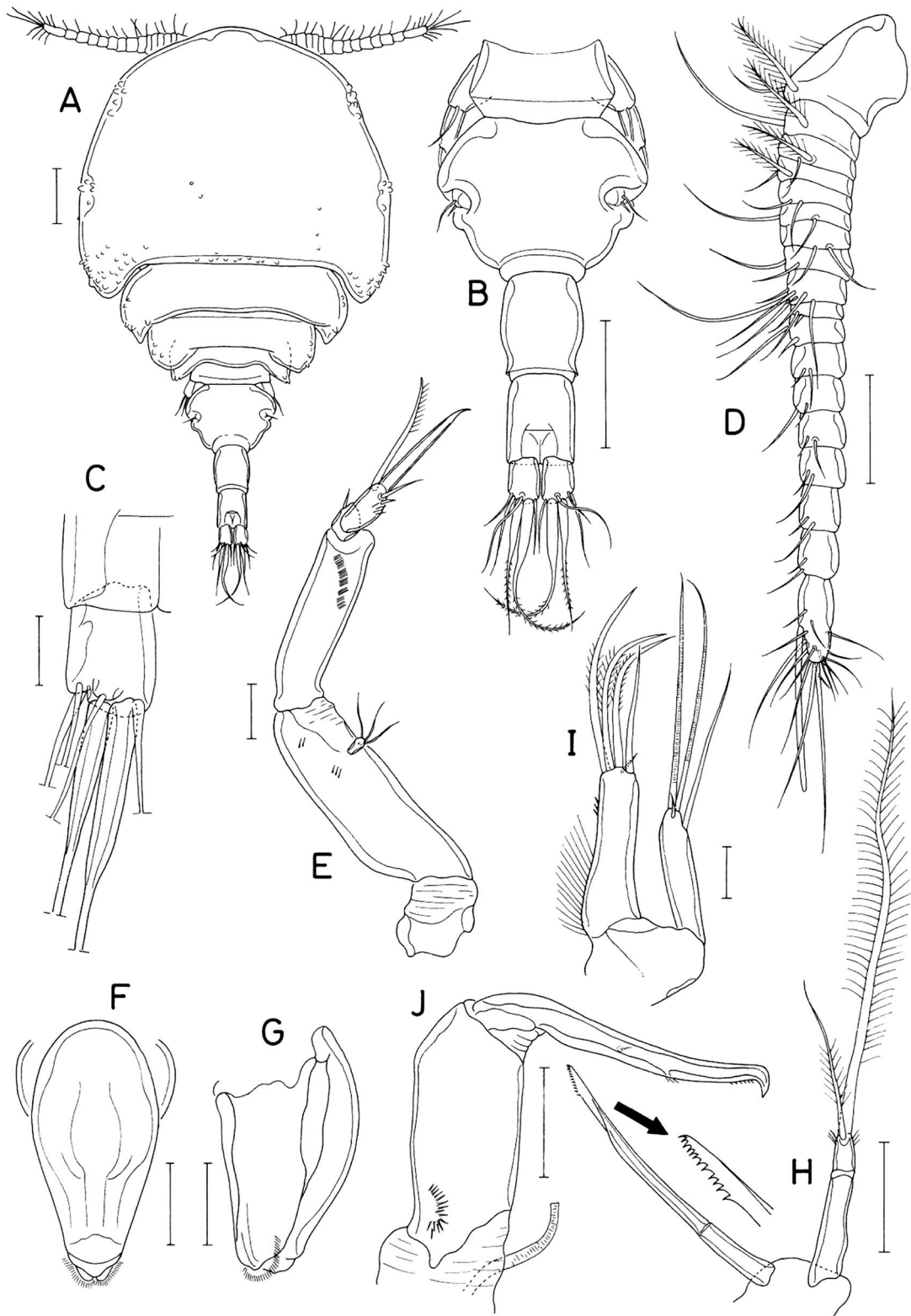


Fig. 4. *Andapontius granulatus* n. gen. n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Caudal ramus, dorsal; D, Antennule; E, Antenna; F, Oral cone, anterior; G, Oral cone, right; H, Mandible; I, Maxillule; J, Maxilla. Scale bars: A, B=0.1 mm, C, E, I=0.02 mm, D, F-H, J=0.05 mm.

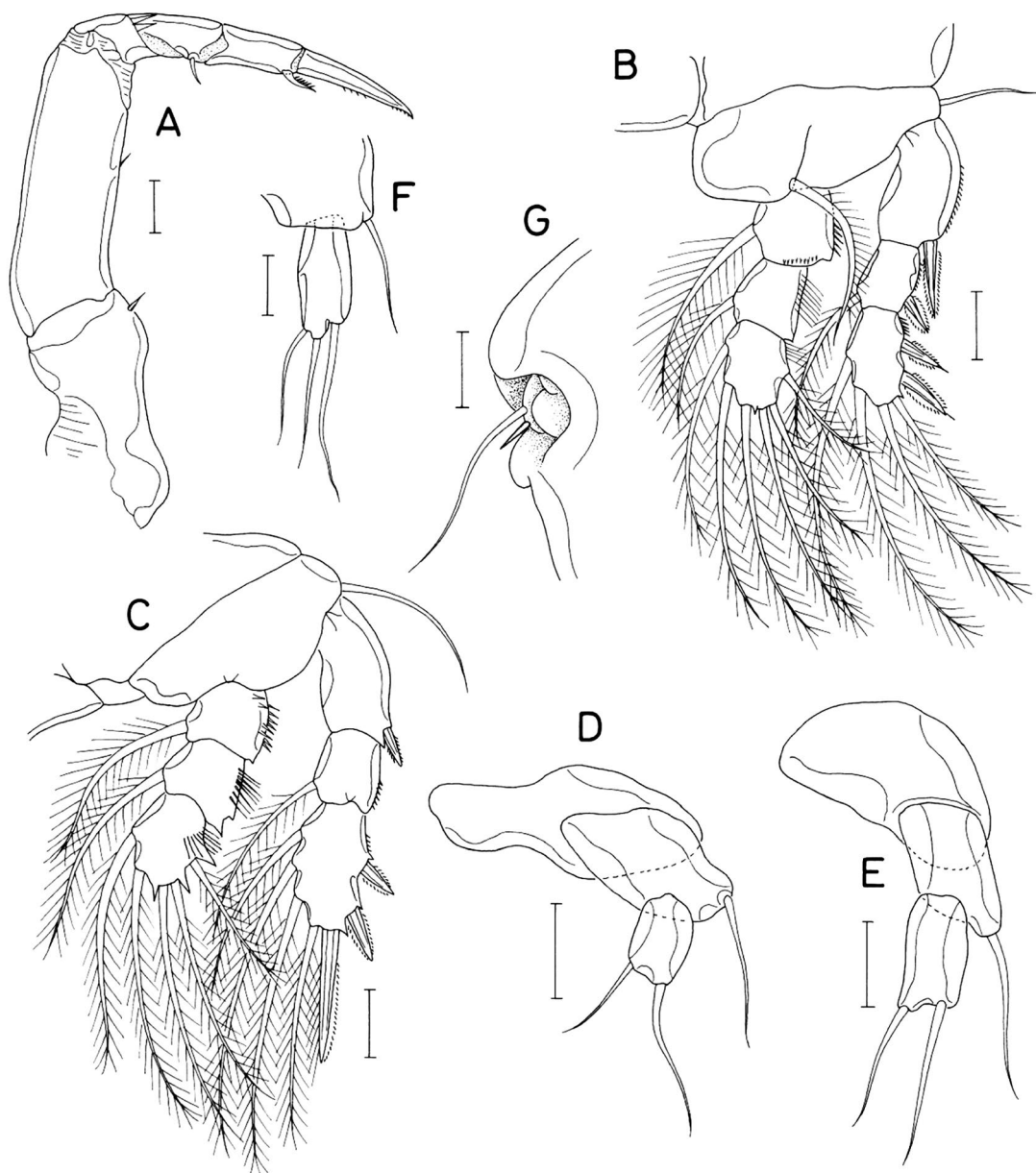


Fig. 5. *Andapontius granulatus* n. gen. n. sp., female. A, Maxilliped; B, Leg 1; C, Leg 2; D, Leg 3; E, Leg 4; F, Leg 5; G, Genital aperture. Scale bars: A-G=0.02 mm.

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

Leg 5 (Fig. 5F) consisting of protopod and 1-segmented exopod; protopod not articulated from fifth pedigerous somite, but with 1 naked outer distal seta; exopod $41 \times 18 \mu\text{m}$, 2.28 times as long as wide, with 3 naked distal setae, all longer than exopod. Leg 6 represented by 1 long and 1 short,

naked setae on genital operculum (Fig. 5G).

Male. Unknown.

Etymology. The specific name *granulatus* alludes to the granulated dorsal surface of prosomal somites of the new species.

***Holobinus* n. gen.**

Diagnosis (female). Asterocheridae. Body cyclopiform,

with well developed exoskeleton. Prosome narrow and 4-segmented. Urosome 4-segmented. Caudal ramus with 6 setae; 2 mid-terminal setae expanded proximally. Rostrum absent. Antennule 18-segmented, with aesthetasc on terminal segment. Antenna with small exopod; endopod 3-segmented, with spiniform terminal claw. Oral cone short, evenly tapering distally. Mandible consisting of stylet and 2-segmented palp armed with 2 unequal terminal setae. Maxillule bilobed; inner lobe with 4 distal setae; outer lobe shorter than inner lobe, with 3 large and 1 minute setae. Maxilla consisting of syncoxa and claw. Maxilliped consisting of syncoxa, basis, and 3-segmented endopod. Legs 1 and 2 biramous, with 3-segmented exopod and 2-segmented endopod. Armature formula of leg 1: I-0; I-0; II, 2, 0 for exopod; 0-0; 0, 2, 0 for endopod. Armature formula of leg 2: I-0; I-1; II, 1, 0 for exopod; 0-0; 0, 2, 0 for endopod. Leg 3 uniramous, consisting of unarmed coxa, basis bearing outer seta, and 2-segmented exopod bearing 1 outer spine on first segment and 2 spines on distal segment; endopod absent. Leg 4 as a lobe bearing 1 apical seta. Leg 5 consisting of 1 dorsodistal seta on fifth pedigerous somite and exopod bearing 3 distal setae. Leg 6 represented by 1 long and 1 minute setae and 1 small spinule on genital operculum.

Type species. *Holobinus angustus* n. sp.

Etymology. The generic name is from an anagram of *Bohol*, the name of an island in the Philippines, where the new copepod genus was found, and *-inus*, a Latin suffix denoting "belonging to." The gender is masculine.

