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To cite this article: Sa Heung Kim & Won Kim (1997) Two new species of the subfamily donsiellinae (Copepoda, Harpacticoida, Thalestridae) associated with the Isopod from Korea, Korean Journal of Biological Sciences, 1:1, 1-13, DOI: [10.1080/12265071.1997.9647343](https://doi.org/10.1080/12265071.1997.9647343)

To link to this article: <https://doi.org/10.1080/12265071.1997.9647343>



Published online: 22 Nov 2010.



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Two New Species of the Subfamily Donsiellinae (Copepoda, Harpacticoida, Thalestridae) Associated with the Isopod from Korea

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Key Words:

Copepoda
Harpacticoida
Pseudonsiella
Xylora
New species
Limnoria, Korea

Two harpacticoid copepods, *Pseudonsiella longicaudata* n. sp. and *Xylora longiantennulata* n. sp. belonging to the subfamily Donsiellinae are described. They were found in the wood infested by isopod of the genus *Limnoria* from the East Sea (Sea of Japan), Korea. The former species is characteristic in having the long caudal ramus and four setae on mandibular basis. The latter one closely resembles *X. nertica* Hicks in general body form, but is clearly distinguished from *X. nertica* in that the antennule is much longer and the caudal ramus is longer, and leg 5 endopod bears four setae.

The copepod fauna belonging to the subfamily Donsiellinae Lang, 1948 has been poorly known, and only ten species of five genera have been described in the subfamily until now: five species of *Donsiella*, one species of *Pseudonsiella*, two species of *Xylora*, and one species each of *Apodonsiella* and *Oligoxylora* (Hicks, 1988 and 1990). Most species of Donsiellinae have been found from wood or seaweed-boring isopods of the genus *Limnoria*. Of these ten species, *Donsiella limnoriae* Stephensen was originally described from Norway (1936). The subfamily Donsiellinae was established and erected within the family Laophontidae T. Scott by Lang (1948) to accommodate Stephensen's species. Later, this species was redescribed by Krishnaswamy and Jhon (1958; 1962) from the region of Solent, U.K. However, the Krishnaswamy and Jhon's species was re-examined by Hicks (1988) who re-named it as *D. angilca* n. sp. Recently, Hicks (1988), in his review on the subfamily Donsiellinae, established four new genera including eight new species from New Zealand and Australia and suggested that the subfamily Donsiellinae is a member of family Thalestridae Sars, 1905. More recently, Hicks (1990) added a new species, *Donsiella phycolimnoriae*, associated with algae-boring limnoriid from Maquarie Island, Australia. In this paper, the authors describe two new species of the subfamily Donsiellinae associated with wood-boring isopods of the genus *Limnoria* from the East Sea (Sea of Japan), Korea.

Materials and Methods

The copepod specimens examined in this study were

all collected by the authors. A decaying wood infested by limnoriid was collected from the fishing net. In order to dislodge the copepods, wood was agitated in 10% ethylalcohol. The washing was then examined under dissecting microscope and the copepods were sorted out. The copepod specimens were fixed with 5% formalin and then preserved in 75% ethylalcohol. The examined specimens were dissected and measured in lactic acid and later, mounted in lactophenol. All figures were drawn with the aid of a camera lucida. Abbreviations used in this paper are: Exp=exopod; Enp=endopod. In the formulae for legs 1-4, Roman numerals indicate spines and Arabic numerals representing setae.

Results

Family Thalestridae Sars, 1905
Subfamily Donsiellinae Lang, 1948
Genus *Pseudonsiella* Hicks, 1988

Pseudonsiella longicaudata n. sp. (Figs. 1-4)

Material examined: 6 ♀♀, 5 ♂♂ from washings of decaying wood infested by isopod of the genus *Limnoria*, collected from Namae Port (37° 45' N, 123° 35' E) Kangwondo, East Sea (Sea of Japan), May 3, 1996. Holotype (♀), allotype (♂), paratypes (3 ♀♀, 2 ♂♂) will be deposited in the U.S. National Museum of Natural History, Smithsonian Institution. Dissected paratypes (2 ♀♀, 2 ♂♂) are deposited in the collection of the authors.

