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# Eight New Species of Ascidicolous Copepods from the Eastern Coast of Korea (Crustacea, Copepoda, Cyclopoida)

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**Abstract** – Eight new species of copepods associated with shallow-water ascidians are described from the eastern coast of Korea. They are *Ascidicola secundus* n. sp. from a *Pyura* sp., *Enteropsis nudus* n. sp. from *Pyura sacciformis* (Drasche), *Mycophilus capillatus* n. sp. from a compound ascidian, *Bonnierilla yangpoensis* n. sp. from *Phallusia* cf. *nigra* Savigny, *Janstockia truncata* n. sp. from *Chelyosoma siboja* Oka, *Pholeterides pilosa* n. sp. from a compound ascidian, *Pachypygus spinosus* n. sp. from a solitary ascidian, and *Paranotodelphys unguifer* n. sp. from *Ascidia samea* Oka.

**Key words** – New species, Ascidicolidae, Enteropsidae, Notodelphyidae, Ascidiacea

## 1. Introduction

Copepods are very commonly associated with ascidians (Boxshall and Halsey 2004). Nevertheless, copepods of this kind are insufficiently studied in the Far Eastern region. Kim (1996, 1998) recorded 11 species of copepods belonging to the Artotrogidae as associates of the tunicate *Halocynthia hilgendorfi igaboja* (Oka). All of these copepods were found on the external surface of the tunic of that tunicate, not from any internal organ or space. Taxonomic studies on the ascidicolous copepods (internal associates) from Korea were carried out by Seo and Lee (1995a, 1995b, 1996, 1997, 1998, 2001), Seo and Rho (1998), and Kim and Moon (2011). Through these studies 18 species were reported, all of them from shallow water.

In the present study we will describe additionally eight new species of ascidicolous copepods discovered from eastern coast of Korea, as follows:

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Family Ascidicolidae
*Ascidicola secundus* n. sp.
Family Enteropsidae
*Enteropsis nudus* n. sp.
*Mycophilus capillatus* n. sp.
Family Notodelphyidae
*Bonnierilla yangpoensis* n. sp.
*Janstockia truncata* n. sp.
*Pholeterides pilosa* n. sp.
*Pachypygus spinosus* n. sp.
*Paranotodelphys unguifer* n. sp.

## 2. Materials and Methods

Ascidicolous copepods studied in the present work had been collected from the eastern coast of Korea. The ascidian hosts were obtained by intertidal sampling or taken from fishing nets at fishery ports. These ascidians were fixed and preserved in ethyl alcohol. In the laboratory, the ascidian samples were dissected and washed in water. The wash water was filtered with fine net and the copepods were picked out from the filtrates under the dissecting microscope. For microscopic study, copepod specimens were dissected after soaking them in lactic acid for about an hour. The type specimens have been deposited in the National Insitute of Biological Resources (NIBR), Incheon, Korea.

## 3. Systematic Accounts

Family **Ascidicolidae** Thorell, 1859
Genus ***Ascidicola*** Thorell, 1859
***Ascidicola secundus* n. sp.** (Figs. 1, 2)

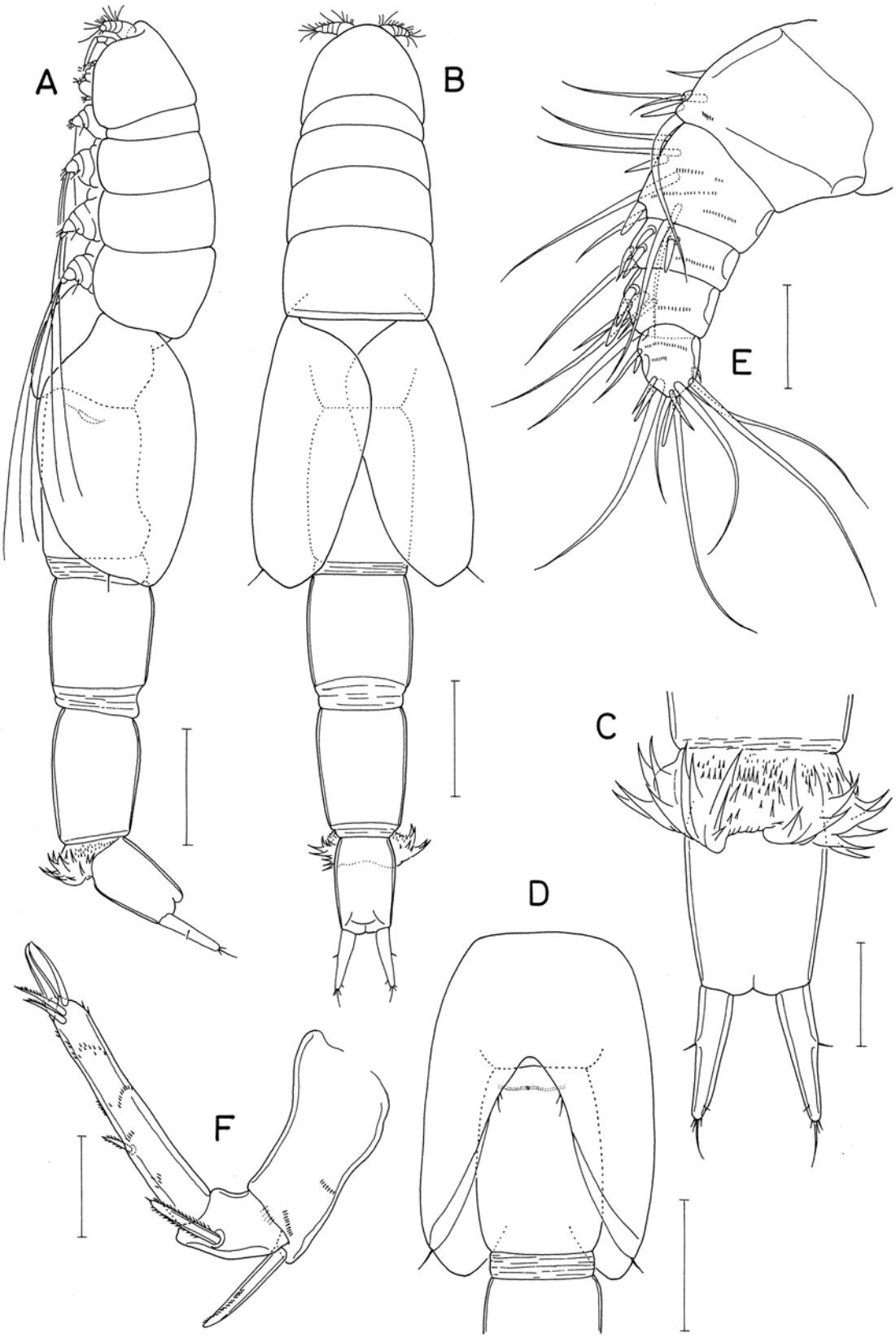


**Fig. 1.** *Ascidicola secundus* n. sp., female. A, habitus, lateral; B, habitus, dorsal; C, anal somite and caudal rami, ventral; D, genital double somite and leg 5, ventral; E, antennule; F, antenna. Scales: A, B, D, 0.5 mm; C, 0.2 mm; E, F, 0.05 mm

**Material examined**

2 mature ♀♀ from the branchial chamber of a *Pyura*-like tunicate taken from a fishing net set in the depth of about 50 m, off Guryonpo (approximately 35°59'N, 129°35'E), on the eastern coast of Korea, 13 November 2009, I.-H. Kim. Holotype (♀) will be deposited in the National Institute of Biological Institute, Incheon. Dissected paratype is kept in the collection of the senior author.

**Description**

Female. Body (Fig. 1A, B) elongated and cylindrical. Body length of dissected paratype 4.30 mm (4.60 mm in holotype). Maximum width 653 μm across last prosomal somite. Prosome 1.26 mm long, occupying about 30% of length of whole body, 5-segmented, and gradually widened from anterior to posterior. Each prosomal somite 307×525, 119×535, 178×604, 257×633, and 396×653 μm, respectively from anterior to posterior. First pedigerous somite distinctly shorter than other prosomal somites, Urosome 5-segmented, not including spinose pad positioned ventrally between second abdominal and anal somites. Fifth pedigerous somite 386 μm long and protruded ventrally. Genital double-somite 713×455 μm. Three free abdominal somites 564× 450, 545×386, and 443×273 μm, respectively. Ventral spinose pad between second abdominal and anal somites well developed and provided with large thorns occurring mainly on distal half and small spinules (Fig. 1C); all of these thorns and spinules recurved. Caudal rami widely separated from each other and slightly divergent; each ramus tapering, 338×80 μm, 4.23 times as long as wide, and armed with 1 lateral, 1 inner subdistal, and 4 distal setae; largest one of distal setae less than 1/3 length of ramus; lateral seta positioned slightly proximal to midlength of ramus; all of these caudal setae naked.

Rostrum not recognized. Antennule (Fig. 1E) short, 187 μm long, 5-segmented, with armature formula 5, 8, 5, 6, and 14; segments gradually narrowed from proximal to distal; first to fourth segments each wider than long, but terminal segment longer than wide; each segment with 1-3 transverse rows of minute spinules on ventral side; some of setae short and blunt (1 on first, 2 on second, 3 on third, 2 on fourth, and 3 on fifth segments); some of setae on terminal segment blunt and aesthetasc-shaped; all setae on antennule naked. Antenna (Fig. 1F) 3-segmented; first segment 83×51 μm with 1 large distal spine (this spine slightly longer than second segment); second segment 35 (measured along middle axis)×32 μm, with 1 large subdistal spine; third segment elongated, 124×23 μm, armed with 1 spine and 4 setae, one of latters small and located slightly proximal to middle, and remaining 3 distal setae not longer than distal spine.

Labrum (Fig. 2A) gradually narrowed posteriorly, with straight posterior margin and 2 dentiform processes on each laterodistal corner. Mandible (Fig. 2B) consisting of coxa and palp; gnathobasic medial margin of coxa with 7 tooth-like projections; palp 2-segmented; proximal segment much shorter than wide, ornamented with transverse row of minute spinules distally; distal segment longer than wide, proximally wider and distally narrower, with 5 naked setae, proximalmost one of which largest. Maxillule (Fig. 2C) consisting of precoxa and palp; precoxa with 8 naked seta medially; palp with 2 larger proximal and 5 distal setae. Maxilla (Fig. 2D) 2-segmented; first segment (syncoxa) with endite tipped by 2 setae; second segment (basis) terminated by large claw-like process and armed with 1 large spine, 1 small seta on concave margin, and on convex margin 3 or 4 proximal and 2 subdistal setae. Maxilliped (Fig. 2E) 1-segmented, tapering, with 3 or 4 (3 is normal) medial and 1 distal setae.

Legs 1-4 with 2-segmented rami and followg armature formula:

Leg 1: coxa 0-0; basis 1-I; exp I-0; IV,I,0; enp 0-0; I,II,1
Leg 2: coxa 0-0; basis 1-0; exp I-0; III,I,0 enp 0-0; 0,II,3
Leg 3: coxa 0-0; basis 1-0; exp I-0; III,I,0 enp 0-1; 0,II,3
Leg 4: coxa 0-0; basis 1-0; exp I-0; II,I,0 enp 0-1; 0,II,2

Distal spine on second exopodal segment of legs 1-4 large, strong, and confluent with distal segment; other spines on these legs much smaller, with serrate margins. Setae on endopods enlarged, with lengths as follows: leg 1 endopod-354 μm; leg 2 endopod-769, 600, and 269 μm from proximal to distal; leg 3 endopod-431, 1115, 1154, and 846 μm from proximal to distal; and leg 4 endopod-1054, 1040, and 1031 μm from proximal to distal.

Leg 5 as large lamella, originated from anterior border of fifth pedigerous somite, slightly extending over posterior border of genital double-somite, and armed with 3 small setae: one on ventrodistal corner and 2 on ventral margin (Fig. 1D). Left and right leg 5 separated dorsally, but connected ventrally in proximal one-third (Fig. 1D). Leg 6 not seen.

Male. Unknown.