Remarks. *Holobinus* n. gen. has a rudimentary leg 4, as a diagnostic feature. There are five genera in the Asterocheridae having no leg 4 or an extremely reduced leg 4 which is represented by a seta or a lobe tipped by one or two setae, as follows: *Cholomyzon*, *Coralliomyzon*, *Oedomyzon*, *Doropontius*, and *Cystomyzon*. Of these, only a single genus, *Cystomyzon*, exhibits further segmental reductions in legs 1–3, like *Holobinus* n. gen. (Table 1). However, the pattern of segmental reductions in legs 1–3 is different between the two genera. In *Holobinus* n. gen. endopods of legs 1 and 2 and the exopod of leg 3 are reduced to a 2-segmented condition, with no endopod in leg 3, while in *Cystomyzon* both rami of leg 1 and the endopods of legs 2 and 3 are 2-segmented. As other significant differences, *Cystomyzon* has a 7-segmented (rather than 18-segmented in *Holobinus* n. gen.) antennule in the female, only a single seta on the outer lobe of the maxillule, no terminal claw on the antenna, and no leg 5 in the female (Stock, 1981).

***Holobinus angustus* n. sp. (Figs. 6, 7)**

Material examined. 3♀♀ from washings of a mixture of unidentified sponges, SCUBA, 09°43'11"N, 124°32'43"E,

Anda, Bohol Island, the Philippines, 3 Apr 2016. Holotype (♀, MABIK Lot No. 8803) and paratype (1♀, MABIK Lot No. 8804) have been deposited in the Marine Biodiversity Institute of Korea. Dissected paratype (1♀) is retained in the collection of the junior author.

Female. Body (Fig. 6A, B) small, cyclopiform, 593 µm in length, with sclerotized exoskeleton. Prosome 352 µm long, distinctly narrowing from anterior to posterior, slightly wider than dorsoventral depth, and consisting of cephalothorax and 3 metasomites. In lateral view dorsal margin of prosome convex (Fig. 6A). All prosomal somites without epimera, but with rounded posterolateral corners. Cephalothorax 250 × 250 µm, occupying more than 70% of prosomal length. Three metasomites distinctly shortened and narrowing from anterior to posterior. Urosome (Fig. 6C) 4-segmented. Fifth pedigerous somite (first urosomal somite) about 36 × 86 µm. Genital complex 114 µm long, narrowing stepwise from anterior to posterior in dorsal view; widest anterior part 127 µm wide (genital aperture located ventrodistally at this part), followed by parallel middle part of 92 µm wide; narrow posterior part trapezoid, gradually widening posteriorly (43 µm wide proximally and 61 µm wide distally). First free abdominal somite 48 × 48 µm, slightly widened distally. Anal somite 30 × 56 µm, distinctly shorter than first abdominal somite and distinctly widening posteriorly. Caudal rami (Fig. 6D) convergent; each ramus slightly widened distally, almost rectangular, 47 × 25 µm, 1.88 times as long as wide, and armed with 6 naked setae; 2 mid-terminal setae (setae IV and V) distinctly larger (103 and 75 µm long, respectively) than other 4, with greatly expanded proximal half; remaining 4 setae slender and shorter than ramus length.

Rostrum absent. Antennule (Fig. 6E) 160 µm long and 18-segmented; armature formula 2, 2, 2, 2, 2, 2, 2, 7, 2, 2, 2, 2, 2, 2, 1, and 16 + aesthetasc, respectively; all of setae naked; one of setae on terminal segment inserted at proximal part of largest terminal seta; aesthetasc on terminal segment relatively short, almost as long as terminal segment. Antenna (Fig. 6F) with short, unornamented coxa. Basis longest segment, ornamented with spinules on proximal half of anterior margin and 2 rows of fine spinules on outer surface. Exopod small, located at 0.6 region of basis, and armed with 1 lateral and 2 distal setae. Endopod 3-segmented; first segment with row of fine spinules along distal half of segment; short second segment with 1 small setae subdistally; distal segment with straight terminal claw (24 µm long) bearing spinules along both margins, and with 2 small subdistal setae and 1 long, bluntly tipped terminal seta.

Oral cone rather short (Fig. 6A) and consisting of distally blunt labrum (anterior part of oral cone, Fig. 6G) and pointed labium (posterior part) (Fig. 6H). Mandibular stylet (Fig. 6I) 73 µm long, with 9 minute teeth distally; palp (Fig. 6J)

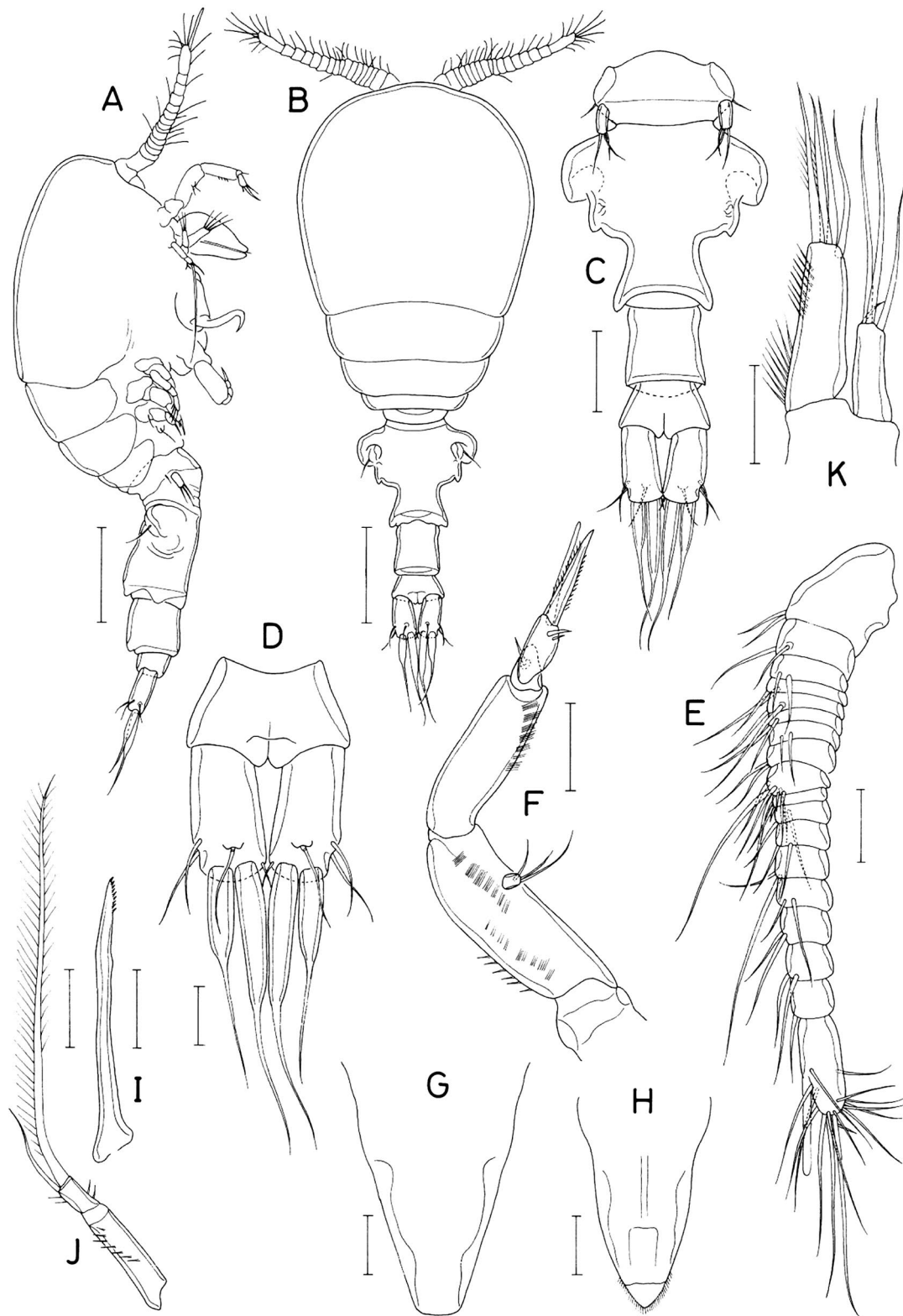


Fig. 6. *Holobinus angustus* n. gen. n. sp., female. A, Habitus, right; B, Habitus, dorsal; C, Urosome, ventral; D, Anal somite and caudal rami, dorsal; E, Antennule; F, Antenna; G, Labral part of oral cone; H, Labial part of oral cone; I, Mandibular stylet; J, Mandibular palp; K, Maxillule. Scale bars: A, B=0.1 mm, C=0.05 mm, D-K=0.02 mm.

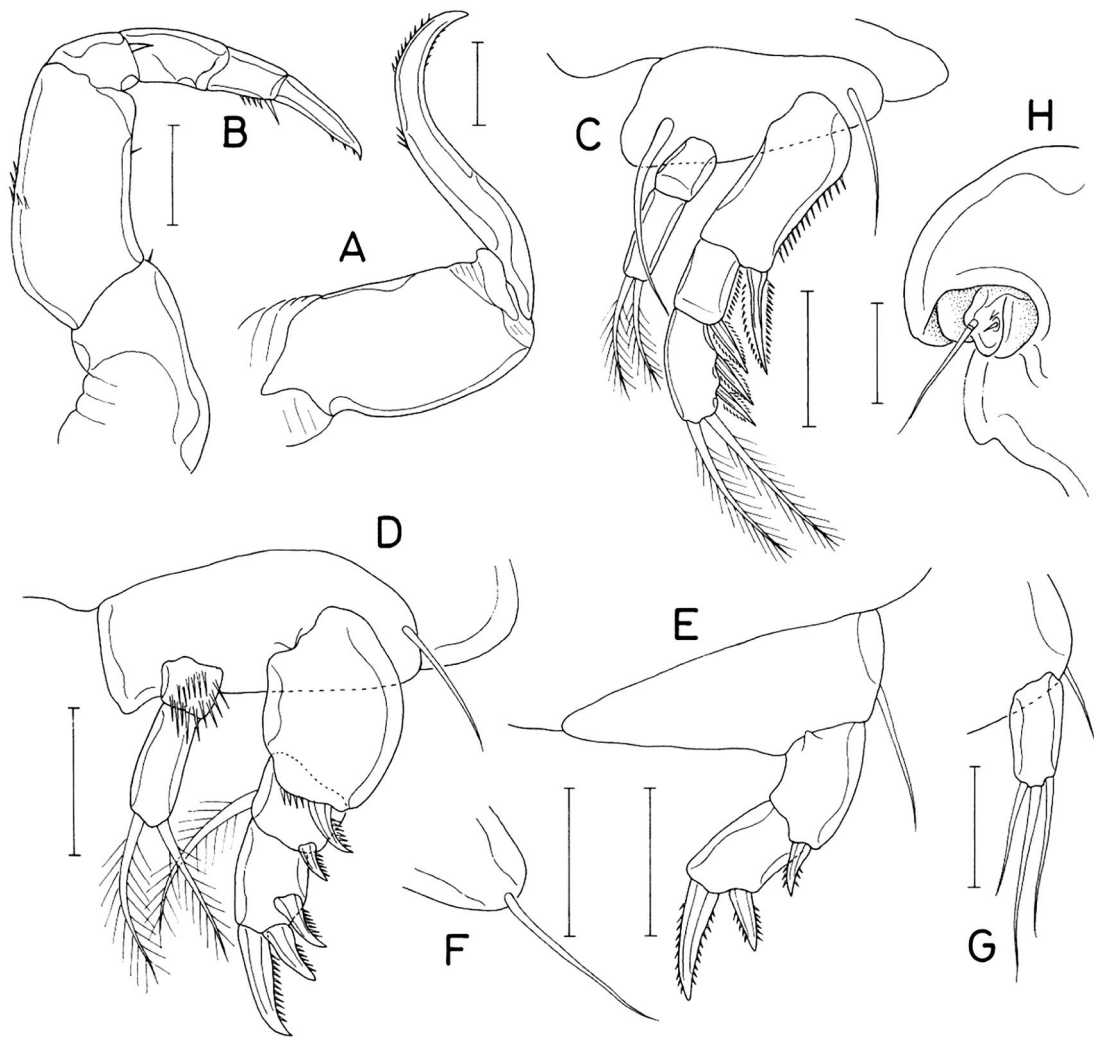


Fig. 7. *Holobinus angustus* n. gen. n. sp., female. A, Maxilla; B, Maxilliped; C, Leg 1; D, Leg 2; E, Leg 3; F, Leg 4; G, Leg 5; H, Genital aperture. Scale bars: A-H=0.02 mm.