Adult female: Body (Fig. 1A) pyriform, dorsoventrally depressed. Length 630 μm measured from anterior margin of rostrum to distal margin of caudal rami. Width 290 μm in greatest dimension of cephalothorax. Ratio of length to width 2.17:1. Cephalothorax semi-

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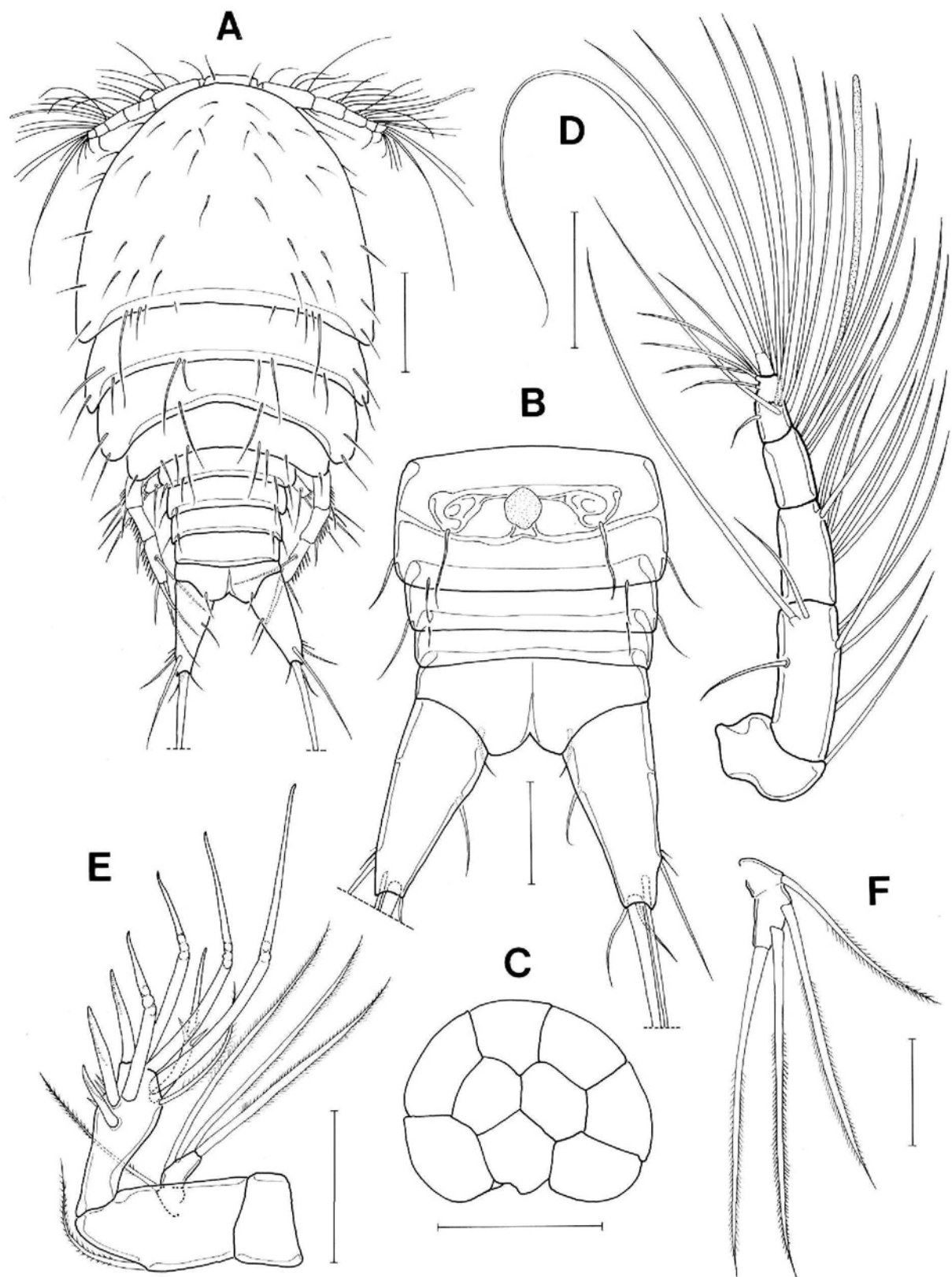


Fig. 1. *Pseudonsiella longicaudata* n. sp. Female. A, habitus, dorsal; B, urosome, ventral; C, egg sac; D, antennule; E, antenna; F, exopod of antenna. Scales: A, C=0.1 mm; B, D, E=0.05 mm; F=0.025 mm.