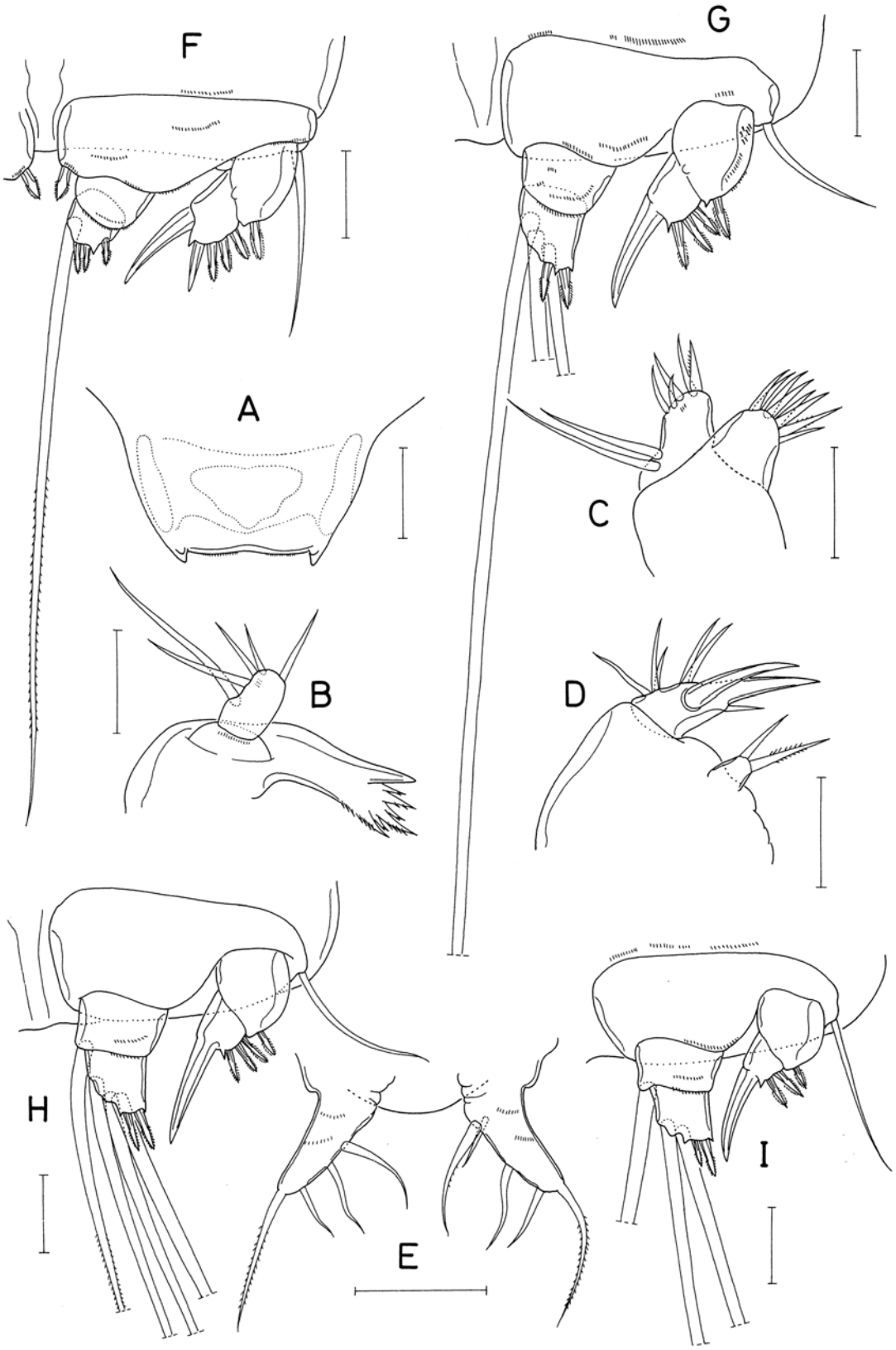


**Fig. 2.** *Ascidicola secundus* n. sp., female. A, labrum; B, mandible; C, maxillule; D, maxilla; E, maxillipeds, ventral; F, leg 1; G, leg 2; H, leg 3; I, leg 4. Scales: 0.05 mm for all

## Remarks

*Ascidicola* Thorell, 1859, the type genus of the family Ascidicolidae, has been remained as a monotypic genus for more than one and half centuries, represented by *A. rosea* Thorell, 1859. Illg and Dudley (1980) listed 26 species in 13 genera of solitary ascidians as host of *A. rosea*.

*Ascidicola rosea* Thorell, 1859 is known from very wide geographic range from the Atlantic, Mediterranean, and Northeast Pacific (Illg and Dudley, 1980; Gotto, 1993; Boxshall and Halsey, 2004). It was recently thoroughly redescribed by Ooishi (2007). However, Ooishi's specimens revealed a number of differences from previous records. For examples, Ooishi (2007) observed 4 setae on the first antennular segment, but Illg and Dudley (1980) described the number of setae as 8; and the apical armature of antenna was described by Ooishi (2007) and Illg and Dudley (1980) as 1 spine and 4 setae, but Huys and Boxshall (1991) illustrated it as 1 spine and 3 setae. Inconsistencies among researchers occur in various other appendages in this species (Ooishi 2007). At least some of these inconsistencies may be attributable to the high morphological variability of this species.

Reliable characters utilizable to distinguish *A. rosea* and *A. secundus* are found to occur mainly on the distal exopodal segments of legs 1-4. The numbers of spines on the exopods of these legs are clearly different between the two species, as the distal exopodal segments of legs 1-4 of *A. rosea* are armed with 6, 6, 5, and 5 spines (Ooishi 2007) or 6, 6, 6, and 5 spines (Illg and Dudley 1980), respectively, but those of *A. secundus* are armed with 5, 4, 4, and 3 spines, respectively. The distal margin of the distal exopodal segment of legs 1-4 in *A. secundus* is armed with 1 large, claw-like spine which is much more prominent than outer spines, whereas the same margin in *A. rosea* is armed with 2 or 3 spines which are similar in thickness to the outer spines.

The spinose pad on the abdomen of *A. secundus* is well developed and provided with large thorns and small spinules. In contrast, in *A. rosea* the spinules are absent (Illg and Dudley 1980) or present (Gotto 1957; Ooishi 2007) and the large thorns are always absent.

Family **Enteropsidae** Aurivillius, 1885

Genus ***Enteropsis*** Aurivillius, 1885

***Enteropsis nudus* n. sp.** (Fig. 3)

**Material examined**

3 ♀♀ from the solitary ascidian *Pyura sacciformis* (Drasche) collected at the depth of about 1 m, Yangpo Port (35°52'53"N, 129°31'28"E) on the eastern coast of Korea, 30 July 2009, I.-H. Kim. Holotype (♀) and paratype (♀) have been deposited in the National Institute of Biological Resources (NIBR), Incheon. Dissected paratype is retained in the collection of the senior author.

**Description**

Female. Body (Fig. 3A, B) maggot-like and fusiform in dorsal view. Body lengths 3.14 (in dissected specimen), 4.29, and 4.54 mm in 3 examined specimens. Body segmentations represented only by dorsal and lateral constrictions. Prosome-urosome distinction also unclear. Prosome consisting of cephalosomal part and 4 metasomal parts; third metasomal part widest, 976 μm wide. Urosome consisting of 2 parts, distictly narrower that metasomal region. Caudal ramus (Fig. 3C) tapering in dorsal and lateral views, about 108 ìm long, about twice as long as proximal width, with 1 terminal seta (or spine) of 25 ìm long and 2 minute subdistal setules.

Rostrum absent. Antennule (Fig. 3D) 1-segmented, strongly tapering, not longer than its basal width, with 8 setae, some of them nipple-shaped, and several fine setules. Antenna (Fig. 3E) also 1-segmented, consisting of broader proximal part and claw-like distal part, with several patches of spinules.

Labrum represented by 4 patches of minute spinules (more than 20 spinules in total). Mandible absent. Maxillule (Fig. 3G) biramous; shorter outer ramus bearing 2 unequal apical spines; larger inner ramus with 2 spinules-bearing apical spines. Maxilla (Fig. 3H) 2-segmented; proximal segment broad, with 1 small claw on medial side; distal segment as strong claw bearing 1 small proximal seta on covex side. Maxilliped absent.

Legs 1-4 uniform, tapering, and consisting of large coxa, smaller, tapering basis, and vestigial exopod and endopod (Fig. 3I). Coxa of these legs unarmed but with several setules. Basis wider than long, with several setules (Fig. 3I) and many minute spinules (Fig. 3J). Exopod and endopod forming pincers (Fig. 3J). Exopod claw-like, well sclerotized, covered with hyaline membrane, and defined from basis. Endopod smaller than exopod, fused to basis, appearing as triangular process. Hyaline lobe lying near base of endopod.

Legs 5 and 6 absent.

Male. Unknown.

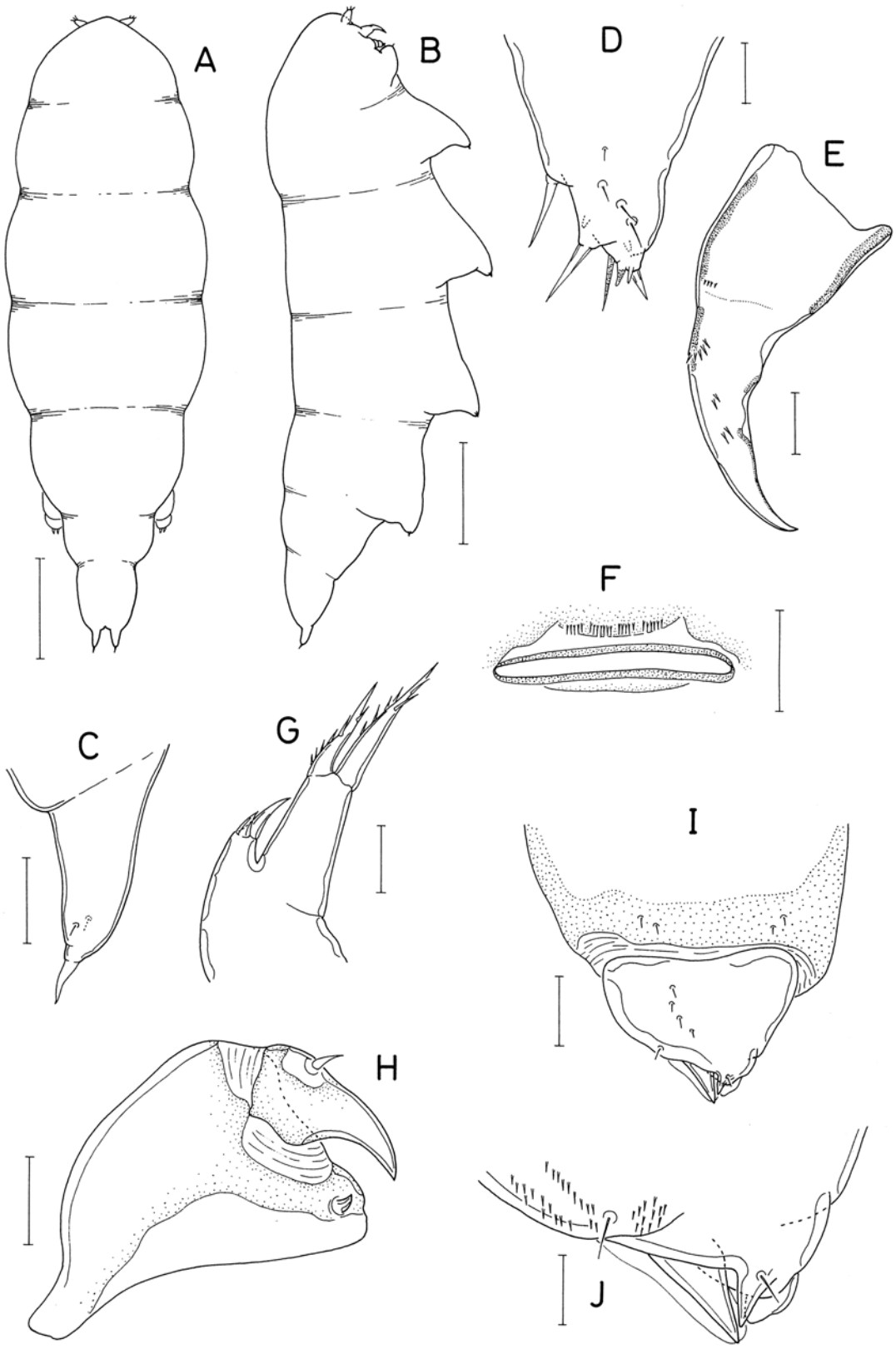


**Fig. 3.** *Enteropsis nudus* n. sp., female. A, habitus, dorsal; B, habitus, lateral; C, right caudal ramus, outer lateral; D, antennule; E, antenna; F, oral area; G, maxillule; H, maxilla; I, leg 3; J, distal part of leg 3. Scales: A, B, 0.5 mm; C, F, H, I, 0.05 mm; D, E, G, J, 0.02 mm

**Etymology**

The specific name *nudus*, meaning "naked" in Latin, alludes to the absence of a labrum in the new species.