2-segmented, both segments ornamented with few spinules; proximal segment 29 μm long; distal segment 11 μm long, distally with 1 large, 113 μm -long, pinnate seta and 1 small, 25 μm -long, naked seta. Maxillule (Fig. 6K) bilobed; inner lobe 33 μm long, with 2 groups of thick setules (or spinules) along inner margin and 4 subequal apical setae; lengths of these setae 33, 31, 30, and 28 μm ; outer lobe 20 μm long, 0.6 times as long as inner lobe, and armed distally with 3 prominent setae (47, 45, and 32 μm long) and 1 rudimentary seta. Maxilla (Fig. 7A) 2-segmented; syncoxa smooth; distal claw strongly curved, with spinules in middle of convex margin and on distal part of both margins. Maxilliped (Fig. 7B) 5-segmented. Syncoxa with 1 rudimentary seta at inner distal corner. Basis with 1 rudimentary seta on inner margin and several spinules on outer surface. Endopod armed with 1,

0, and 1 setae on first to third segments, respectively; third segment with several spinules on inner margin; terminal claw 22 μm long, about 1.8 times as long as third endopodal segment, with few spinules along distal region of inner margin.

Legs 1 and 2 (Fig. 7C, D) biramous, with 3-segmented exopod and 2-segmented endopod. First exopodal segment of leg 1 with spinules along outer margin. First exopodal segment of leg 2 expanded, with smooth outer margin. First endopodal segment of leg 1 smooth, but that of leg 2 spinulose. Leg 3 (Fig. 7E) uniramous, with 2-segmented exopod. Basis of legs 1–3 with naked outer seta. Basis of leg 1 with long and naked inner seta. Leg 4 (Fig. 7F) represented by a lobe tipped by 1 naked seta. Inner seta of coxa absent in all of legs. Armature formula for legs 1–3 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1:	0-0	1-1	I-0; I-0; II, 2, 0	0-0; 0, 2, 0
Leg 2:	0-0	1-0	I-0; I-1; II, I, 0	0-0; 0, 2, 0
Leg 3:	0-0	1-0	I-0; I, I, 0	Absent

Leg 5 (Fig. 7G) consisting of 1-segmented free exopod and 1 naked outer seta on fifth pedigerous somite; exopod $18 \times 9 \mu\text{m}$, twice as long as wide, gradually narrowing distally, and armed with 3 distal, naked setae. Leg 6 represented by 1 minute seta, 1 minute spinule and 1 longer, basally articulated seta on genital operculum (Fig. 7H).

Male. Unknown.

Etymology. The specific name *angustus* is a Latin meaning “narrow”, alluding to the narrow body of the new species.

Remarks. In both *Holobinus angustus* n. sp. and *Andapontius granulatus* n. sp., the exoskeleton is thick, well-developed and the two mid-terminal setae of the caudal ramus are proximally expanded. Presumably, the shareness of these features may reflect their similar habitats or hosts.

Genus *Dermatomyzon* Claus, 1889

***Dermatomyzon boxshalli* n. sp. (Figs. 8, 9)**

Material examined. 1 ♀ (holotype, MABIK Lot No. 8805) from washings of a mixture of unidentified sponges, SCUBA, $9^{\circ}45'14.15''\text{N}$, $124^{\circ}35'41.27''\text{E}$, depth 28 m, Anda, Bohol Island, the Philippines, 31 Mar 2016. Holotype (dissected and mounted on a glass slide) has been deposited in the Marine Biodiversity Institute of Korea.

Female. Body (Fig. 8A) cyclopiform, 1.05 mm in length. Prosome oval, $682 \mu\text{m}$ long, consisting of cephalothorax and second to fourth pedigerous somites. Cephalothorax $464 \mu\text{m}$ long, about 68% of prosomal length. Posterolateral corners of cephalothorax and second and third pedigerous somites rounded or blunt. Fourth pedigerous somite with point at both sides of posterior margin; mid-region of posterior margin concave. Urosome (Fig. 8B) 5-segmented. Fifth pedigerous somite $133 \mu\text{m}$ wide, with angular lateral apices. Genital double-somite $127 \times 112 \mu\text{m}$, 1.13 times as long as wide, with sub-parallel lateral margins; genital aperture located dorsolaterally at proximal one-third. Three free abdominal somites 58×91 , 47×93 , and $38 \times 93 \mu\text{m}$, respectively. Second free abdominal and anal somites dark brown in color, contrasting to pale yellow in remaining parts of body. Anal somite with fine spinules on ventral surface and along posteroventral margin (Fig. 8C). Caudal ramus (Fig. 8C) $46 \times 41 \mu\text{m}$, 1.12 times as long as wide, armed with 6 setae and with short tubular extension and spinules on posterior margin and setules on inner margin.

Rostrum (Fig. 8D) prominent, tapering, longer than wide,

with rounded posterior apex. Antennule (Fig. 8E) $300 \mu\text{m}$ long and 13-segmented; armature formula 1, 10, 2, 5, 2, 2, 2, 1, 1, 2, 2 + aesthetasc, 1, and 11; seta on first segment not enlarged, shorter than width of segment; 6th seta on second segment and distal seta on third segment spiniform, with spinules along proximal margin, all of remaining setae naked; 2 distalmost segments narrower than other proximal segments; aesthetasc on antepenultimate segment long, about 0.6 times as long as combined antennular segments. Antenna (Fig. 8F) with short, unornamented coxa. Basis the longest segment with fine spinules and setules in distal half. Exopod $16 \times 5 \mu\text{m}$, about 3 times as long as wide, and armed with 3 setae (1 distal, 1 subdistal, and 1 lateral), all of these setae with annulation at base. Endopod 2-segmented; first segment with scattered spinules; second segment with 4 setae (1 lateral and 3 distal) and setules; terminal claw $80 \mu\text{m}$ long, more than 3 times as long as second endopodal segment, weakly curved distally, with fine spinules along both margins.

Oral cone (Fig. 8G) $136 \times 114 \mu\text{m}$, strongly tapering, its distal third digitiform, abruptly narrower than proximal part. Mandible (Fig. 8H) consisting of stylet and 1-segmented palp; stylet $107 \mu\text{m}$ long, with narrowed distal third and several minute teeth at distal region; palp $39 \mu\text{m}$ long, gradually narrowing distally, and armed with 2 pinnate unequal setae distally, smaller seta $56 \mu\text{m}$ long and larger seta more than twice as long as smaller one. Maxillule (Fig. 8I) bilobed; inner lobe curved, armed with 5 weakly spinulose setae of almost equal lengths (more or less than $57 \mu\text{m}$ long) and with few lateral spinules (or setules); outer lobe about $3/4$ length of inner lobe and armed with 3 distal (including minute one) and 1 subdistal setae and with few setules on outer margin; all of setae on outer lobe naked. Maxilla (Fig. 8J) consisting of syncoxa and claw (basis); syncoxa smooth; claw longer and more slender than syncoxa, curved near distal quarter, with 1 large, naked seta proximally (or between syncoxa and claw), 1 small seta near proximal third, setules and spinules near middle and distal region, and terminated by 1 spine (this spine clearly articulated from claw). Maxilliped (Fig. 9A) consisting of syncoxa, basis, and 4-segmented endopod; syncoxa broadened distally, with 1 pinnate seta at inner distal corner and setules at outer distal corner; basis with 1 small pinnate seta at distal third of inner margin and row of setules near middle of outer surface; 4 endopodal segments with 2, 1, 1, and 1 small setae, respectively; second segment obscure; terminal claw $73 \mu\text{m}$ long, twice as long as last endopodal segment, gently curved, with fine spinules along concave inner margin.

Legs 1–4 (Fig. 9B–E) with 3-segmented rami. Leg 1 basis with spinules at inner distal corner; inner seta spiniform and shorter than first endopodal segment. All of setae on legs