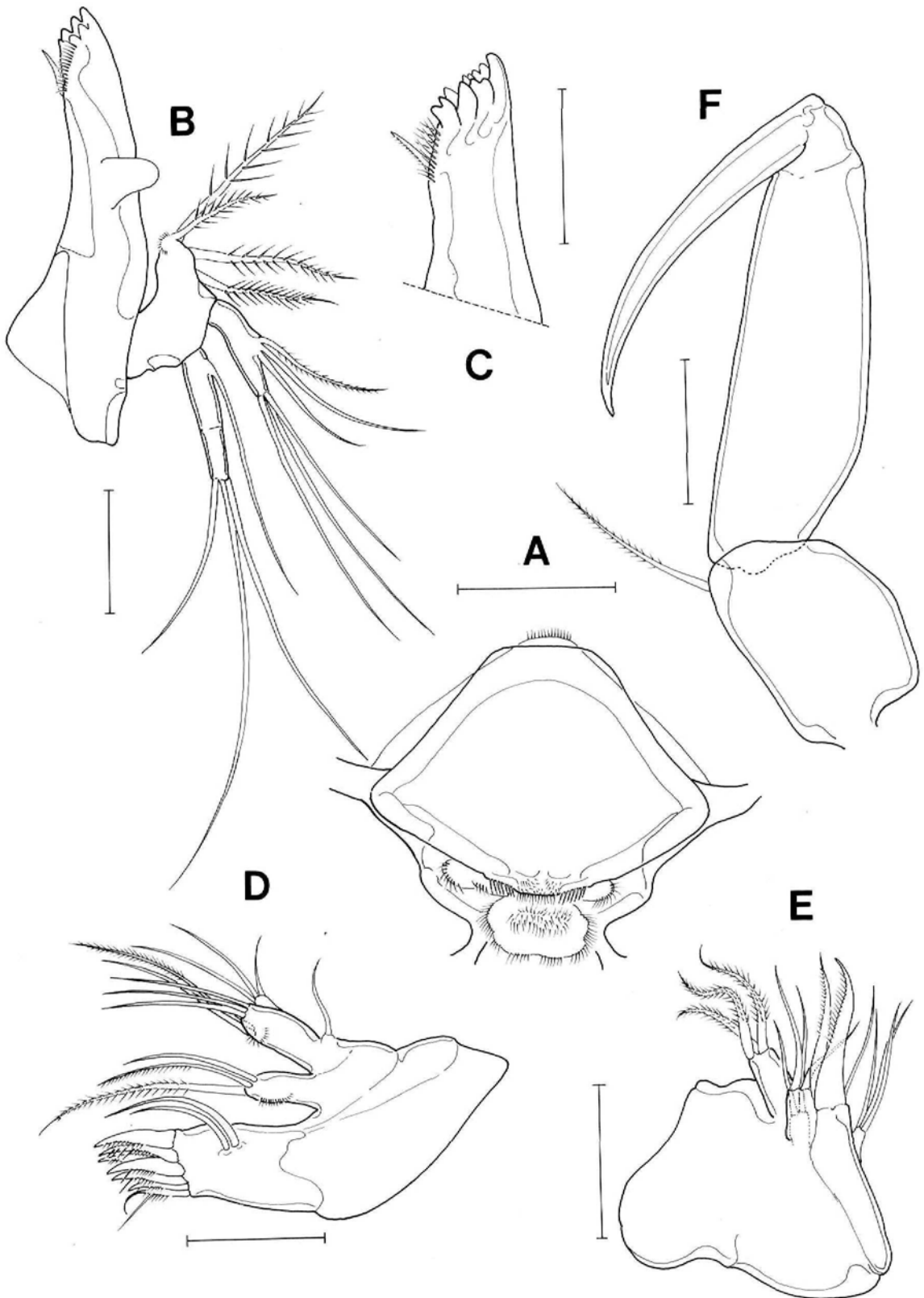


Fig. 2. *Pseudonsiella longicaudata* n. sp. Female. A, labrum and paragnaths; B, mandible; C, gnathobasis of mandible; D, maxillule; E, maxilla; F, maxilliped. Scales: A=0.05 mm; B-F=0.025 mm.