**Remarks**

The genus *Enteropsis* Aurivillius, 1885 comprises 11 known species (Ooishi 2009). Ooishi (2008a, 2009) classified those 11 species into 3 groups: group I, group II-A, and group II-B. With a single terminal process on the antenna and the separated caudal rami, *Enteropsis nudus* n. sp. should be placed in group II-A which comprises only 2 species, *E. onychophorus* Schellenberg, 1922 and *E. roscoffensis* Chatton and Brement, 1909. *Enteropsis nudus* is distinguished from these two relatives by the absence of setae on the labrum. It is further distinguishable from *E. onychophorus* by the unsegmented antennule and from *E. roscoffensis* by the presence of 2 setae on each outer and inner lobes of the maxillule (2 and 3 setae in *E. roscoffensis*). It is remarkable that both *E. onychophorus* and *E. roscoffensis* have dorsally positioned anus. The anus of *E. nudus* is placed at the terminal end of abdomen.

Genus ***Mychophilus*** Hesse, 1865

***Mychophilus capillatus* n. sp.** (Fig. 4)

**Material examined**

2 ♀♀ from a compound ascidian collected at the depth of 1 m, Yangpo Port (35°52'53"N, 129°31'28"E) on the eastern coast of Korea, 30 July 2009, I.-H. Kim. Holotype (♀) has been deposited in the National Institute of Biological Resources (NIBR), Incheon. Dissected paratype is retained in the collection of the senior author.

**Description**

Female. Body (Fig. 4A) vermiform, cylindrical, unsegmented, curved dorsally, and covered with numerous fine setules (Fig. 4C; setules not figured in Fig. 4A). Prosome and urosome not divisible. Body length of dissected specimen 1.48 mm. Genital area represented by small sclerotization. Anus positioned dorsally just anterior to level of genital area, separated from posterior end of body by distance of 400 μm. Posterior end of body rounded. Caudal ramus (Fig. 4B) small, 17×10 μm, with 1 spiniform terminal element of 38 μm long.

Rostrum absent or represented by rounded anterior prominence in cephalic area (Fig. 4C). Antennule (Fig. 4D) as tapering lobe, 1-segmented, with 3 anterior setae, 4 apical setae, and several setules. Proximalmost one of 3 anterior setae and one of 4 apical setae small, hyaline and digitiform. Antenna (Fig. 4E) 2-segmented; proximal segment strongly tapering, covered with numerous setules and with several spinules distally; distal segment claw-like, with pointed apex, covered with setules and spinules.

Labrum and mandible absent (Fig. 4C). Maxillule (Fig. 4F) bilobed, each lobe with setules and pair of process-like setae, Maxilla (Fig. 4G) 2-segmented; broad proximal segment unarmed, but with fine setules distally; second segment as massive claw bearing setules and 1 naked proximal seta on convex side,

Legs 1-4 uniform, separated from one another by same intervals (Fig. 4A), and consisting of large coxa, smaller basis, and reduced exopod and endopod. Coxa of these legs unarmed but with numerous fine spinules ditally. Basis wider than long, unornamented, and tapering in distal half. Exopod and endopod forming pincers (Fig. 4H). Exopod claw-like, well sclerotized, covered with hyaline membrane, and defined from basis. Endopod broader than exopod, blunt, and fused to basis.

Legs 5 and 6 absent.

Male. Unknown.

**Etymology**

The specific name *capillatus* is a Latin meaning "hairy". It refers to hairy body surface of the new species.

**Remarks**

The genus *Mychophilus* Hesse, 1865 comprises 3 known species, *M. fallax* Stock, 1967 from the Red Sea, *M. palmatus* López-González and Conradi, 1996 from the Strait of Gibraltar, and *M. roseus* Hesse, 1866 from the Europe and the Mediterranean. All of these species are associated with compound ascidians.

Although Ooishi (2008b) considered the labral setae typical of the genus *Mychophilus*, *M. capillatus* n. sp. lacks any setal element on the labrum. Other major features of *M. capillatus* which are different from those of its 3 congeners are displayed in the position of anus, the shape of the caudal ramus and maxilla, and the segmentation and setation of the antennule and antenna. The anus of *M. capillaus* is positioned posterior to the midlength of body, which is contrasted to the placement of the anus in other species where it is positioned in the middle in *M. roseus* or anterior to the

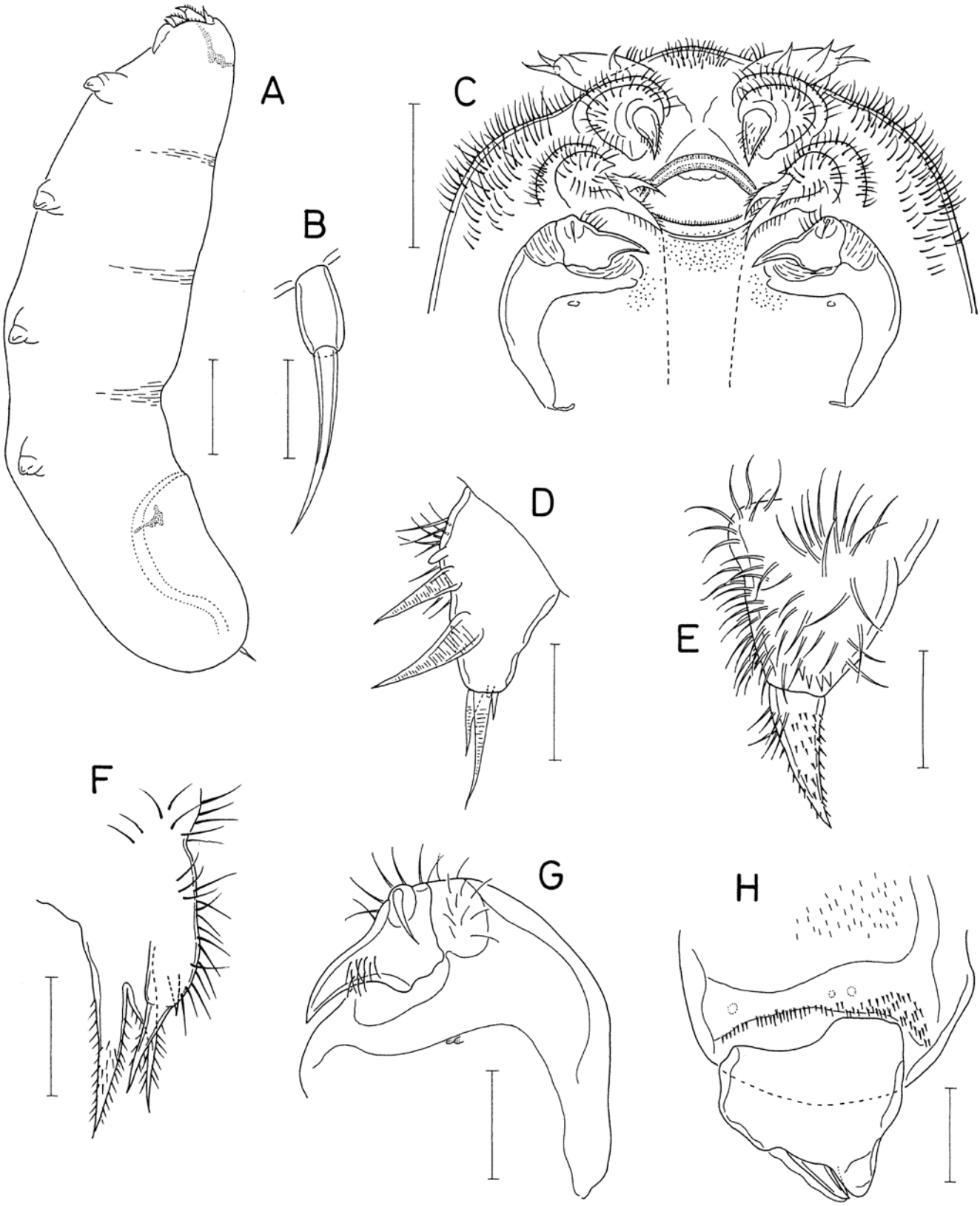


**Fig. 4.** *Mycophilus capillatus* n. sp., female. A, habitus, lateral; B, caudal ramus; C, cephalic area, ventral; D, antennule; E, antenna; F, maxillule; G, maxilla; H, leg 1. Scales: A, 0.2 mm; B, D-H, 0.02 mm; C, 0.05 mm

midlength in *M. fallax* and *M. palmatus*. The caudal ramus of *M. capillatus* has a large terminal spine which is much longer than the ramus, whereas this spine does not exceed a half length of the ramus in other 3 species. The antennule of *M. capillatus* is unsegmented and armed with 8 setae in contrast to 2-segmented condition with 2 setae on the distal segement in *M. fallax*, 1-segmented with 6 setae in *M. palmatus*, and 2-segmented with 5 setae on the distal segment in *M roseus*. The antenna of *M. capillatus* is 2-segmented which is compared to 1-segmented state of *M. palmatus* and 3-segmented state in *M. roseus* and *M. fallax* (Stock 1967a mentioned a 2-segmented antenna of *M. fallax* but his figure reveals 3-segmented state). Finally, the maxilla of *M. capillatus* has a strong, claw-like distal segment, with 1 seta, whereas it is unsegmented and lobate in *M. fallax*, or the distal segment is slender or small, without any seta in *M. palmatus* and *M. roseus*.

The displacement of the anus to dorsal side of body is a character distinguishing *Mychophilus* from *Enteropsis* (Illg and Dudley 1980; Boxshall and Halsey 2004). However, Ooishi (2008a) stated that several species of *Enteropsis*, including *E. roscoffensis* she redescribed, have dorsally displaced anus. These genera are in need of redefinitions. *Mychophilus capillatus* seems also lie in an intermediate position of the two genera. The maxilla of this species, in which the distal segment is developed to a strong claw, is typical of the genus *Enteropsis*.

Family **Notodelphyidae** Dana, 1853
Genus ***Bonnierilla*** Canu, 1891
***Bonnierilla yangpoensis* n. sp.** (Figs. 5, 6)

**Material examined**

4 ♀♀ from a small solitary ascidian (*Phallusia* cf. *nigra* Savigny) collected at the depth of about 1 m, Yangpo Port (35°52'53"N, 129°31'28"E) on the coast of the Sea of Japan, 30 July 2009, I.-H. Kim. Holotype (♀) and paratypes (2♀♀) have been deposited in the National Institute of Biological Resources (NIBR), Incheon. Dissected paratype is retained in the collection of the senior author.

**Description**

Female. Body (Fig. 5A) consisting of cephalosome, unsegmented metasome, and urosome. Prosome 2.20 mm long. Cephalosome clearly defined from metasome. Metasome compressed laterally; region corresponding to first to fourth pedigerous somites forming brood pouch. Urosome (Fig. 5B) cylindrical, almost unsegmented, but 5 urosomal segments discernible by vestigial dorsal and lateral segmentation lines and slight constrictions; first urosomal somite short and obscure; first abdominal somite longest among urosomal segments, probably formed by original genital and first abdominal somites, with 2 pairs of minute lateral setules. Caudal rami (Fig. 5C) divergent, slightly directed ventrally, distinctly tapering and 205×77 μm (2.66:1), with 6 equally small, naked setae.

Rostrum as hemi-circular lobe. Antennule (Fig. 5D) 295 μm long, 8-segmented, but segmentations unclear; proximal 2 segments distinctly broader than remaining distal segments; armature formula 3, 16, 6, 4+aesthetasc, 1, 3, 4, and 11+2 aesthetascs; first segment with patch of few minute spinules on anterior margin; 2 largest setae on first segment pinnate, all other setae naked. Antenna (Fig. 5E) 4-segmented, consisting of short coxa, basis, and 2-segmented endopod; one small seta lying on junction between basis and first endopodal segment; first endopodal segment shorter than basis, 63×35 μm, with 1 minute subdistal seta and 1 row of minute spinules; second endopodal segment 100×28 μm (3.57:1), distinctly longer than other segments, with 3 minute setae; terminal claw undulated, covered by thick hyaline substance, proximally with 3 bluntly-ended setae on outer side.