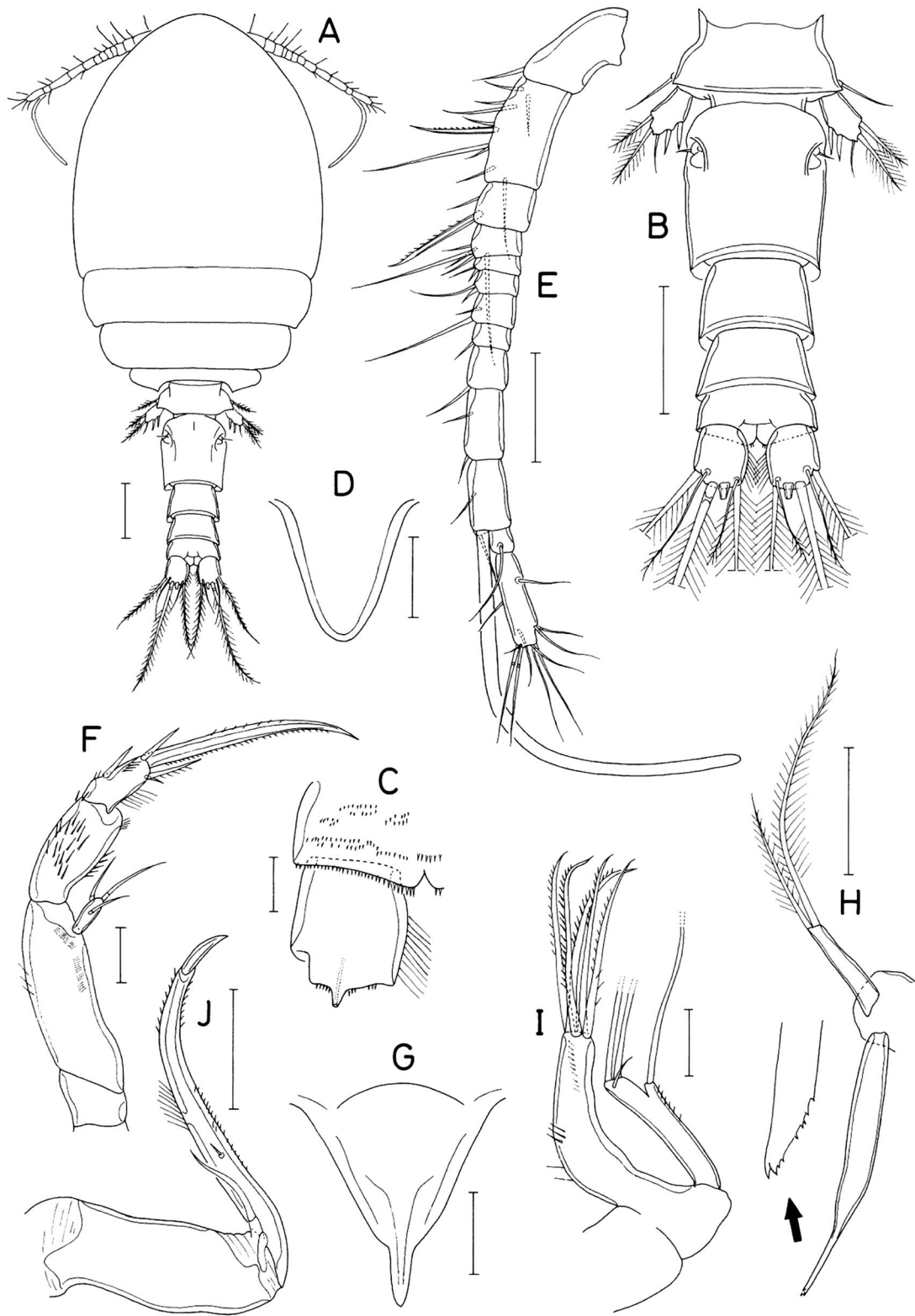


Fig. 8. *Dermatomyzon boxshalli* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Right caudal ramus, ventral; D, Rostrum; E, Antennule; F, Antenna; G, Oral cone; H, Mandible; I, Maxillule; J, Maxilla. Scale bars: A, B=0.1 mm; C, F, I=0.02 mm; D, E, G, H, J=0.05 mm.

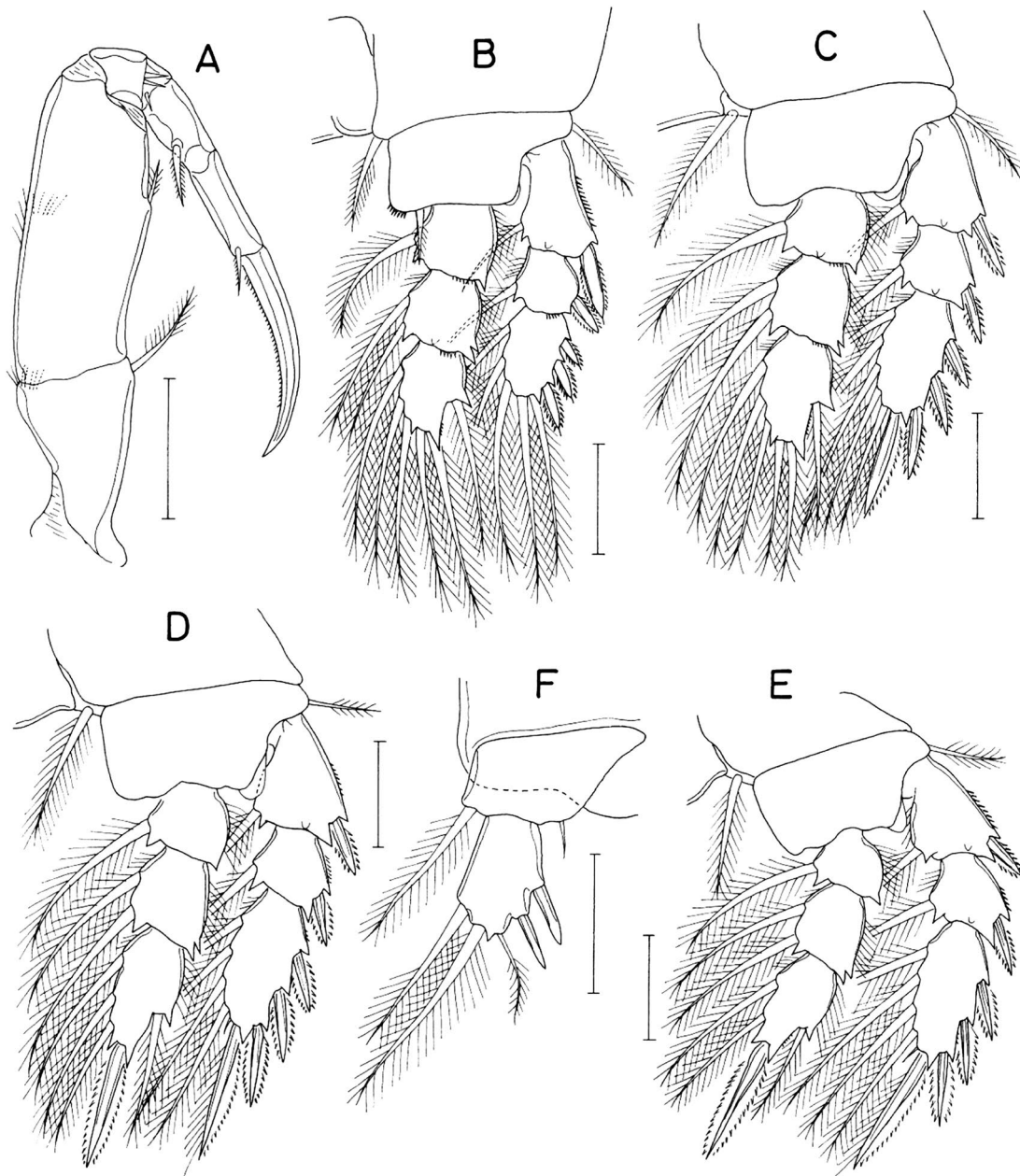


Fig. 9. *Dermatomyzon boxshalli* n. sp., female. A, Maxilliped; B, Leg 1; C, Leg 2; D, Leg 3; E, Leg 4; F, Leg 5. Scale bars: A-F=0.05 mm.

1-4 pinnate. Legs 3 and 4 with 1 minute setule (rudiment of a seta) between terminal spine and inner distal seta on third exopodal segment. Armature formula for legs 1-4 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1:	0-1	1-1	I-1; I-1; III, 2, 3	0-1; 0-2; 1, 2, 3

Leg 2:	0-1	1-0	I-1; I-1; III, I, 5	0-1; 0-2; 1, 2, 3
Leg 3:	0-1	1-0	I-1; I-1; III, I, 4	0-1; 0-2; 1, I, 3
Leg 4:	0-1	1-0	I-1; I-1; III, I, 4	0-1; 0-2; 1, I, 2

Leg 5 (Fig. 9F) consisting of free protopod and exopod. Protopod clearly articulated from fifth pedigerous somite, wider than long, and armed with 1 pinnate outer distal seta

and 1 vestigial inner distal seta. Exopod $44 \times 27 \mu\text{m}$, 1.63 times as long as wide, and armed with 2 inner spines (proximal one $20 \mu\text{m}$ long and distal one $19 \mu\text{m}$ long), 1 small distal seta, 2 larger, outer subdistal setae; distal apex pointed. Leg 6 represented by 1 small naked seta on genital operculum (Fig. 8B).

Male. Unknown.

Etymology. The new species is named after Prof. Geoffrey A. Boxshall who thoroughly described and illustrated *Dermatomyzon nigripes* Brady and Robertson, 1875 (Boxshall, 1990).

Remarks. *Dermatomyzon* Claus, 1889 is a monotypic genus represented by *D. nigripes* (Brady and Robertson, 1875) (see Ivanenko and Ferrari, 2003). Differences of *D. boxshalli* n. sp. from *D. nigripes* are slight but cannot be ignored, revealing in the caudal ramus, antennule and maxilla.

The caudal ramus of the female of *D. nigripes* was recorded as 1.3 times (Boxshall, 1990) or 1.31 times (Kim, 1998) or twice (Brady, 1910) as long as wide, compared to 1.12 times as long as wide in *D. boxshalli* n. sp.

Unlike *D. boxshalli* which has a 13-segmented female antennule, the same appendage of the female of *D. nigripes* is known as 19-segmented (Claus, 1889; Giesbrecht, 1899; Brady, 1910; Sars, 1915; Eiselt, 1965; Boxshall, 1990; Kim, 1998; Ivanenko and Ferrari, 2003), although Giesbrecht (1899) reported a 14-segmented condition as a variety. In all previously illustrated antennule of *D. nigripes*, the seta on the first segment appears to be large, distinctly longer than the width of the segment, whereas it is small, shorter than the width of the segment in *D. boxshalli* n. sp.

The maxilla of *D. boxshalli* n. sp. has a large seta at base of distal claw (or between the syncoxa and the claw). In previous records of *D. nigripes* this seta has been recognized as a small, rudimentary element (Boxshall, 1990; Kim, 1998), if any.

Family Entomolepididae Brady, 1899

Genus *Entomopsyllus* McKinnon, 1988

***Entomopsyllus brevicaudatus* n. sp. (Figs. 10, 11)**

Material examined. 2♀♀ from washings of a mixture of unidentified sponges, SCUBA, depth 25–34 m, $09^{\circ}44'16''\text{N}$, $124^{\circ}35'18''\text{E}$, Anda, Bohol Island, the Philippines, 5 Apr 2016. Holotype (♀, MABIK Lot No. 8806) has been deposited in the Marine Biodiversity Institute of Korea. Dissected paratype (1♀) is retained in the collection of the junior author.

Female. Body (Fig. 10A) extremely flattened dorsoventrally. Prosome oval in dorsal view, $1.15 \times 0.81 \text{ mm}$ and 4-segmented, consisting of cephalothorax and second to fourth

pedigerous somites. Prosomal somites well-sclerotized, 655, 100, 80, and $313 \mu\text{m}$ long, respectively, from anterior to posterior, along midline. Cephalothorax comprising more than half length of prosome. Third pedigerous somite broadened laterally. Urosome (Fig. 10B) 3-segmented, mostly concealed by prosome in dorsal view of body, consisting of genital complex and 2-segmented abdomen. Fifth pedigerous somite fused with genital complex, without trace of articulation between them. Genital complex $189 \times 125 \mu\text{m}$, consisting of broader anterior 0.4 and narrower posterior 0.6 parts; genital aperture located ventrolaterally; paired hollows present dorsolaterally near genital apertures (Fig. 10B). First free abdominal somite $73 \times 62 \mu\text{m}$, longer than wide. Anal somite $69 \times 69 \mu\text{m}$, unornamented. Caudal rami widely separated from each other; each ramus (Fig. 10C) $77 \times 24 \mu\text{m}$, 3.21 times as long as wide, gradually broadening distally, spinulose along distal 2/3 of inner margin, and armed with 6 setae distally; 2 of these setae (setae III and VI) articulated proximally, with broader proximal part and narrower distal part.