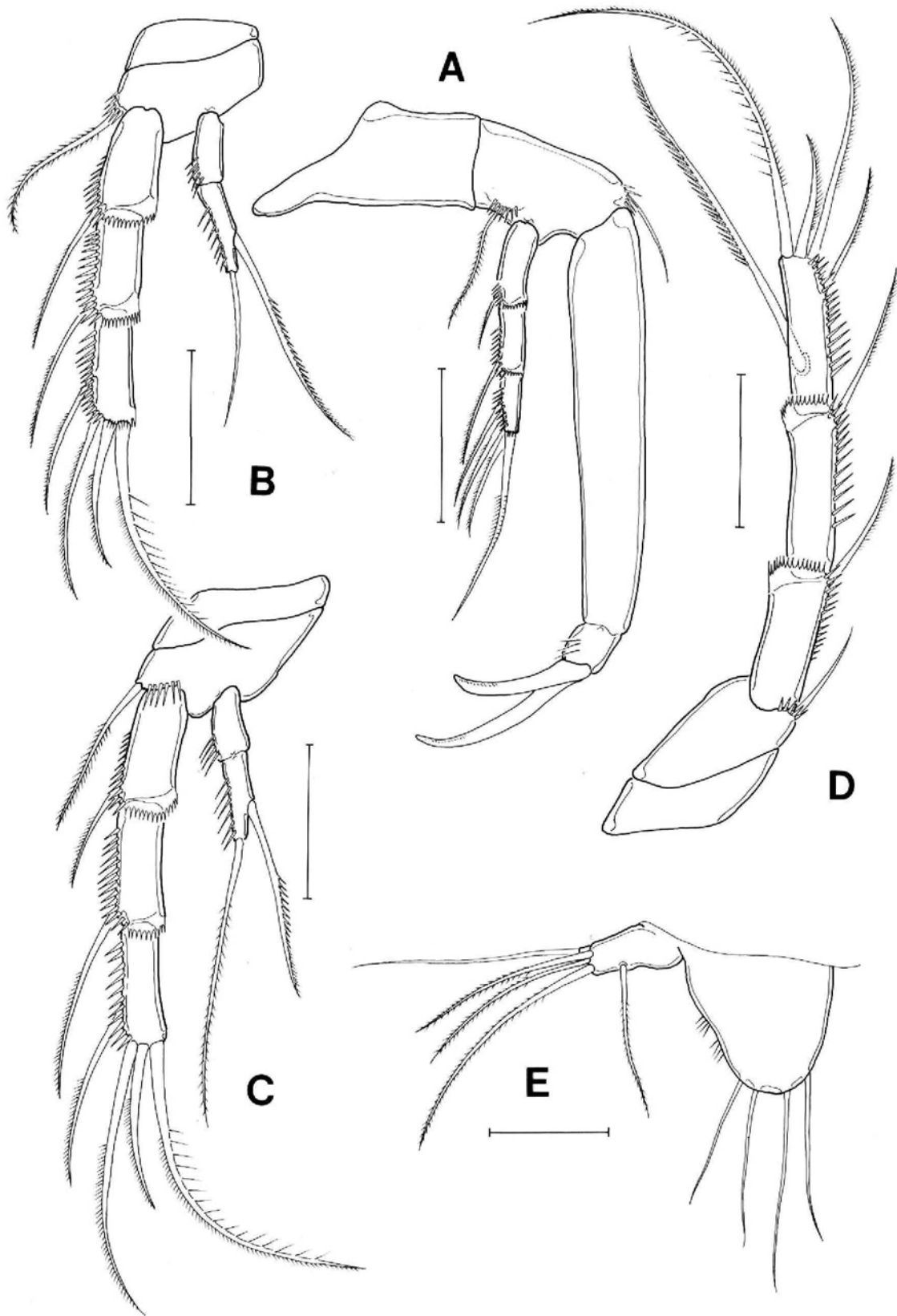


Fig. 3. *Pseudonsiella longicaudata* n. sp. Female. A, leg 1; B, leg 2; C, leg 3; D, leg 4; E, leg 5. Scales: 0.05 mm in all.