Labrum (Fig. 5F) wider than long, tapering, with hemi-circular posterior lobe and dense setules on posterior margin. Mandible (Fig. 5G) consisting of coxa and biramous palp; medial margin of gnathobase of coxa with 5 teeth and fine serration and on dorsal margin 2 small pinnate setae; basis of palp with 1 seta on medial margin and mediodistally 4 setae and row of spinules; exopod obscurely 2-segmented, with 2 proximal and 3 distal setae; endopod 1-segmented, with 8 setae. Maxillule (Fig. 5H) with precoxa bearing 9 setae on arthrite; coxobasis with 3 medial setae, 1 seta on endite, and 2 very unequal setae on epipodite; exopod and endopod 1-segmented, with 4 and 2 setae, respectively. Maxilla (Fig. 6A) consisting of syncoxa, basis and 3-segmented endopod; syncoxa distinctly tapering, with 8 setae (arranged as 3, 1, 2, 2 from proximal to distal); basis with 3 unequal setae; endopod incompletely segmented, with 1, 1, and 3 setae respectively on proximal to distal segments. Maxilliped (Fig. 6B) 1-segmented but bearing subdistal vestige of segmentation and armed with 7 medial and 2 distal setae.

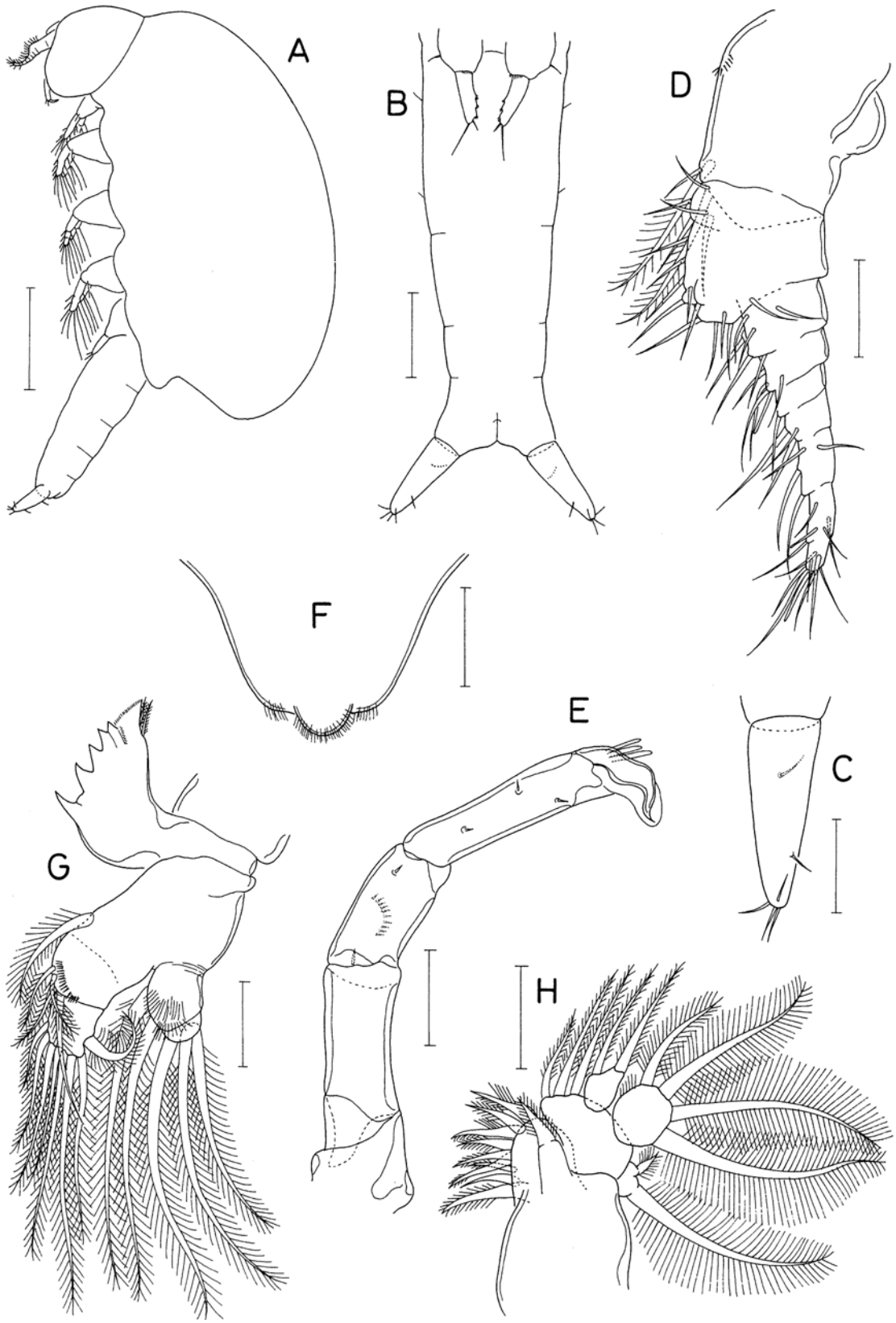


**Fig. 5.** *Bonnierilla yangpoensis* n. sp., female. A, habitus, lateral; B, urosome, ventral; C, caudal ramus; D, antennule; E, antenna; F, labrum; G, mandible; H, maxillule. Scales: A, 0.5 mm; B, 0.2 mm; C, 0.1 mm; D-H, 0.05 mm

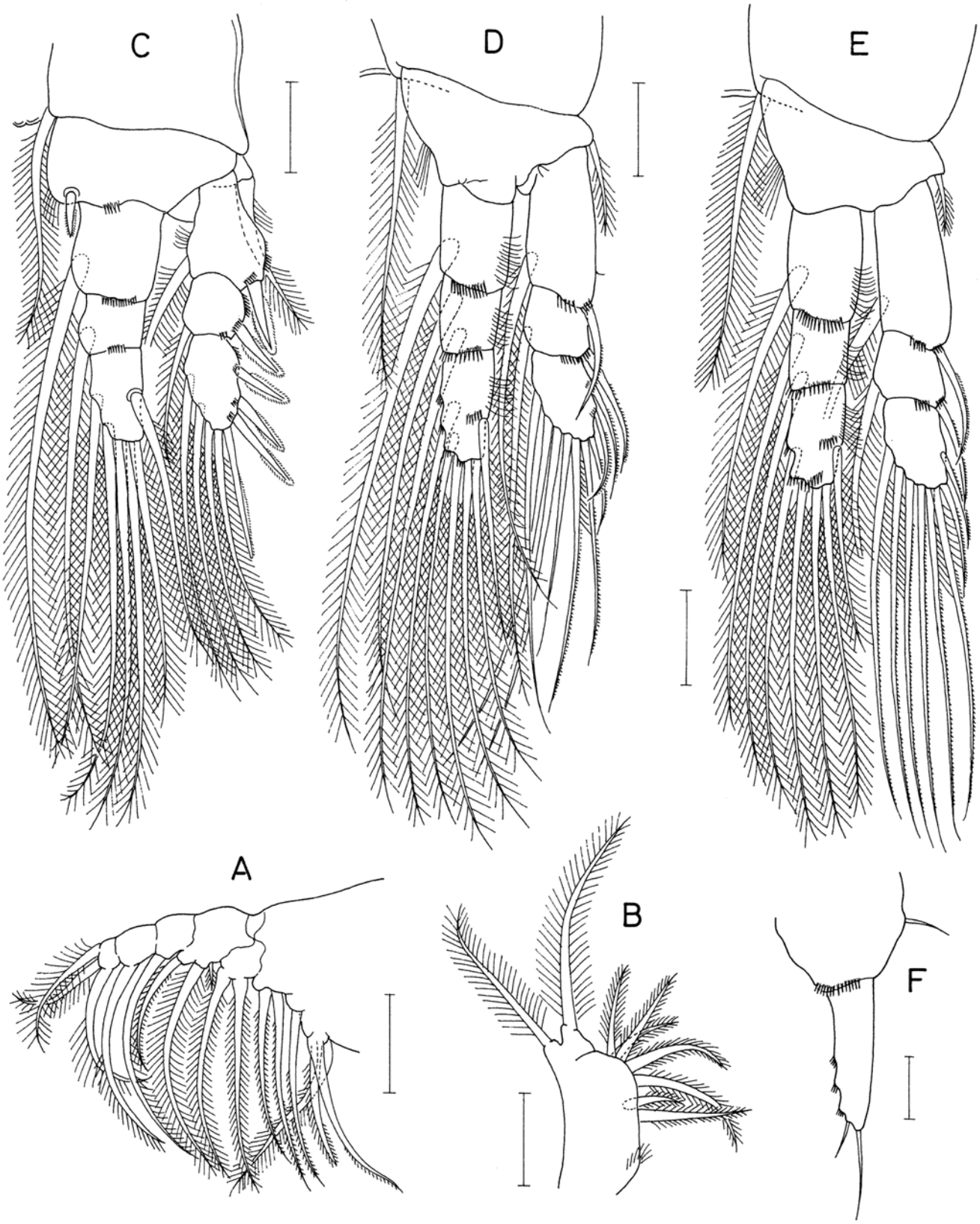


**Fig. 6.** *Bonnierilla yangpoensis* n. sp., female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, leg 4; F, leg 5. Scales: 0.05 mm for all

Legs 1-4 with 3-segmented rami and following armature formula.

Leg 1: coxa 0-1; basis 1-I exp I-1; I-1; III,I,4 enp 0-1; 0-1; 1,3,2

Legs 2 & 3: coxa 0-1; basis 1-0 exp 1-1; 1-1; 3,1,5 enp 0-1; 0-2; 1,2,3

Leg 4: coxa 0-1; basis 1-0; exp 1-1; 1-1; 2,1,5; enp 0-1; 0-2; 1,2,2

Outer seta on basis of leg 1 distinctly larger than that of other legs (Fig. 6C cf. Fig. 6D, E). Five medial setae naked on third exopodal segment of legs 2 and 3.

Leg 5 (Fig. 6F) 2-segmented; proximal segment with 1 thin, naked outer seta and row of spinules distally; distal segment 121×37 μm, with 2 thin, distal setae and 3 patches of minute spinules on medial margin. Leg 6 not seen.

Male. Unknown.

**Etymology**

The specific name *yangpoensis* is taken after the type locality Yangpo Port.

**Remarks**

The genus *Bonnierilla* Canu, 1891 comprises 10 known species (Ho 1984). *Bonnierilla yangpoensis* n. sp. possesses a combination of distinguishing traits that the terminal claw of antenna is covered with a hyaline cap; the endopod of maxillule has 2 setae; the maxilliped has 7 lateral and 2 apical setae; leg 1 has an inner seta on the coxa and an inner spine on the basis; and the exopod of leg 5 has 2 setae. This combination of character states of *B. yangpoensis* are shared only by *B. projecta* Stock, 1967. *Bonnierilla projecta* was reported from the Red Sea as an associate of *Phallusia nigra* Savigny (Stock 1967b) and recently found also in Korean waters by the present authors from an *Ascidia* sp. They also show close similarities in the forms and structures of the caudal ramus, antennule, antenna, mandible, and maxilla.

Despite the close similarity in appendages between the two species, they cannot be considered conspecific, because *Bonierrilla projecta* is very characteristic in having the angular posterior end of prosome and a pair of dorsal crests which extend along both dorsolateral sides of the prosome. These features are not observable in *B. yangpoensis*. One may suspect that our specimens are not fully grown adults. However, there is no significant size difference revealed between the specimens of *B. yangpoensis* and those of *B. projecta*: the length of the prosome is 2.19 mm in *B. yangpoensis* which is not different from 2.20 mm in an ovigerous female of *B. projecta* from Korea or 1.95-2.68 mm in the Stock's (1967b) type specimens of *B. projecta*.