Rostrum absent. Antennule (Fig. 10D) $309 \mu\text{m}$ long, slender, and 17-segmented; armature formula 1, 2, 8, 1, 2, 5, 3, 2, 2, 2, 2, 2, 2, 3 + aesthetasc, 1, and 11; aesthetasc on antepenultimate segment slender, setiform; all of setae naked, stiff and brittle. Antenna (Fig. 10E) with short, unornamented coxa. Basis with few scattered spinules. Exopod elongate, $69 \times 6.5 \mu\text{m}$, 10.62 times as long as wide, slightly shorter than first endopodal segment, ornamented with patches of setules on all surfaces, and armed with 1 distal and 1 subdistal, naked setae. Endopod 2-segmented; first segment $73 \mu\text{m}$ long, with many spinules on outer surface; second segment $33 \mu\text{m}$ long, with setules and spinules, and armed with 1 lateral and 3 unequal distal setae; terminal claw $42 \mu\text{m}$ long, weakly curved, with few spinules on margins.

Oral siphon (Fig. 10F) about $910 \mu\text{m}$ long, thin, extending over posterior margin of prosome. Mandible (Fig. 10G) consisting stylet and palp; stylet thread-like, with annulation proximally; palp slender and 2-segmented; proximal segment $40 \mu\text{m}$ long and smooth; distal segment hirsute, $85 \mu\text{m}$ long, with 2 setae distally (94 and $46 \mu\text{m}$ long, respectively). Maxillule (Fig. 10H) bilobed, both lobes widely separated from each other; inner lobe shorter than outer lobe, with 3 extremely unequal setae distally; lengths of these setae 450, 197, and $98 \mu\text{m}$, respectively; outer lobe spinulose, with 4 small, naked setae distally, longest $83 \mu\text{m}$. Maxilla (Fig. 10I) consisting of syncoxa and distal claw (basis); syncoxa slightly expanded near proximal third and unornamented; distal claw strongly curved near tip, with few setules near distal third. Maxilliped (Fig. 11A) consisting of syncoxa, basis, and 4-segmented endopod; syncoxa with 1 small seta subdistally; basis unarmed, but with spinules on outer mar-

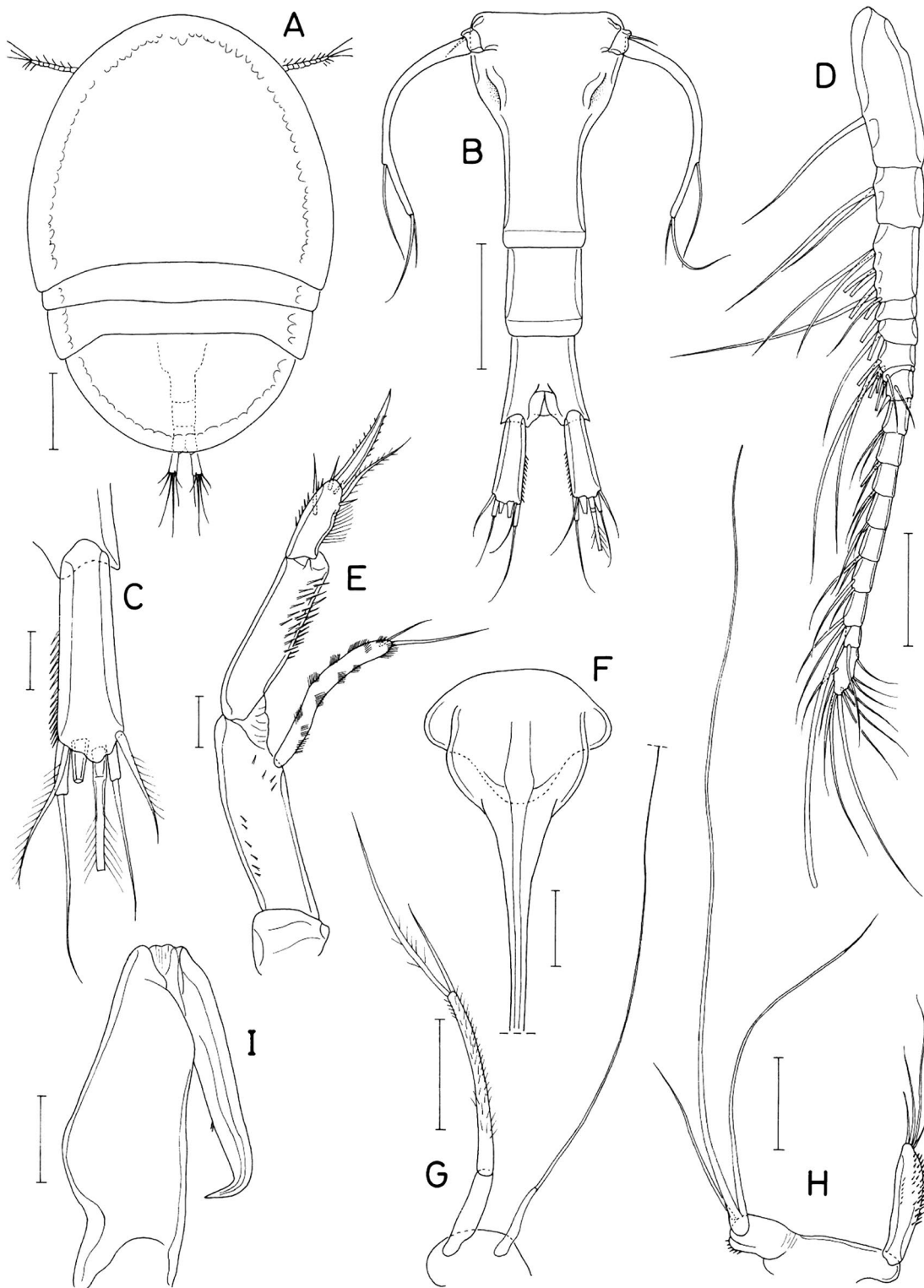


Fig. 10. *Entomopsyllus brevicaudatus* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Caudal ramus, dorsal; D, Antennule; E, Antenna; F, Oral siphon; G, Mandible; H, Maxillule; I, Maxilla. Scale bars: A=0.2 mm, B=0.1 mm, C, E=0.02 mm, D, F-I, 0.05 mm.

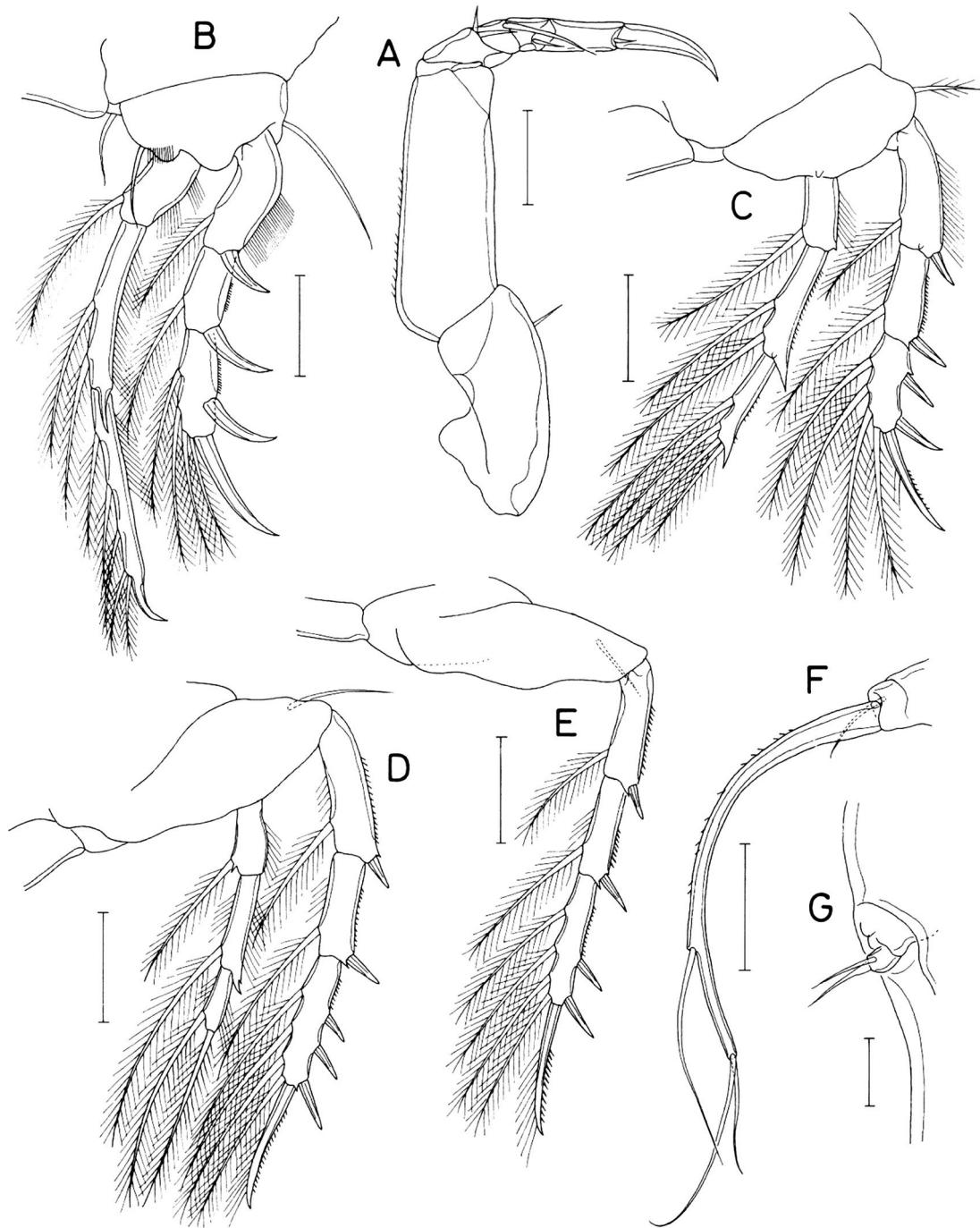


Fig. 11. *Entomopsyllus brevicaudatus* n. sp., female. A, Maxilliped; B, Leg 1; C, Leg 2; D, Leg 3; E, Leg 4; F, Leg 5; G, Genital aperture. Scale bars: A-F=0.05 mm, G=0.02 mm.

gin; endopod with 2, 1, 1, and 1 setae, respectively, on first to fourth segments; terminal claw 60 μ m long, 1.58 times as long as last endopodal segment.