circular anteriorly, nearly as long as wide, with scattering long hairs on dorsal surface and along lateral margins; lateral margin wrapped ventrally. Hyaline material narrow but distinct. Rostrum moderately rounded in anterior margin, with 4 sensilla, curved ventrally. Epimera of cephalothorax somewhat extended posteriorly. First to fourth metasomal somites with some long hairs near lateral and posterior margins; first metasomal somite as wide as cephalothorax, more extended than that of cephalothorax posteriorly; second metasomal somite as wide as first one, broadly rounded posteriorly; third metasomal somite 0.77 times as short as second one, rounded posteriorly; fourth metasomal somite 0.48 times as short as greatest dimension of body, with 1 seta on lateral and dorsal margin, respectively. Ratio of prosome to urosome 2.18:1. Abdomen (Fig. 1B) relatively short, nearly as long as wide. Genital double-somite indistinctly subdivided by chitinous material; genital area with orbicular receptaculum seminis. Genital complex and following abdominal somite with sensilla on dorsal and ventral surface posteriorly. Caudal rami (Fig. 1B) tapering posteriorly, about 2.67 times longer than greatest width, with 6 setae; outermost seta of distal margin small, indistinct. Single egg sac (Fig. 1C) with 9 eggs.

Antennule (Fig. 1D) long, 6-segmented; second segment longest, about 2.65 times longer than wide, with setal formula: 1, 9, 7, 5+1 aesthetasc, 7, and 8.

Antenna (Fig. 1E and F) with allobasis; allobasis thick, about 2.3 times longer than wide, with 1 medial seta. Endopod 1-segmented; sub-distal margin with small spinules, 2 pectinated spines, and 1 geniculate seta; distal margin with 4 geniculate (inner-most geniculate seta with spines on medial part) and 1 naked setae. Exopod (Fig. 1F) indistinctly 2-segmented; first segment nearly triangular, with 1 seta; second segment tapering distally, longer than wide, with 3 bipinnate setae.

Mandible (Fig. 2B and C) with gnathobase (Fig. 2C) bearing 1 seta and setules at dorsal corner, comb-like projections on cutting edge. Coxa-basis with a low of setules on inner margin, 4 bipinnate setae. Endopod 1-segmented, as long as exopod, with 3 medial and 3 distal setae. Exopod about 3.42 times longer than wide, indistinctly 2-segmented; first segment with 1 seta near basis; second segment nearly twice as long as first segment, with 3 long and simple terminal setae.

Arthrite of maxillule (Fig. 2D) with 7 claw-like spines on cutting edge and 2 surface setae. Coxal endite with a row of setules on distal margin, 3 terminal setae. Basal endite with 5 setae. Exopod unsegmented, with 3 naked setae. Endopod small, unsegmented, with 1 simple seta.

Syncoxa of maxilla (Fig. 2E) with 3 endites; distal-most with 3 pinnate setae; proximal-most bilobed,

with 2 and 2 setae, respectively. Basis with 1 strong serrate claw and 2 setae (1 seta strong and unipinnate). Endopod small, unsegmented, with 3 simple setae.

Maxilliped (Fig. 2F) prehensile. Basis with 1 plumose seta, without spinules. First endopod 3.5 times longer than wide, tapering distally; inner margin straight and smooth; outer margin with 1 seta. Second endopod represented by 1 strong and simple claw reaching 3/4 distance from distal margin of basis.

Legs 1-4 (Figs. 3B-D) with 3-segmented exopod and 2-segmented endopod except for leg 4. Leg 1 (Fig. 3A) endopod 2-segmented; first segment naked, about 2 times longer than exopod excluding distal setae; second segment nearly rectangular, with 2 finely pinnate terminal claws. Endopod of leg 4 completely reduced. Exopodal segments of legs 1-4 and endopodal segments of leg 2 and 3 with spinules on lateral and distal margin. Armature formulae for legs 2-4 as follows:

leg 2 basis 1-0 exp. 1-0; 1-0; III, 1
 enp. 0-0; 1, 1
 leg 3 basis 1-0 exp. 1-0; 1-0; III, 1
 enp. 0-0; 1, 1
 leg 4 basis 1-0 exp. 1-0; 1-0; III, 1, 1

Baseoendopod of leg 5 (Fig. 3E) triangular, with fine setules on outer margin and 4 setae on distal margin. Exopod unsegmented, elongated distally, 1.8 times longer than wide, with 1 medial and 4 distal setae.

Leg 6 represented by 1 long seta.