Genus ***Janstockia*** Boxshall and Marchenkov, 2005

***Janstockia truncata* n. sp.** (Figs. 7, 8)

**Material examined**

5 ♀♀ from the solitary ascidian *Chelyosoma siboja* Oka taken from a fishing net set off Sacheon Port (35°50'14"N, 128°52'37"E) in Kangnung, 21 March 2009, I.-H. Kim. Holotype (♀) and paratypes (2♀♀) have been deposited in the National Institute of Biological Resources (NIBR), Incheon. Dissected paratypes (2♀♀) are retained in the collection of the senior author.

**Description**

Female. Body (Fig. 7A) vermiform, cylindrical, covered with fine setules, and consisting of head, elongate trunk and small abdomen. Body length 8.04 mm (7.40-8.75 mm), based on 4 specimens. Head 0.63×1.00 mm, expanded posterolaterally (Fig. 7B). Trunk about 0.67 mm in maximum thickness. First pedigerous somite with lateral expansions; these expansions longer than wide, extending slightly over posterolateral expansions of head. Intervals 0.58 mm between first and second legs, 2.21 mm between second and third legs, 3.62 mm between third and fourth legs, and 3.46 mm between fourth leg and posterior end of abdomen. Posterior region of trunk with several wrinkles, representing vestige of urosomal somites. Abdomen probably formed by fusion of original anal somite and caudal rami, 170×253 μm, truncated, with several caudal setae (Fig. 7C).

Rostrum as hemi-circular lobe (Fig. 7D). Antennule (Fig. 7E) about 127 μm long and 118 μm in proximal width, unsegmented, strongly tapering, covered by numerous hair-like setae on anterior surface and distal area; setae not distinguishable from these setules. Antenna (Fig. 7F) 3-segmented, and stocky; first segment (coxa) short, wide and unarmed; second segment (basis) slightly longer than wide and unarmed; third segment small, with 5 small setae and patch of spinules, and terminated by strong claw.

Labrum (Fig. 7G) prominent, tapering, but posteriorly rounded lobe, and accompanied by tapering paired lateral processes. Mandible (Fig. 8A) as a lobe bearing 3 lateral and 4 distal setae. Maxillule (Fig. 8B) broad, with 4 thick setae (1 dorsal and 3 medioventral), 3 globular distal lobes, and several ventral setules. Maxilla absent. Maxilliped (Fig.

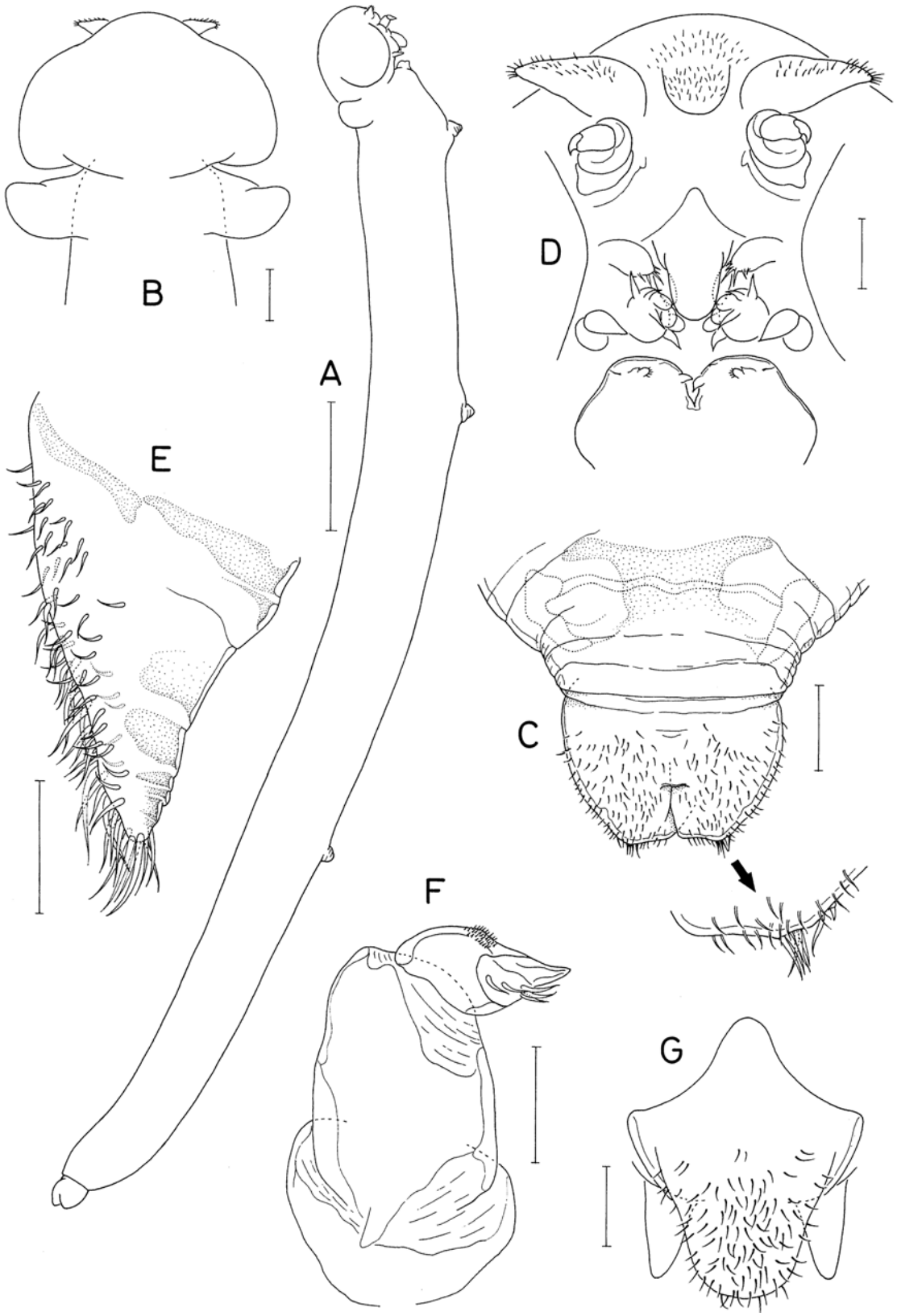


**Fig. 7.** *Janstockia truncata* n. sp., female. A, habitus, lateral; B, anterior part of body, dorsal; C, urosome, dorsal; D, cephalic area, ventral; E, antennule; F, antenna; G, labrum. Scales: A, 1 mm; B, 0.2 mm; C, D, 0.1 mm; E-G, 0.05 mm

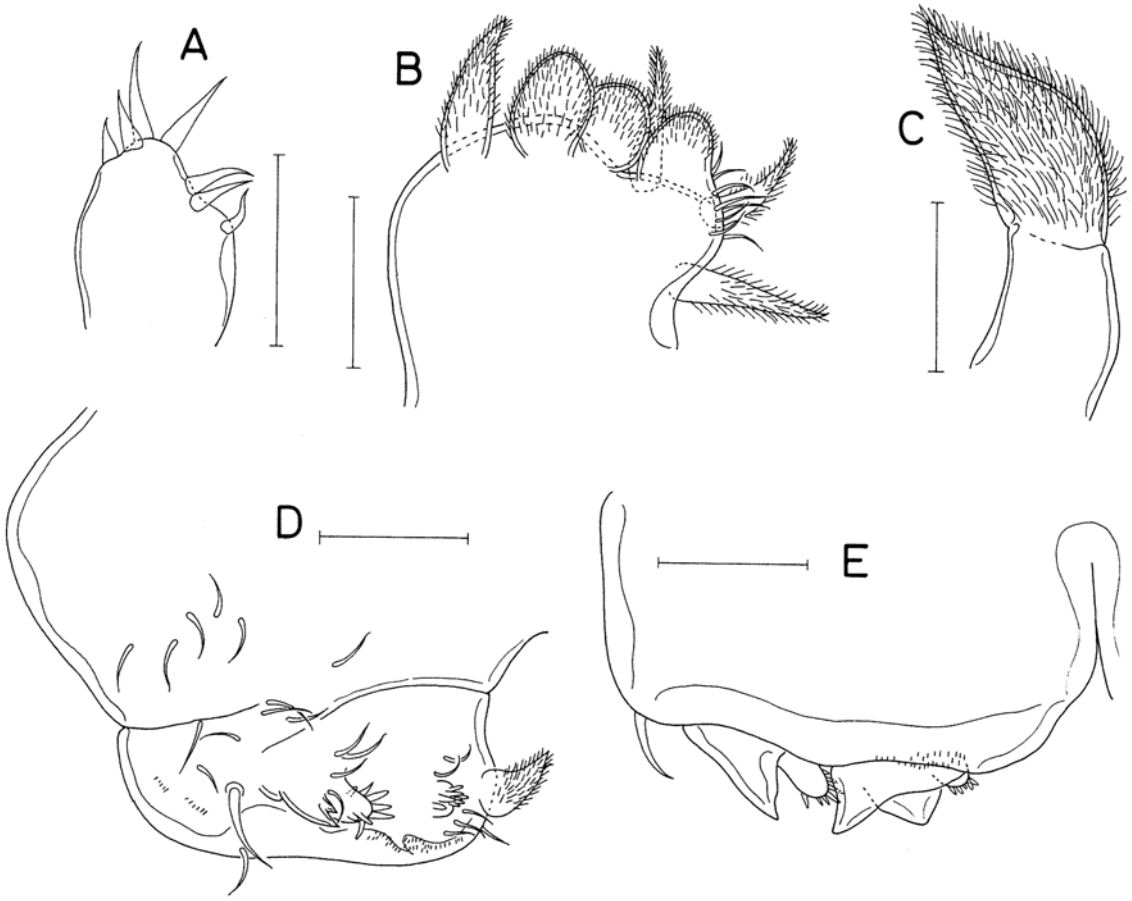


**Fig. 8.** *Janstockia truncata* n. sp., female. A, maxillule; B, maxilla; C, maxilliped; D, leg 1; E, leg 2. Scales: 0.05 mm for all

8C) incompletely 2-segmented; proximal segment naked; distal segment tapering, covered with numerous hair-like setules, but without seta.

Leg 1 (Fig. 8D) consisting of coxa, basis, and rudimentary rami; coxa unarmed, only with several setules; basis with 1 outer seta, and 1 leaf-like inner seta, and several setules; exopod lobate, with about 7 small setae, and accompanied with outer bifid process; endopod also lobate, with several minute setae.

Leg 2 (Fig. 8E) consisting of coxobasis and transformed rami; coxobasis with outer seta, but inner seta lacking; exopod consisting of triangular outer process and inner lobe bearing 7 minute setae; endopod consisting of 2 triangular outer processes and small inner lobe bearing 5 minute setae.

Legs 3 and 4 not different from leg 2. Legs 5 and 6 absent.

Male. Unknown.

**Etymology**

The specific name *truncata* originated from the truncated abdomen of the new species.

**Remarks**

Boxshall and Marchenkov (2005) differentiated the genus *Janstockia* from its relative genus *Ophioseides* Hesse, 1864 by the trilobate form of the maxillule and the presence of the two-segmented maxilliped of *Janstockia*. Their differentiation of *Janstockia* is supported here by the finding of *J. truncata* n. sp which shares very similar maxillule and maxilliped with *J. phallusiella* Boxshall and Marchenkov, 2005. *Janstockia phallusiella*, the only known species of the genus, is known from Suez Canal as an associate of the ascidian *Phallusia nigra* Savigny.

As differences between these two species, *J. truncata* reveals that 1) the maxilla is absent, 2) the labrum bears the paired tapering lateral processes, 3) the posterolatral expansions of the cepahosome are not so prominent as those of *J. phallusiella*, 4) the maxilliped carries no seta (3 distal and 2 subdistal setae are recorded in *J. phallusiella*), and 5) the lateral expansions of the first pedigerous somite is more prominent; width across this region is greater than the maximum width of the cephalosome (smaller in *J. pallusiella*).