Legs 1-3 (Fig. 11B-D) biramous, with 3-segmented rami.

Leg 4 (Fig. 11E) uniramous, with 3-segmented exopod; endopod absent. Rami of all legs slender. Leg 1 with naked inner coxal seta; outer and inner setae on basis also naked; endopod extremely slender and distinctly longer than ex-

Table 2. Differences among four nominal species of *Entomopsyllus*

Characters	<i>E. adriae</i> (Eiselt, 1959)	<i>E. nichollsi</i> McKinnon, 1988	<i>E. stocki</i> Kim, 2004	<i>E. brevicaudatus</i> n. sp.
Caudal ramus, length/width	7	5	5.79	3.21
Segments of ♀ antennule	16	11 or 12	15	17
Inner seta on basis of leg 1	Absent	Absent	Absent	Present
Setae on 2nd endopodal segment of leg 2	2	1	1	2
Setae on 3rd endopodal segment of leg 2	5	5	6	4
Armature of 3rd exopodal segment of leg 3	II, I, 4	II, I, 4	II, I, 4	III, I, 4
Setae on 3rd endopodal segment of leg 3	3	3	3	2
Armature of 3rd exopodal segment of leg 4	II, I, 3	II, I, 4	II, I, 2	II, I, 4
Distributions and references	Adriatic Sea (Eiselt, 1965)	Australia (McKinnon, 1988)	Madagascar (Kim, 2004)	The Philippines (this paper)

opod. Legs 2–4 without inner coxa seta. Second and third endopodal segments of legs 1 and 2 with pronounced, spiniform outer distal process. Legs 3 and 4 with incomplete articulation between coxa and basis. Armature formula for legs 1–4 as follows:

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

Leg 5 (Fig. 11F) 2-segmented. Protopod short, incompletely articulated from somite, with 1 dorsal seta. Exopod elongate and arched, 174 × 12 μm, 14.5 times as long as wide, with spinules on outer margin, and armed with 3 naked setae: outer lateral seta 88 μm long, located at 0.74 of exopod length; 2 distal setae 77 and 45 μm long, respectively. Leg 6 (Fig. 11F) represented by 2 setae on genital operculum.

Male. Unknown.

Etymology. The specific name is a combination of Latin words *brevis* (= short) and *cauda* (= tail), alluding to the relatively short caudal rami of the new species.

Remarks. Species of *Entomopsyllus* McKinnon, 1988 are readily distinguishable from one another on the basis of their species-specific leg setations. *Entomopsyllus brevicaudatus* n. sp. uniquely has an inner seta on the basis of leg 1, only four setae on the third endopodal segment of leg 2, and only two setae on the third endopodal segment of leg 3. Differences of leg setations among four species are summarized in Table 2.

The caudal ramus of *E. brevicaudatus* n. sp. is shorter than those of three congeners, only 3.21 times as long as wide, comparable to at least 5 times known in *E. nichollsi* McKinnon, 1988. The female antennule of *E. brevicaudatus*

n. sp. is 17-segmented, with more expressed segments than in other congeners.

Genus *Paralepeopsyllus* Ummerkutty, 1960

***Paralepeopsyllus leei* n. sp. (Figs. 12, 13)**

Material examined. 4 ♀♀ from washings of a mixture of unidentified sponges, SCUBA, depth 28 m, 09°43'02"N, 124°32'17"E, Anda, Bohol Island, the Philippines, 4 Apr 2016. Holotype (♀, MABIK Lot No. 8807) and paratypes (2 ♀♀, MABIK Lot No. 8808) have been deposited in the Marine Biodiversity Institute of Korea. Dissected paratype (♀) is retained in the collection of the junior author.

Female. Body (Fig. 12A) discoid, and circular in dorsal view. Prosome 940 μm long, 3-segmented, 832 μm in greatest width, well-sclerotized, ornamented with numerous setules and pits; each pit with bifurcate sensilla (Fig. 12C). First prosomal somite (cephalothorax) 563 μm long along midline, with truncate rostral prominence and extended, angular posterolateral corners. Second prosomal somite (fused second and third pedigerous somites) 45 μm long along midline, 709 μm wide, with deeply concave posterior margin and angular posterolateral corners. Third prosomal somite (fourth pedigerous somite) 332 × 532 μm, with serrate posterior margin. Urosome (Fig. 12B) 3-segmented, narrow, and mostly concealed by prosome in dorsal view of body. Fifth pedigerous somite obscure. Genital complex 152 × 98 μm, 1.55 times as long as wide, consisting of broader anterior 2/5 and narrower posterior 3/5; narrower posterior part gradually narrowing posteriorly; genital aperture located laterally at posterolateral areas of broader anterior part. First free abdominal somite 61 × 52 μm. Anal somite 55 × 64 μm, distinctly widened distally; anal operculum small but distinct. Caudal rami well-separated from each other; each ramus (Fig. 12D) 61 × 20 μm, 3.05 times as long as wide, with

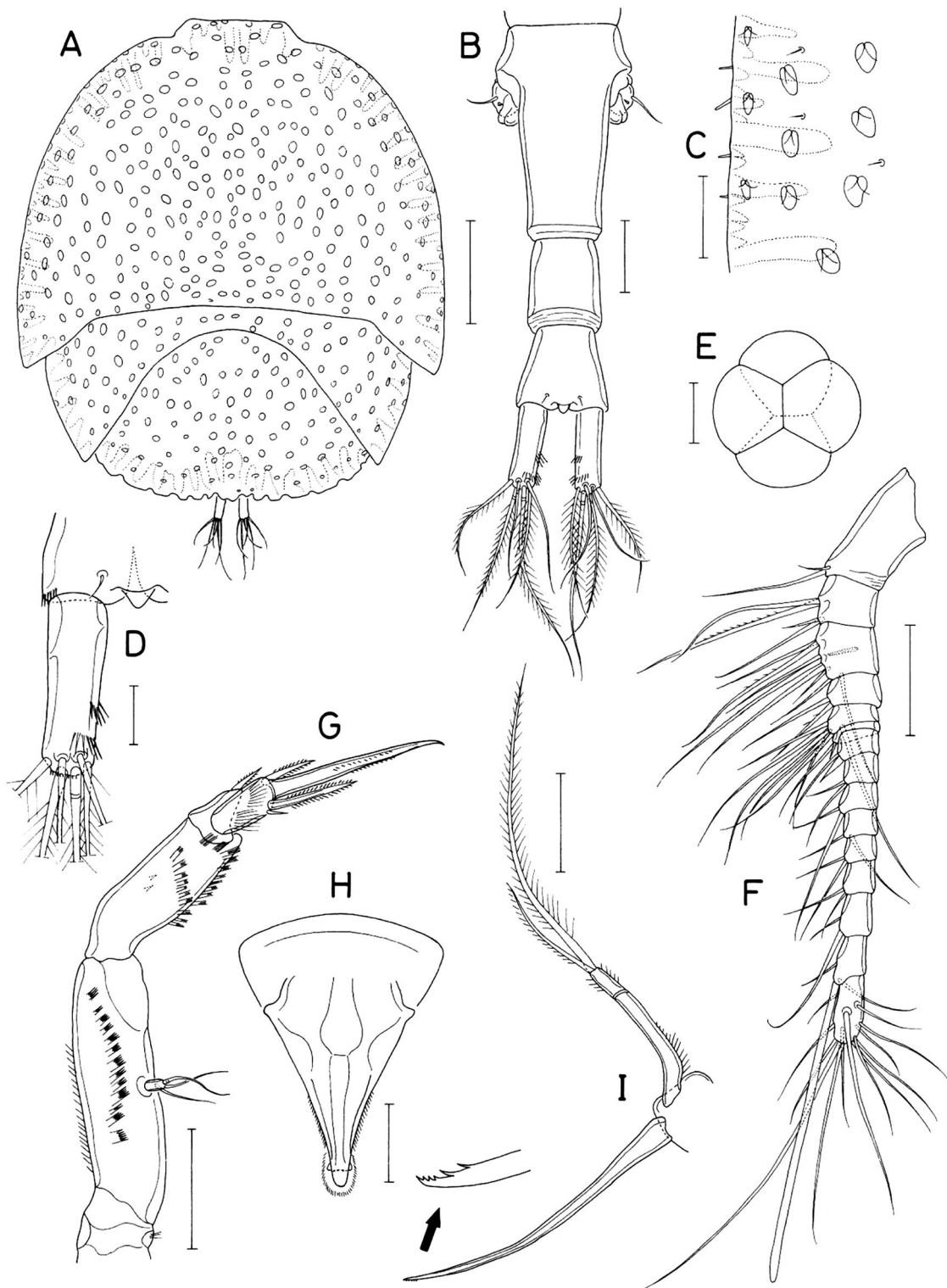


Fig. 12. *Paralepeopsyllus leei* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Dorsal ornamentalations of cephalothorax; D, Caudal ramus, dorsal; E, Egg sac; F, Antennule; G, Antenna; H, Oral cone; I, Mandible. Scale bars: A=0.2 mm, B, C, F-H=0.05 mm, D, I=0.02 mm, E=0.1 mm.