Adult male: Body (Fig. 4A) 570 μ m long, 290 μ m wide, with slenderer prosome than in female. Other dissected paratype 540 \times 260 μ m in size. Ratio of length to width 1.97:1. Epimera of cephalothorax and metasomal somites more extended than that of female posteriorly. Abdomen (Fig. 4B) 1.30 times longer than wide, relatively longer than that of female. Genital somite free. Length of prosome to urosome ratio approximately 1.83:1.

Antennule (Fig. 4C) prehensile, 6-segmented; second segment longest, about 1.52 times longer than wide; fifth segment thick, broad, and rounded in posterior margin. Setal formula for each segments: 1, 1, 11, 8, 13+1 aesthetasc, and 10.

Third exopodal segment of leg 2 (Fig. 4D and E) with 1 simple spine and 3 terminal setae. Endopod narrow, 1.42 times longer than exopod; first segment with several spinules on outer margin; second segment 1.5 times longer than first segment, with spinules on outer margin and 1 serrate medial seta on inner margin; third segment (Fig. 4E) 1.51 times longer than first and second segments, with spinules on outer margin, 1 long naked seta, and 1 chitinized

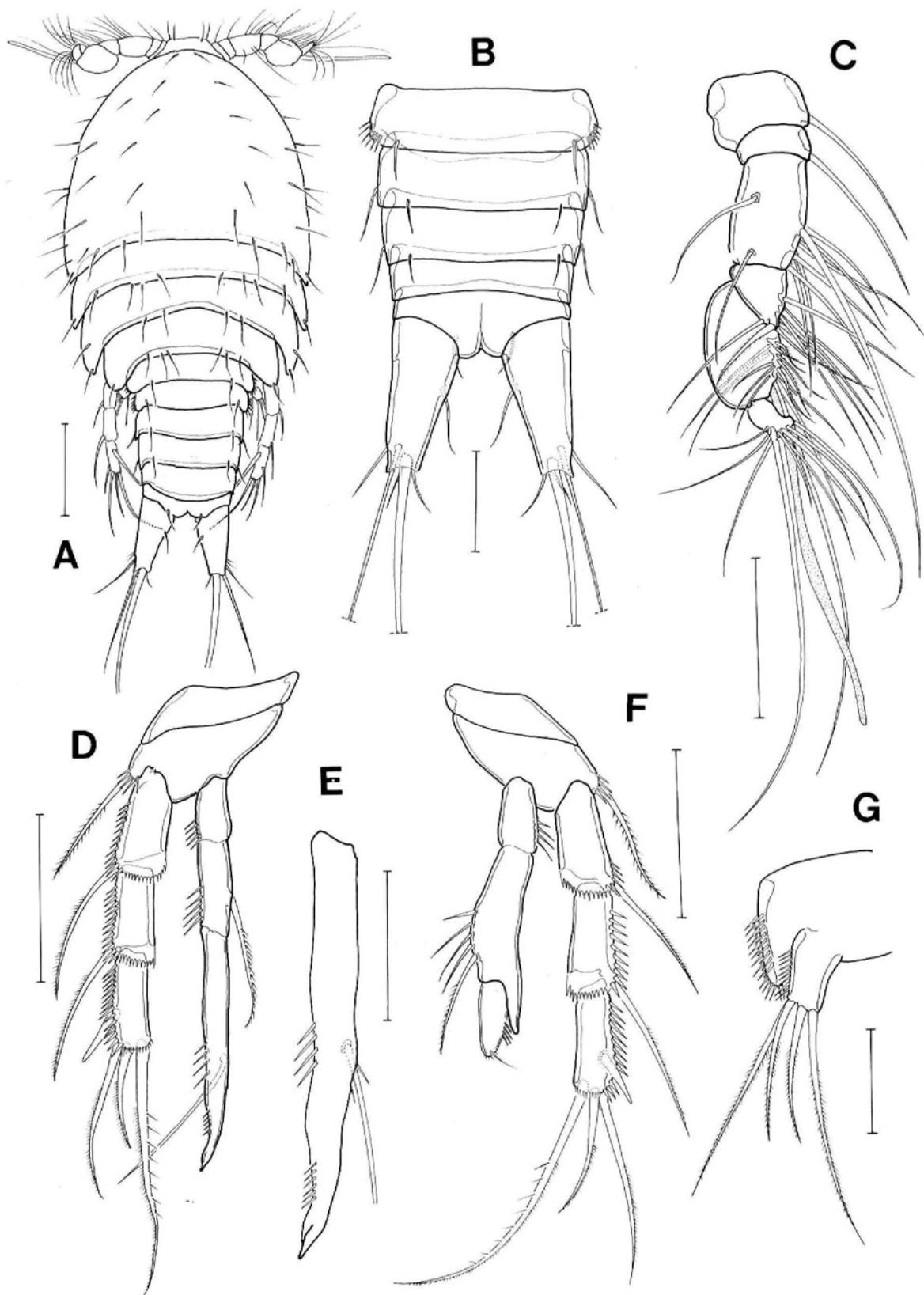


Fig. 4. *Pseudonsiella longicaudata* n. sp. Male. A, habitus, dorsal; B, urosome, ventral; C, antennule; D, leg 2; E, third endopodal segment of leg 2; F, leg 3; G, leg 5. Scales: A=0.1 mm; B-D, F=0.05 mm; E, G=0.025 mm.