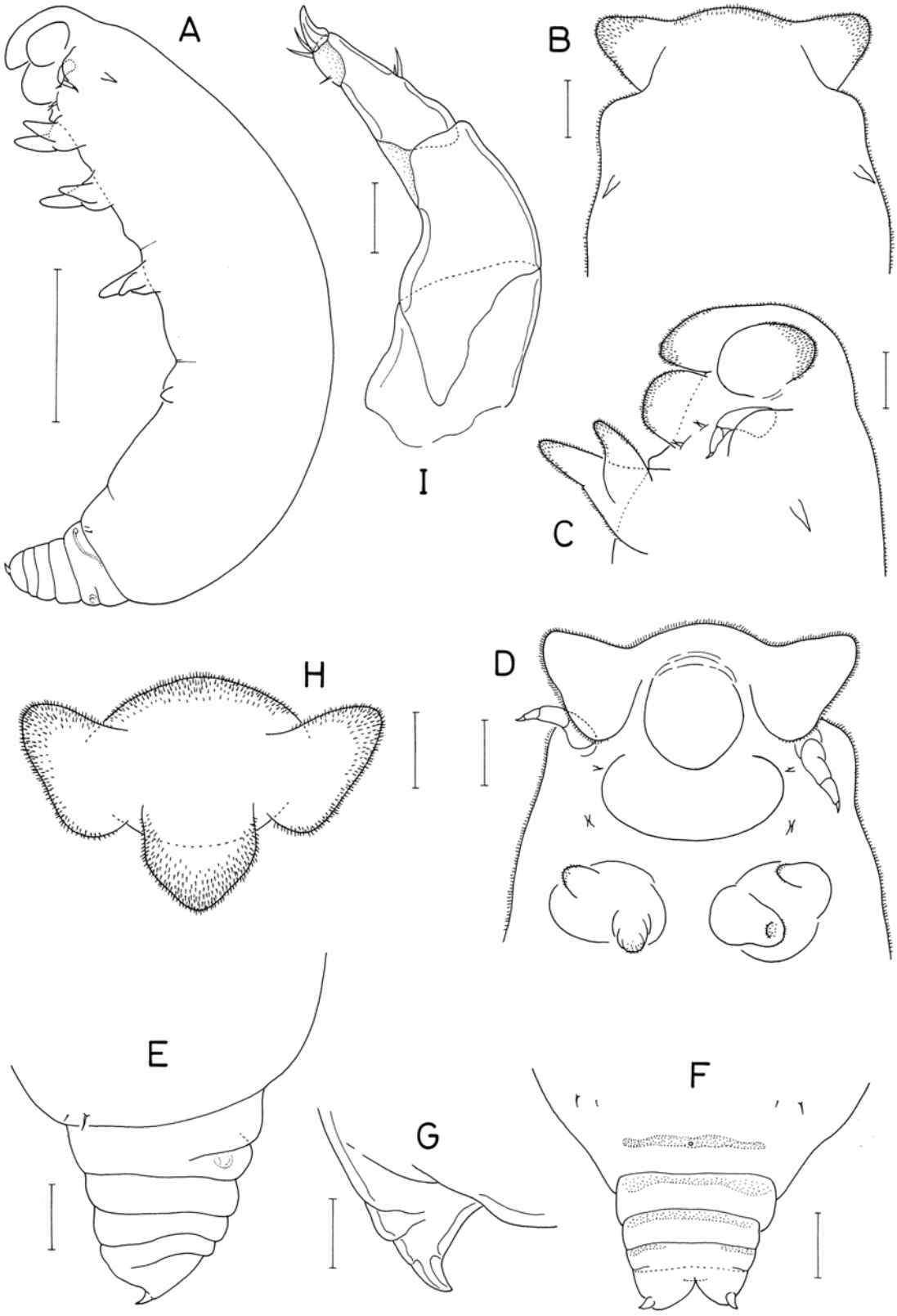


**Fig. 9.** *Pholeterides pilosa* n. sp., female. A, habitus, lateral; B. cephalothoracic area, dorsal; C, same, lateral; D, same, ventral; E, urosome, left; F, same, ventral; G, anal somite and caudal ramus, lateral; H, antennules and rostrum, anterior; I, antenna. Scales: A, 0.5 mm; B-F, H, 0.1 mm; G, I, 0.2 mm

Genus ***Pholeterides*** Illg, 1958

***Pholeterides pilosa* n. sp.** (Figs. 9, 10)

**Material examined**

11 ♀♀ from a compound ascidian taken from a fishing net set off Hujin Port (38°09'15"N, 128°36'36"E) in Yangyang, 8 January 2011, S. Y. Moon. Holotype (♀) and paratypes (7 ♀♀) will be deposited in the National Institute of Biological Resources (NIBR), Incheon. Dissected paratypes (3♀♀) are retained in the collection of the senior author.

**Description**

Female. Body (Fig. 9A) vermiform, curved ventrally, and consisting of large unsegmented prosome and small segmented urosome. Body surface covered densely with minute setues. Mean body length 3.40 mm (2.30-3.80 mm), based on 7 specimens. Body length of dissected specimen 3.04 mm. Maximum dorsoventral thickness of body 608 μm, measured across posterior part of prosome. Anterior part of prosome with slcerotized process (Fig. 2C) on dorsolateral surface at level of leg 1 (Fig. 9B, C). Fifth pedigerous somite fused to prosome (Fig. 9F). Urosome (Fig. 9E, F) 5-segmented, comprising genital somite and 4 segmented abdomen; suture line incomplete between 2 terminal somites. Caudal rami fused with anal somite, tapering, and terminated by highly sclerotized claw (Fig. 9G).

Rostrum large, directed ventrally (Fig. 9C), as long as wide, parallel in proximal half and strongly tapering in distal half (Fig. 9H). Antennule ear-like, unsegmented, unarmed, and tapering, with rounded end (Fig. 9B, H). Antenna (Fig. 9I) 3-segmented and tapering; first and second segments unarmed and suture line between them indistinct; third segment with 2 small setae on middle of ventral margin, 1 setule at subdistal region of dorsal margin, 2 distal setae, and teminated by strong claw.

Labrum inflated (Fig. 9C, D) and much wider than long. No mouth visible posterior to or beneath labrum. In ventral and lateral views of cephalic area, only 2 pairs of mouthparts visible. Mandible (first mouthparts) as elongated process bearing 1 setae on anterior margin (Fig. 10A). Maxillule (second mouthparts) distally weakly bilobed, with 2 and 1 setae on inner and outer lobes respectively (Fig. 10B). Maxilla and maxilliped absent.

Leg 2 (Fig. 11D) bilobed and unsegmented; inner lobe (endopod) shorter than outer lobe (exopod); both lobes unarmed, only covered with numerous setules. Legs 1 and 3 identical to leg 2 in structure. Leg 3 variable, absent or represented by small lobe (Fig. 9A) or somewhat developed and bilobed, but always smaller than anterior legs.

Leg 5 probably represented by 2 minute setules on ventrodistal region of prosome (Fig. 9A, F). Leg 6 not discernible.

Male. Unknown.

**Etymology**

The specific name *pilosa* is derived from the Latin *pilosus* (covered with hairs), referring to the hairy body surface of the new species.

**Remarks**

The new species can be assigned satisfactorily to the genus *Pholeterides* Illg, 1958, on the basis of morphological similarities revealed between *Pholeterides furtiva* Illg, 1958, the type species, and *P. pilosa* n. sp. The vermiform

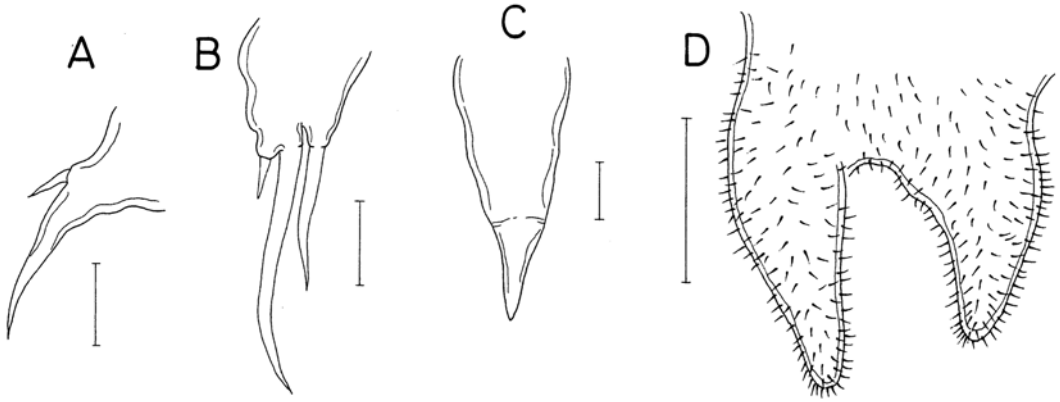


**Fig. 10.** *Pholeterides pilosa* n. sp., female. A, mandibular palp; B, maxillule; C, dorsolateral process; D, leg 2. Scales: A-C, 0.01 mm; D, 0.1 mm

body, the small but segmented urosome, the bilobed legs 1-3, the reduced leg 4, the presence of a dorsolateral process on the cephalic area, and the expanded antennule, rostrum and labrum are shared by these two species. In the original description of *P. furtiva*, Illg (1958) illustrated the dorsolateral process on the anterior part of prosome but did not mention it in the description. Boxshall and Marchenkov (2007) interpreted this process as the posterolateral angle of dorsal cephalic shield, which is shared by *P. pilosa*. Illg (1958) mentioned three pairs of mouthparts in *P. furtiva*, which are, according to Boxshall and Marchenkov (2007), the mandible, maxillule, and maxilla, respectively. The two pairs of mouthparts in *P. pilosa* are difficult to determine their nature among the three mouthparts. However, the difference in the number of mouthparts may be a distinguishing feature of *P. furtiva* and *P. pilosa*. The unsegmented condition of the two mouthparts seem to be an additional distinguishing feature of *P. pilosa* in consideration to that some of mouthparts are segmented in *P. furtiva* as illustrated by Illg (1958) and Boxshall and Marchenkov (2007).

Genus ***Pachypygus*** Sars, 1921

***Pachypygus spinosus* n. sp.** (Figs. 11, 12)

**Material examined**

1 ♀ (holotype) from a small solitary ascidian collected at Imwon Port (37°13'45"N, 129°20'43"E) in Samcheok, 25 September 2009, I.-H. Kim. Holotype (dissected and mounted on a glass slide) has been deposited in the National Institute of Biological Resources (NIBR), Incheon.

**Description**

Female. Body (Fig. 11A) cylindrical, consisting of cephalosome, 4-segmented metasome and 5-segmented urosome. Prosome 1.58 mm long. Last 2 metasomites with weak epimera. First urosomite (fifth pedigerous somite) short (Fig. 11B). Anal somite shorter and narrower than preceding somite, proximal half of its ventral surface sclerotized, with several scattered spinules on both sides (Fig. 11C). Caudal rami strongly divergent (Fig. 11B, C); each ramus tapering, 125×54 μm (2.31:1) with 2 setae, 4 distal claws and on outer margin 3 spinules.

Rostrum as hemi-circular lobe. Antennule (Fig. 11D) 203 μm long, distinctly tapering, and 8-segmented, with armature formula 2, 16, 9+aesthetasc, 5, 3+aesthetasc, 2, 2+aesthetasc, and 7+aesthetasc; all setae naked. Antenna (Fig. 11E) 3-segmented; coxa short and unarmed; basis longest among segments, with 1 small seta in middle; endopod 57×29 μm, with 1 proximal and 3 subdistal setae; terminal claw with 3 setae proximally.

Labrum (Fig. 11F) much wider than long, posteriorly trilobate, with 2 patches of setules on both posterolateral lobes and spinules on median lobe. Mandible (Fig. 11G) consisting of coxa and biramous palp; gnathobase of coxa with 5 teeth (arranged as 1, 2, 2) and serration on medial margin and 2 small setae on dorsal margin; basis with 1 medial seta; endopod 2-segmented, but first segment confluent with basis, with 5 setae, 1 on proximal and 4 on distal segments; endopod also 2-segmented and armed with 3 and 9 setae respectively on proximal and distal segments. Maxillule (Fig. 11H) with 9 setae on arthrite of precoxa; coxobasis with 1 seta on endite, 2 very unequal setae on epipodite, and 4 setae on medial margin; exopod 1-segmented, wider than long, with 4 setae; endopod 2-segmented, with 3 setae on first segment and 3 setae on reduced second segment. Maxilla (Fig. 12A) with 10 setae on syncoxa (these setae arranged as 4, 1, 2, 3 from proximal to distal); basis with 1 strong, claw-like spine, and 2 setae; endopod 2-segmented, with 1 and 5 setae respectively on proximal and distal segments. Maxilliped (Fig. 12B) incompletely 3-segmented, with 7, 1, and 4 setae on first to third segments, respectively.

Legs 1-4 with 3-segmented rami and following armature formula.