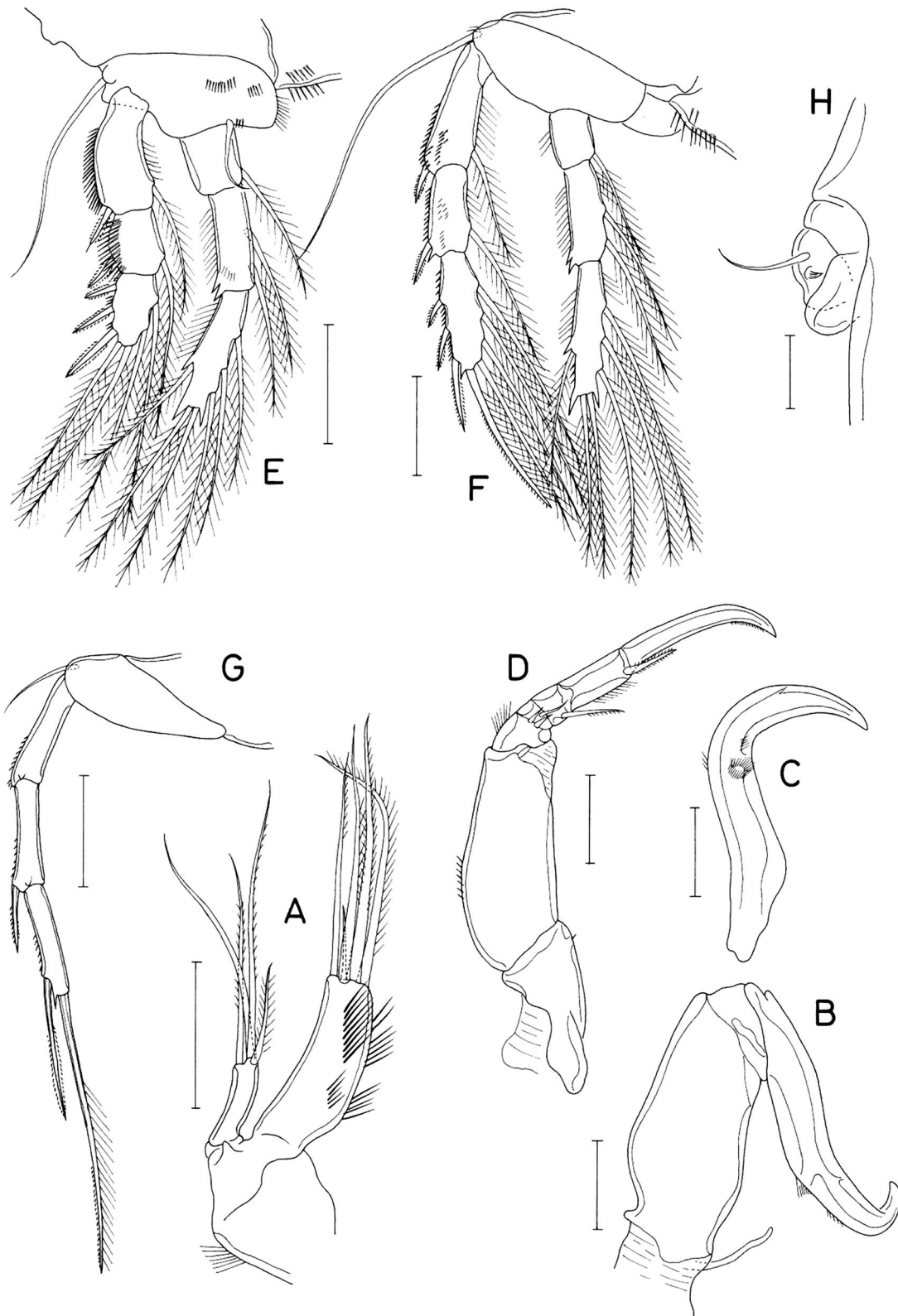


Fig. 13. *Paralepeopsyllus leei* n. sp., female. A, Maxillule; B, Maxilla; C, Claw of maxilla; D, Maxilliped; E, Leg 1; F, Leg 2; G, Leg 3; H, Genital aperture. Scale bars: A-G=0.05 mm, H=0.02 mm.

4 pinnate distal setae and 2 naked dorsal setae, and with 2 transverse rows of spinules on distal half of inner surface of ramus; posterior margin of caudal ramus with fine spinules. Egg sac (Fig. 12E) globular, $268 \times 250 \mu\text{m}$, containing 4 eggs; each egg about $160 \mu\text{m}$ in diameter.

Rostrum absent. Antennule (Fig. 12F) $260 \mu\text{m}$ long and 15-segmented; third segment with trace of articulation on one surface; armature formula 2, 4, 8, 2, 7, 2, 2, 2, 2, 2, 2, 2, 2 + aesthetasc, and 13; all setae naked, except 1 weakly spinulose seta on each of second, third and fourth segments. Antenna (Fig. 12G) with short coxa; basis with longitudinal row of fine pectens and row of setules. Exopod small, $8 \times 4 \mu\text{m}$, with 2 distal and 1 lateral naked setae; one of distal setae annulated at base. Endopod 3-segmented; first segment unarmed but with 2 rows of fine pectens; short second segment with 1 pinnate seta distally; third segment with 2 pinnate spiniform setae, 1 minute seta, and setules; terminal claw $73 \mu\text{m}$ long, with minute spinules in middle.

Oral cone (Fig. 12H) shaped as inverted triangle, $174 \times 127 \mu\text{m}$, with fine setules along distal part of lateral margin. Mandible (Fig. 12I) comprising stylet and palp. Stylet $156 \mu\text{m}$ long, slender, with 6 teeth distally, proximal 2 larger than distal 4. Palp 2-segmented; proximal segment $61 \mu\text{m}$ long, with short setules in proximal half; distal segment shorter, $17 \mu\text{m}$ long, with short setules, and terminated by 2 unequal, pinnate setae (168 and $62 \mu\text{m}$ long, respectively). Maxillule (Fig. 13A) bilobed; inner lobe $59 \times 23 \mu\text{m}$, setulose, and armed with 5 setae distally, one of setae small and remaining 4 longer setae pinnate, longest $93 \mu\text{m}$ long and shortest $77 \mu\text{m}$ long; outer lobe $31 \times 8 \mu\text{m}$, markedly smaller than inner lobe, with 4 setae distally of 96 , 87 , 74 , and $35 \mu\text{m}$ long. Maxilla (Fig. 13B) consisting of syncoxa and distal claw; syncoxa smooth, with 1 slender tube proximally; distal claw (basis) (Fig. 13C) strongly curved, with setules in middle. Maxilliped (Fig. 13D) with 1 rudimentary seta at inner distal corner of syncoxa; basis unarmed, but with few setules on outer margin; endopod 4-segmented, with 2, 1, 1, and 1 setae respectively on first to fourth segment; terminal claw $91 \mu\text{m}$ long, about 2.3 times as long as fourth endopodal segment, distally curved and spinulose.

Legs 1 and 2 (Fig. 13E, F) biramous, with 3-segmented rami; outer seta on basis of these legs large and naked. Leg 3 (Fig. 13G) uniramous, with 3-segmented exopod; endopod absent. Inner seta absent on coxa of legs 1–3. Leg 4 absent. Both sides of intercoxal plate spinulose in legs 1 and 2, but naked in leg 3. Second endopodal segment of legs 1 and 2 with bicuspid outer distal corner. Armature formula for legs 1–3 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1:	0-0	1-1	I-1; I-1; III, 2, 2	0-1; 0-2; 1, 2, 3

Leg 2:	0-0	1-0	I-1; I-1; III, I, 4	0-1; 0-2; 1, 2, 3
Leg 3:	0-0	1-0	0-0; I-0; I, I, 0	Absent

Leg 5 absent. Leg 6 represented by 1 naked seta and 1 small spine on genital operculum (Fig. 13H).

Male. Unknown.

Etymology. This new species is named after Dr. Hyi Seung Lee, Korea Institute of Ocean Science & Technology, who was the leader of the field survey carried out in April, 2016, to Bohol Island, the Philippines and made it possible for us to examine washings of sponges.

Remarks. *Paralepeopsyllus leei* n. sp. may be differentiated from the only species of the genus, *P. mannarensis* Ummerkuty, 1960 known from the Gulf of Mannar (Ummerkuty, 1960) by differences in the antennule and leg 3 of the female. The antennule of the new species is 15-segmented, compared to 14-segmented antennule in *P. mannarensis*. The exopod of leg 3 of *P. leei* n. sp. displays a setation which is very different from that of *P. mannarensis*, as follows: (1) the first segment is unarmed (vs. with an outer spine in *P. mannarensis*); (2) the second segment without an inner seta (vs. with an inner seta in *P. mannarensis*); and (3) the third segment with 2 spines (vs. with 3 setae in *P. mannarensis*).

Paralepeopsyllus dambayensis n. sp. (Figs. 14, 15)

Material examined. 4♀♀ from washings of a mixture of unidentified sponges, SCUBA, depth 10–15 m, $12^{\circ}10'36.03''$ N, $109^{\circ}18'51.04''$ E, Dam Bay in Vinh Nguyen Island, Vietnam, 29 Apr 2016. Holotype (♀, MABIK Lot No. 8809) and paratypes (2♀♀, MABIK Lot No. 8810) have been deposited in the Marine Biodiversity Institute of Korea. Dissected paratype (♀) is retained in the collection of the junior author.

Female. Body (Fig. 14A) shaped as that of *Paralepeopsyllus leei* n. sp., with similar ornamentation on dorsal surface. Prosome 1.03 mm long, with greatest width $898 \mu\text{m}$. Cephalothorax $597 \mu\text{m}$ long along midline, with truncate rostral prominence. Second prosomal somite (fused second and third pedigerous somites) $36 \mu\text{m}$ long along midline, $816 \mu\text{m}$ wide, with deeply concave posterior margin. Third prosomal somite $378 \times 592 \mu\text{m}$, with straight posterior margin bearing row of transparent nodes like drops of water. Urosome (Fig. 14B) 3-segmented and slender. Fifth pedigerous somite obscure. Genital complex $133 \times 106 \mu\text{m}$, 1.25 times as long as wide, tapering posteriorly; genital apertures located laterally. First free abdominal somite $56 \times 55 \mu\text{m}$. Anal somite $55 \times 68 \mu\text{m}$, trapezoid; anal operculum small but distinct. Caudal rami well-separated from each other; each ramus (Fig. 14C) $98 \times 21 \mu\text{m}$, 4.67 times as long as wide, with 4 pinnate distal setae and 2 naked dorsal setae; posterior mar-