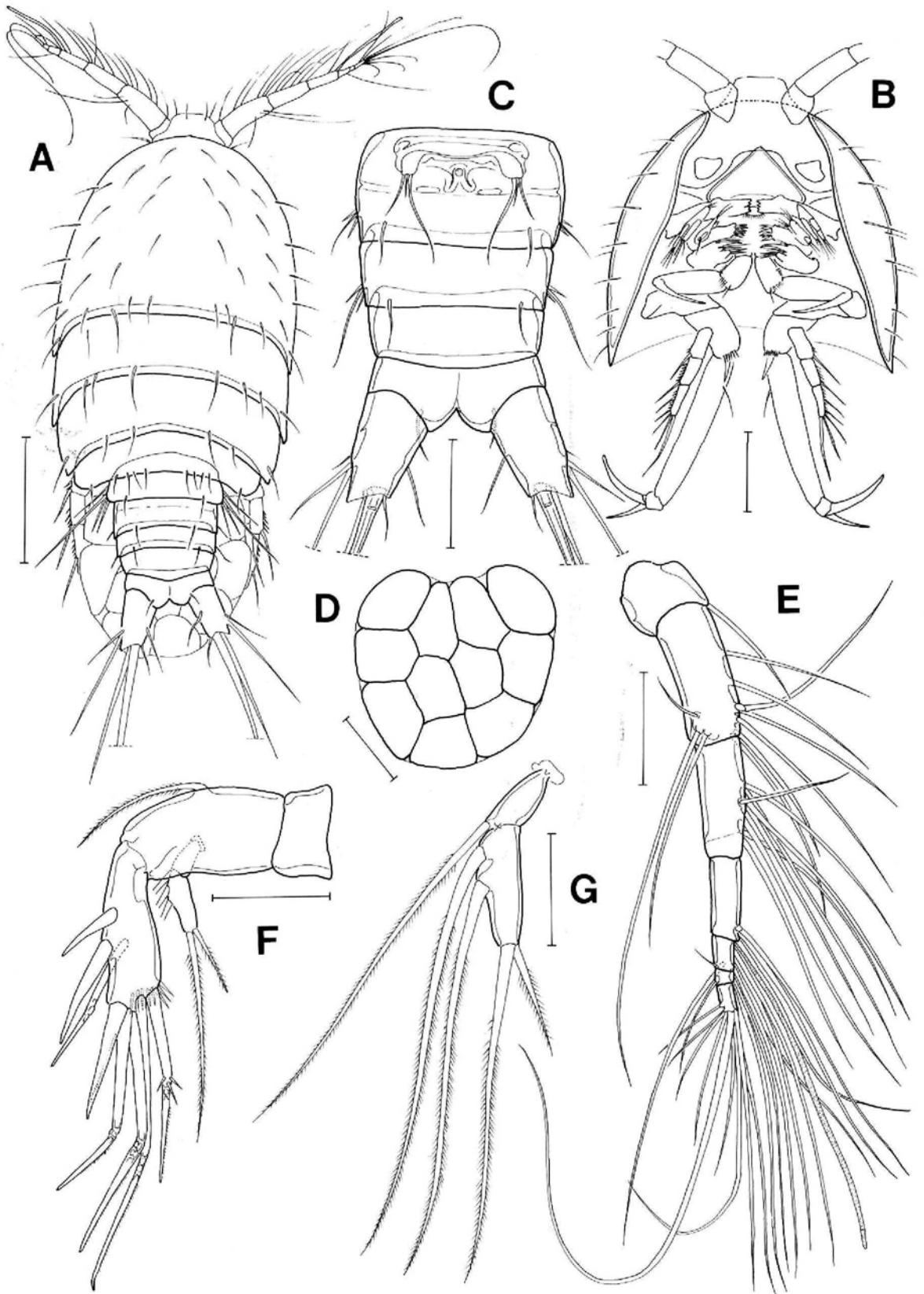


Fig. 5. *Xylora longiantennulata* n. sp. Female. A, habitus, dorsal; B, cephalothorax, ventral; C, urosome, ventral; D, egg sac; E, antennule; F, antenna; G, exopod of antenna. Scales: A=0.2 mm; B, C=0.1 mm; D, E=0.05 mm; G=0.025 mm.

apical process.

Exopod of leg 3 (Fig. 4F) as in female except for distal spine on medial part. Endopod somewhat shorter than exopod; first segment with several spinules on outer margin; second segment slightly convex medially, 2.68 times longer than wide, with 4 long lateral spinules, 1 pinnate sub-distal seta, extended process on outer distal edge; third segment ellipsoid, with several spinules on outer margin and 1 short seta on terminal edge.

Leg 5 (Fig. 4G) uniramous, sub-rectangular (about 1.4 times longer than wide), with 4 distal setae and lateral spinules.

Leg 6 represented by 1 bipinnate seta.

Etymology: The specific name *longicaudata* (Latin meaning long tail) refers to the long caudal rami of the new species

Remarks: The genus *Pseudonsiella* Hicks, 1988 is characterized by the reduced endopod of leg 4, and only one species, *P. aotearoa* Hicks, 1988 is known from New Zealand. The new species is clearly separated from *P. aotearoa* in having the combination of following characteristics: (1) each second to fourth segment of antennule are much longer than wide; (2) the caudal ramus is 2.67 times as long as wide; (3) second endopodal segment of antenna bears 3 setae; (4) basis of mandible bears 4 bipinnate setae; (5) exopod of leg 5 is about 1.5 times longer than wide. The new species is also similar to *Donsiella victoriae* Hicks, 1988 and *D. bisetosa* Hicks, 1988 in general body form and in the form of appendages such as 2-segmented endopod of leg 2 and 3, elongated exopod of leg 5, and basis of mandible bearing 4 setae. However these species are clearly separated from the species of genus *Pseudonsiella* in that the leg 4 is armed with a diminutive endopod.