Leg 1: coxa 0-1; basis 1-I; exp I-1; I-1; II,II,4; enp 0-1; 0-1; 1,2,3

Legs 2 & 3: coxa 0-1; basis 1-0; exp I-1; I-1; III,I,5; enp 0-1; 0-2; 1,2,3

Leg 4: coxa 0-1; basis 1-0; exp I-0; I-1; II,II,0; enp 0-1; 0-2; 1,2,2

Inner distal spine on basis of leg 1 setiform. First endopodal segment of leg 1 with 3 setules on outer side. Outer seta on basis of legs 1-4 naked and of similar sizes (Fig. 12C-E). Medial setae on 2 distal segments of legs 2 and 3 greatly reduced. Inner seta on coxa of legs 3 and 4 small and naked (Fig. 12E).

Leg 5 (Fig. 12F) 2-segmented; proximal segment with 1 outer distal seta and spinules distally; distal segment nearly quadrate, 83×42 μm, with 1 small claw and 1 seta distally, and several spinules in distal half of medial margin. Leg 6 absent.

Male. Unknown.

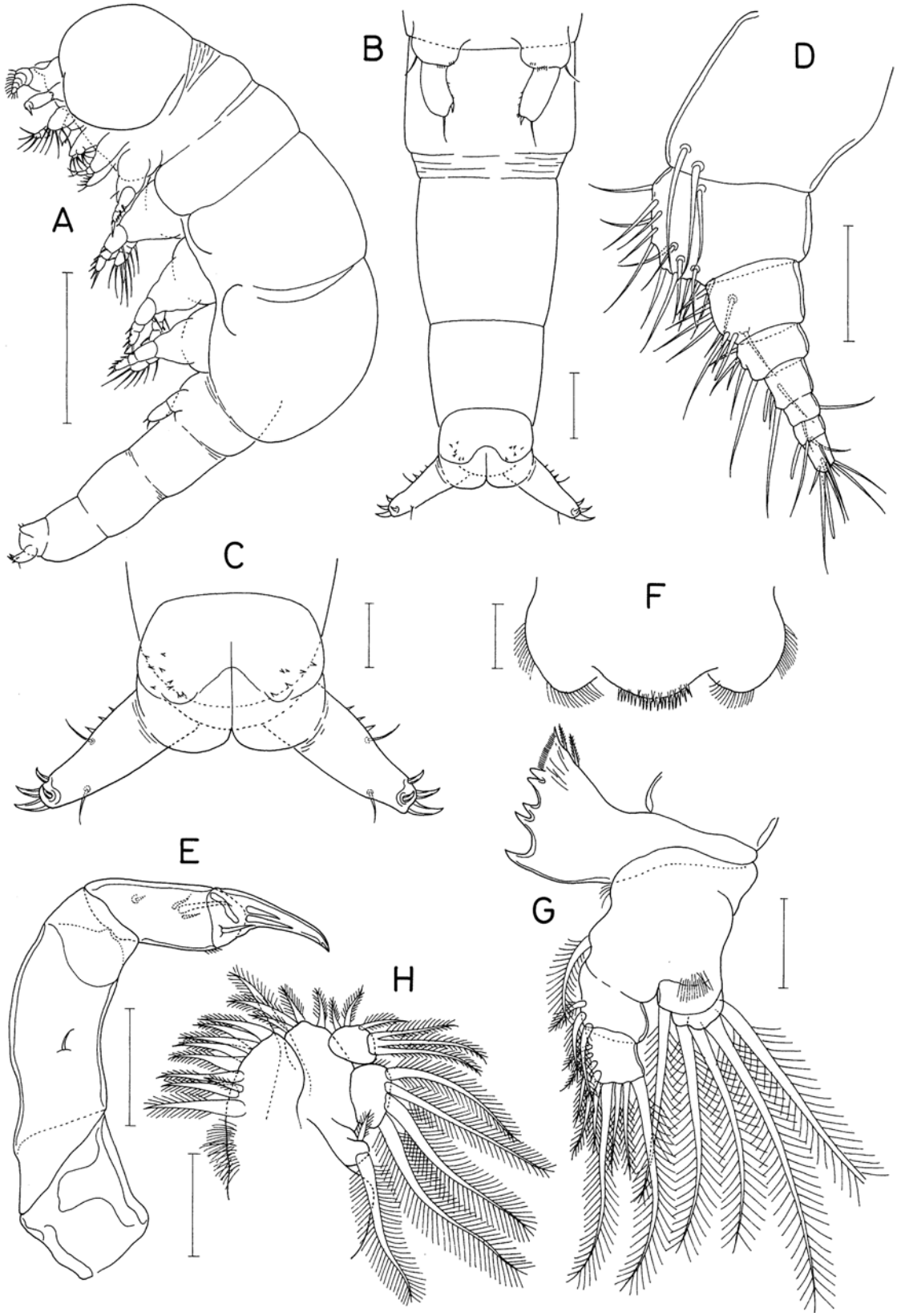


**Fig. 11.** *Pachypygus spinosus* n. sp., female. A, habitus, lateral; B, urosome, ventral; C, distal part of urosome, ventral; D, antennule; E, antenna; F, labrum; G, mandible; H, maxillule. Scales: A, 0.5 mm; B, 0.1 mm; C-E, G, H, 0.05 mm; F, 0.02 mm

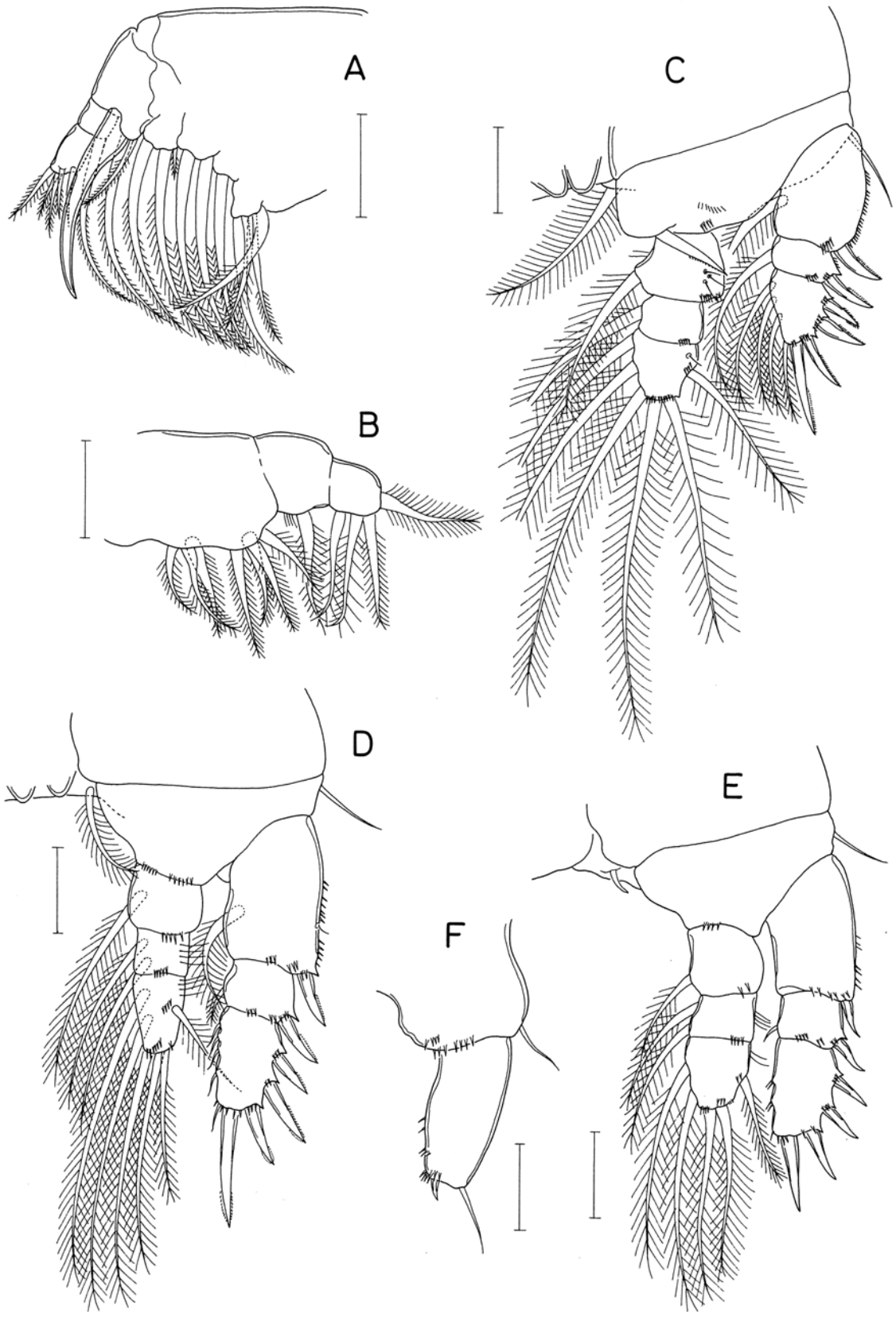


**Fig. 12.** *Pachypygus spinosus* n. sp., female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, leg 4; F, leg 5. Scales: 0.05 mm for all

**Etymology**

The specific name *spinosus* ia a Latin meaning "thorny", alluding to the presence of spines on the anal somite and caudal rami of the new species.

**Remarks**

The genus *Pachypygus* comprises eight known species: *P. australis* Gotto, 1975; *P. curvatus* Ooishi, 1961; *P. freemani* (Hamond, 1968); *P. gibber* (Thorell, 1859); *P. globosus* Ooishi, 1963; *P. macer* Illg, 1958; *P. minutus* (Canu, 1892); and *P. typicus* (Canu, 1892).

Two outstanding features of *Pachypygus spinosus* n. sp. may differentiate it from its eight congeners: the maxilla has 2-segmented endopod and the maxilliped has 7 setae on the first segment.

*Pachypygus spinosus* is also distinguishable from the congeners by its leg setation, because species of this genus carry various setations on the exopods of swimming legs. In *P. spinosus* the third exopodal segment of leg 1 has 4 spines+4 setae (3 spines+4 setae in *P. minutus*), the same segment of leg 2 has 4 spines+5 setae (4 spines+0 seta in *P. gibber* and *P. macer*, and 5 spines+0 seta in *P. globosus*), the same segment of leg 3 has 4 spines+5 setae (4 spines+4 setae in *P. australis*, 4 spines+0 seta in *P. gibber* and *P. macer*, and 5 spines+0 seta in *P. globosus*), the same segment of leg 4 has 4 spines+0 seta (2 spines+5 setae in *P. australis*, 4 spines+5 setae in *P. curvatus*, 3 spines+5 setae in *P. freemani* and *P. typicus*, and 5 spines+0 seta in *P. globosus*).

Genus ***Paranotodelphys*** Schellenberg, 1922

***Paranotodelphys unguifer* n. sp.** (Figs. 13, 14)

**Material examined**

1 ♀ (holotype) from the solitary ascidian *Ascidia samea* Oka collected at the depth of about 1 m, Yangpo Port (35°52'53"N, 129°31'28"E) on the east coast of Korea, 12 August 2009, I.-H. Kim. Holotype (dissected and mounted on a glass slide) has been deposited in the National Institute of Biological Resources (NIBR), Incheon.

**Description**

Female. Body (Fig. 13A) laterally compressed, with large prosome and small, cylindrical urosome. Prosome 2.18 μm long. Cephalosome indistinctly defined from metasome. Metasome unsegmented, but divisible into 4 parts by weak constrictions; last part corresponding to fourth pedigerous somite longer than combined 3 anterior somites, with angular ventrodistal corner. Urosome (Fig. 13B) originated from ventral side of prosome, perpendicular to axis of prosome, and indistinctly 5-segmented; first urosomite (fifth pedigerous somite) defined ventrally but fused dorsally to prosome; remaining four urosomites gradually narrowed distally, obscurely segmented, defined only by weak lateral constrictions. Caudal rami slightly divergent, widely separated from each other, tapering, and 102×37 μm (2.76:1), with 5 naked setae.