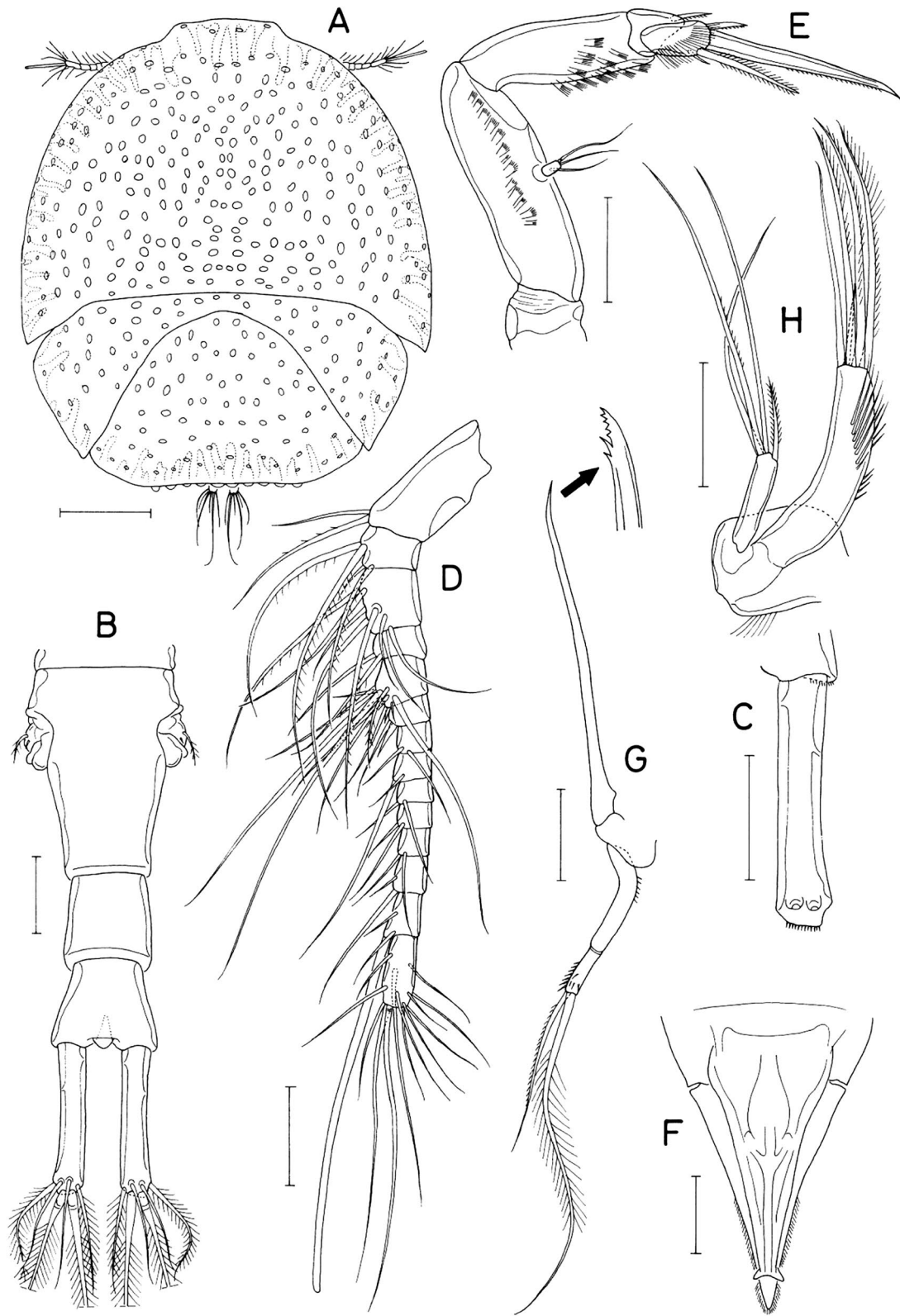


Fig. 14. *Paralepeopsyllus dambayensis* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Caudal ramus, dorsal; D, Antennule; E, Antenna; F, Oral cone; G, Mandible; H, Maxillule. Scale bars: A=0.2 mm, B-H=0.05 mm.

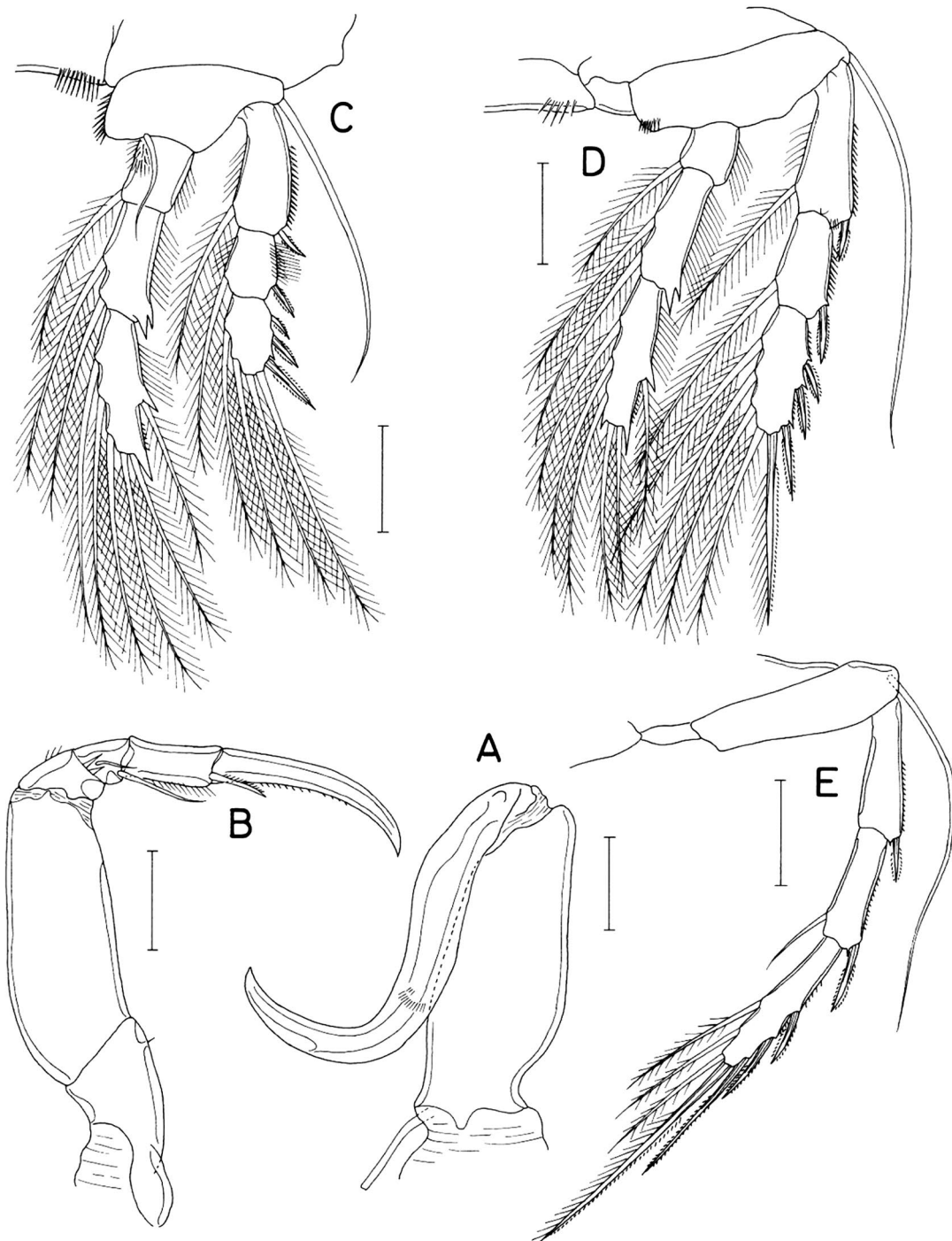


Fig. 15. *Paralepeosyllus dambayensis* n. sp., female. A, Maxilla; B, Maxilliped; C, Leg 1; D, Leg 2; E, Leg 3. Scale bars: A-E=0.05 mm.

gin of caudal ramus with fine spinules. Egg sac not seen.

Rostrum absent. Antennule (Fig. 14D) 259 μ m long and 14-segmented; armature formula 2, 4, 8, 2, 11, 2, 2, 2, 2,

2, 2, 2, 2+aesthetasc, and 13; several setae on proximal segments weakly pinnate, other setae naked. Antenna (Fig. 14E) with short coxa; basis with longitudinal row of fine

pectens. Exopod small, $9 \times 5 \mu\text{m}$, with 2 distal and 1 lateral naked setae; one of distal setae annulated at base. Endopod 3-segmented; first segment unarmed but with 3 rows of fine pectens; short second segment with 1 small seta distally; third segment with 3 setae, one of them being minute, and setules; terminal claw $95 \mu\text{m}$ long, with minute spinules on distal half of concave margin.

Oral cone (Fig. 14F) $197 \times 136 \mu\text{m}$, similar to that of *P. leei* n. sp. Mandible (Fig. 14G) comprising stylet and palp. Stylet $189 \mu\text{m}$ long, slender, with 7 teeth distally, proximal 2 of them larger than distal 5. Palp 2-segmented; proximal segment $60 \mu\text{m}$ long, with short setules on proximal region; distal segment shorter, $27 \mu\text{m}$ long, with short setules, and terminated by 2 unequal setae (200 and $91 \mu\text{m}$ long, respectively). Maxillule (Fig. 14H) bilobed; inner lobe $82 \times 19 \mu\text{m}$, with thick setules in distal half, and armed with 5 setae distally, one seta small and remaining 4 longer setae subequal, longest $100 \mu\text{m}$; outer lobe $40 \times 9 \mu\text{m}$, markedly smaller than inner lobe, with 4 setae distally; lengths of these 4 setae 123 , 117 , 97 , and $33 \mu\text{m}$. Maxilla (Fig. 15A) consisting of syncoxa and distal claw; syncoxa smooth; distal claw massive and strongly curved, with few fine setules in middle. Maxilliped (Fig. 15B) with 1 rudimentary seta at inner distal corner of syncoxa; basis unarmed; endopod 4-segmented, with 2, 1, 1, and 1 setae, respectively, on first to fourth segment; terminal claw $109 \mu\text{m}$ long, about 2.4 times as long as fourth endopodal segment, gently curved, with fine spinules along concave margin.

Legs 1 and 2 (Fig. 15C, D) biramous, with 3-segmented rami. Leg 3 (Fig. 15E) uniramous, with 3-segmented exopod, but without endopod. Inner seta of coxa absent in legs 1–3. Outer seta on basis of legs 1–3 large and naked. Leg 4 absent. Both sides of intercoxal plate spinulose in legs 1 and 2, but naked in leg 3. Second endopodal segment of legs 1 and 2 with bicuspid outer distal corner. Armature formula for legs 1–3 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1:	0-0	1-1	I-1; I-1; III, 2, 2	0-1; 0-2; 1, 2, 3
Leg 2:	0-0	1-0	I-1; I-1; III, I, 4	0-1; 0-2; 1, 2, 3
Leg 3:	0-0	1-0	I-0; I-1; III, I, 3	Absent

Leg 5 absent. Leg 6 represented by 1 pinnate seta and 1 minute spinule on genital operculum (Fig. 14B).

Male. Unknown.

Etymology. The specific name is derived from the type locality of the new species, Dam Bay.

Remarks. *Paralepeopsyllus dambayensis* n. sp. is distinguishable from the two congeners by different setation of leg 3, as follows: the first segment of exopod with an outer spine (absent in *P. leei* n. sp.); the second segment with

an inner seta (absent in *P. leei* n. sp.); and the third segment with four spines and three setae (only three setae in *P. mannarensis* Ummerkutty, 1960 and only two spines in *P. leei* n. sp.).

Paralepeopsyllus dambayensis n. sp. is morphologically closer to *P. mannarensis* than to *P. leei* n. sp., because the former two species share the 14-segmented antennule in the female and similar length/width ratio of the female caudal ramus (about 5 times as long as wide, as in *P. dambayensis* n. sp., when measured on the basis of the illustration given by Ummerkutty, 1960). Ummerkutty (1960) illustrated his species as having an unsegmented mandibular palp, five distal setae on the outer lobe of the maxillule, and a pinnate outer seta on the basis of legs 1 and 2. These features are not applicable to *P. dambayensis* n. sp., although those features of *P. mannarensis* need to be confirmed.

ACKNOWLEDGMENTS

This study was carried out as a part of the project (grant number; 20140513) funded by the Ministry of Oceans and Fisheries, Republic of Korea, and the project (contract no. PE99513) by the Korea Institute of Ocean Science and Technology, Republic of Korea.

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Received March 7, 2017
 Revised April 5, 2017
 Accepted April 8, 2017