Rostrum (Fig. 13C) much longer than wide, with rounded posterior apex and vestigial transverse line laterally in middle. Antennule (Fig. 13D) ambiguously segmented, consisting of first segment, strongly tapering middle part, and 3 small distal segments; first segment with 8 setae, 2 of them larger than other setae and pinnate; suture line distinct between first segment and middle part; middle part occupying more than half length of antennule and formed by fusion of several segments, with 31 setae+aesthetasc, fourth proximal seta small and claw-like; 3 distal segments indistinctly defined, with 2 setae, 2 setae+aesthetasc, and 7 setae+aesthetasc, respectively from proximal to distal. Antenna (Fig. 13E) 2-segmented; proximal segment formed by fusion of original coxa, basis and first endopodal segment, with vestige of suture line delimiting original coxa and basis, 1 small subdistal naked seta, and 2 large pinnate setae representing exopod; 1-segmented endopod with 11 setae and strong terminal claw.

Labrum not examined. Mandible (Fig. 13F) consisting of coxa and biramous palp; coxa with 6 teeth of unequal sizes and 2 subsidiary denticles on medial margin of gnathobase, and 1 small naked stae on dorsal margin; palp with 1 seta on medial margin; exopod 2-segmented but segmentation obsolete in opposite view, with 5 setae, outermost one of them distinctly smaller than other 4; endopod 1-segmented but bipartite with constriction in middle and armed with 4 medial setae on proximal part and 10 setae on distal part. Maxillule (Fig. 13G) consisting of precoxa, coxobasis, and 1-segmented exopod and endopod; precoxa with produced arthrite bearing 9 setae; coxobasis with 2 medial setae, but characteristically lacking endite or epipodite; exopod indistinctly delimited from coxobasis, with 2 setae; endopod with 4 unequal setae. Maxilla (Fig. 14A) consisting of broad syncoxa, basis and 3-segmented endopod; syncoxa with 4, 2, and 3 setae on 3 endites respectively from proximal to distal; distalmost one of 4 setae on proximal endite small

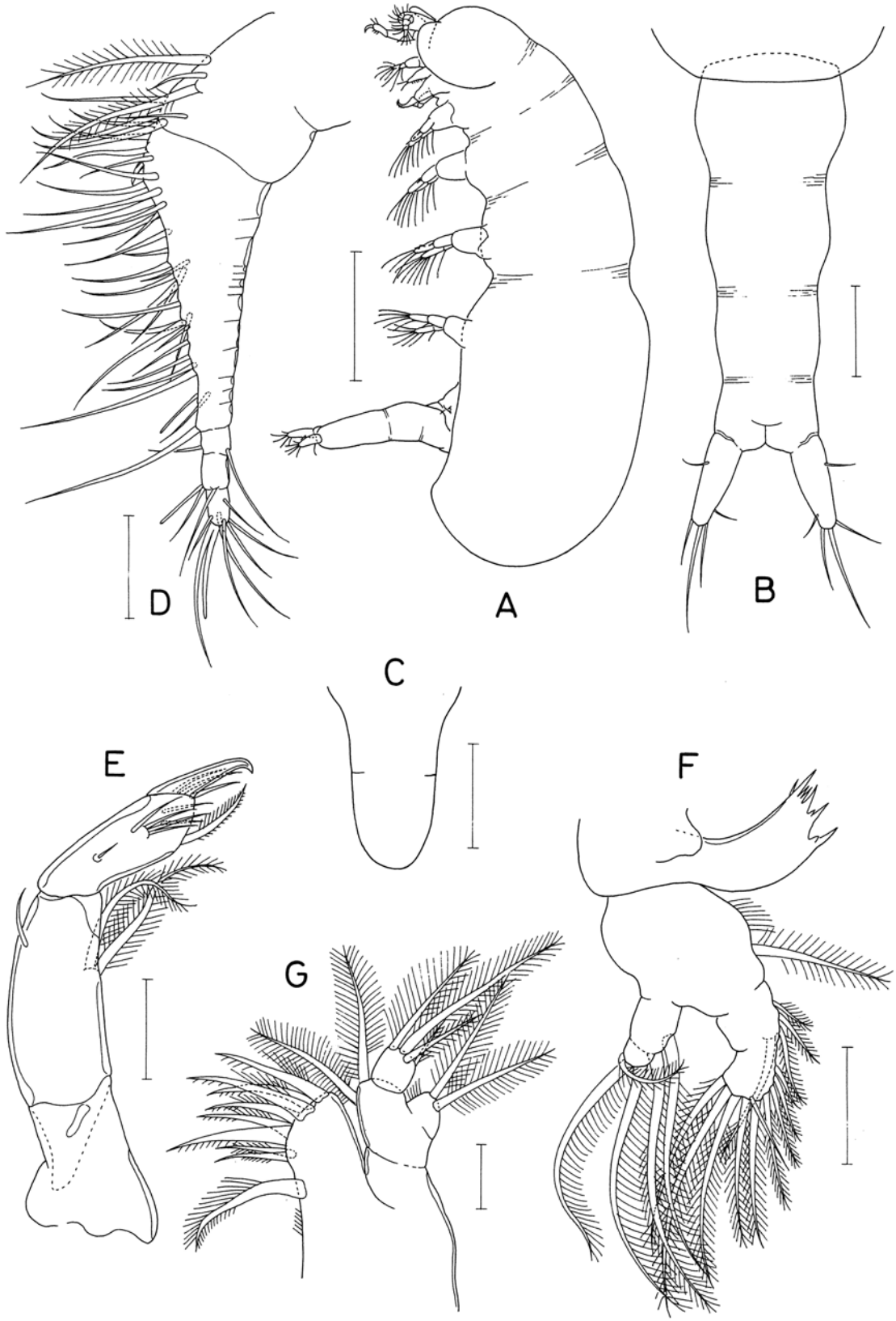


**Fig. 13.** *Paranotodelphys unguifer* n. sp., female. A, habitus, lateral; B, urosome, dorsal; C, rostrum; D, antennule; E, antenna; F, mandible; G, maxillule. Scales: A, 0.5 mm; B, 0.1 mm; C-G, 0.05 mm

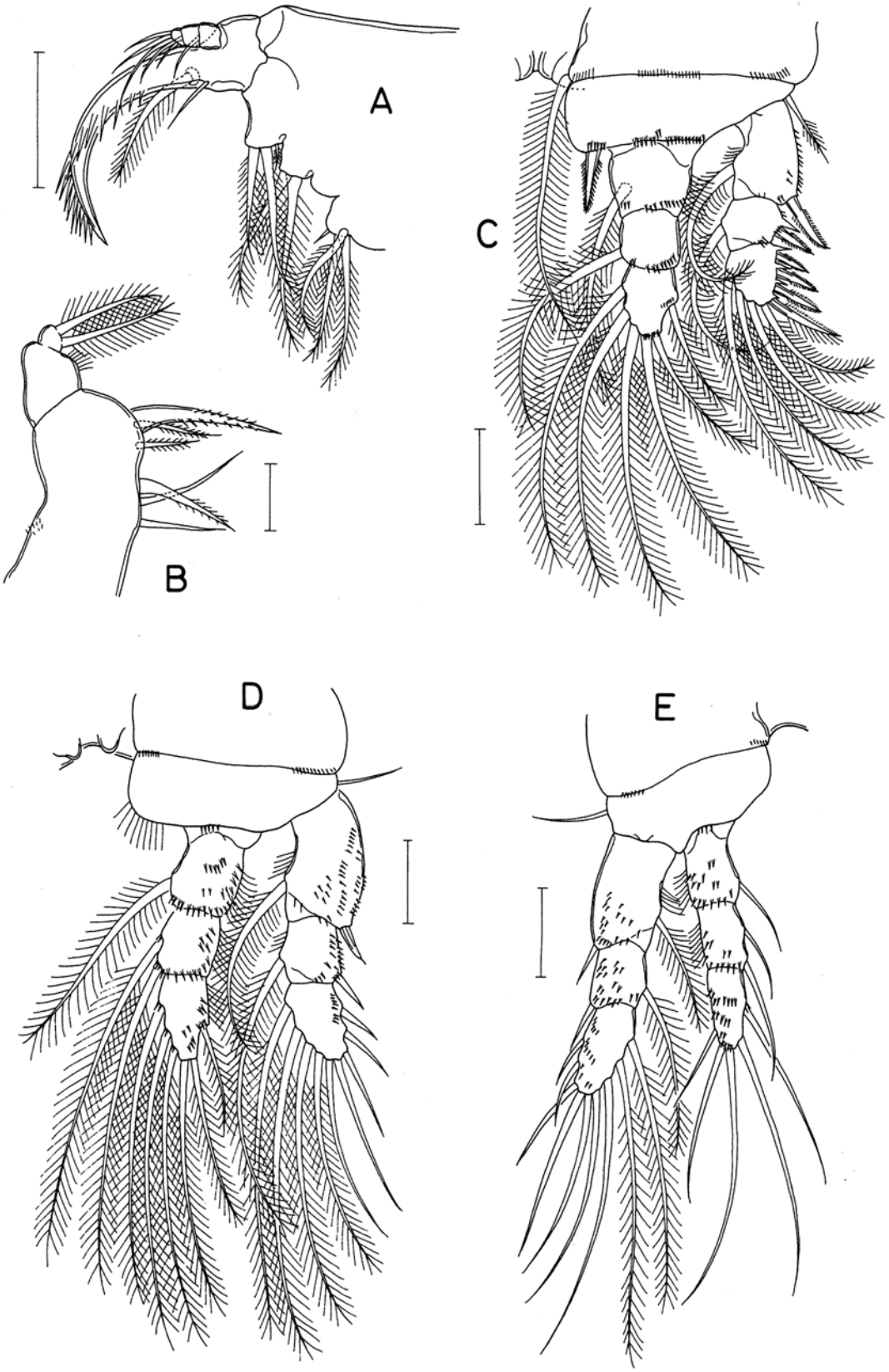


**Fig. 14.** *Paranotodelphys unguifer* n. sp., female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, leg 4. Scales: A, C-E, 0.05 mm; B, 0.02 mm

and naked; proximalmost one of 3 setae on distal endite small but pinnate; basis with 2 setae and 1 enlarged, spinules-bearing hook extending far beyond endopod; endopod reduced, with 1, 1, and 4 naked setae respectively on first to third segments. Maxilliped (Fig. 14B) 3-segmented; first segment with 6 setae, distalmost one of them enlarged; second segment unarmed but with setules on medial margin; third segment small and incompletely segmented from second segment, with 2 pinnate setae.

Legs 1-4 with 3-segmented rami, with armature formula as follows:

Leg 1: coxa 0-1; basis 1-I; exp I-1; I-1; III,I,4; enp 0-1; 0-1; 1,2,3

Legs 2 & 3: coxa 0-0; basis 1-0; exp I-1; 1-1; 3,1,5; enp 0-1; 0-2; 1,2,3

Leg 4: coxa 0-0; basis 1-0; exp 1-0; 1-1; 3,1,5; enp 0-1; 0-2; 1,2,2

Outer margin of second and third exopodal segments of leg 1 with well developed, acute processes near base of spines. Inner seta on coxa of leg 1 enlarged (Fig. 14C), but legs 2-4 without this seta (Fig. 14D, E).

Leg 5 vestigial, represented by 2 minute setae. Leg 6 absent.

Male. Unknown.

**Etymology**

The specific name *unguifer* is a combination of the Latin *unguis* (a claw) and *fero* (to bear). It alludes to the having a large claw on the basis of the maxilla.

**Remarks**

Within the Notodelphyidae the presence of two large setae on the basis of antenna, which represent the exopod, and the 3-segmented maxilliped are displayed by three genera, *Notodelphys* Allman, 1847, *Notodelphyopsis* Schellenberg, 1921, and *Paranotodelphys* Schellenberg, 1922. With the absence of a seta on the second segment of the maxilliped, the new species is more related to the latter two genera than to the former.

The most characteristic features of the new species seem to be the presence of an enlarged hook on the basis of the maxilla and the absence of the endite and epipodite on the maxillule. No species of *Notodelphyopsis* and *Paranotodelphys* reveals these features.

*Notodelphyopsis* and *Paranotodelphys* are distinguished from each other only by the segmentation of urosome (Illg 1958; Marchenkov and Boxshall 2003): 4-segmented in the former genus and 5-segmented in the latter. However, this distinction is not always clear; in some species of *Paranotodelphys* the fifth pedigerous somite is obsolete, as the case of *P. illgi* Marchekov and Boxshall, 2003. The new species also reveals the similar condition. We place it in *Paranotodelphys*, the more inclusive genus.

## Acknowledgements

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