The following diagnostic characters are added to the Hicks's diagnosis for *Pseudonsiella*: (1) basis of mandible with 4 setae; (2) second endopodal segment of antenna with only 3 setae; (3) egg sac single with 9 eggs.

Variations are found in the exopod of mandible and the second endopodal segment of antenna. Previously recorded species, *P. aotearoa* undoubtedly has biarticulated exopod in antenna and mandible, while an ovigerous female in this study has unsegmented exopod in these appendages.

Genus *Xylora* Hicks, 1988

Xylora longiantennulata n. sp. (Figs. 5 - 8)

Material examined: 48 ♀♀, 37 ♂♂, washed from decaying wood infested by isopod of the genus *Limnoria*, (together with *Pseudonsiella longicaudata* n. sp.), collected from Namae Port (37° 45' N, 123° 35'

E) Kangwondo, East sea (Sea of Japan), May. 3, 1996. Holotype (♀), allotype (♂), and paratypes (10 ♀♀, 10 ♂♂) will be deposited in the U.S. National Museum of Natural History, Smithsonian Institution. Other paratypes (37 ♀♀, 22 ♂♂ including the dissected specimens) are kept in the collection of the authors.

Adult female: Body (Fig. 5A) pyriform, length 810 μm (750-820 μm) measured from anterior margin of rostrum to distal margin of caudal rami. Width 340 μm (310-350 μm) in greatest dimension. Ratio of length to width 2.98 ± 0.03 : 1. Cephalothorax (Fig. 5B) semi-ellipsoid anteriorly, nearly as long as wide, with sensilla scattering on dorsal surface and along lateral margins; lateral margin wrapped ventrally. Hyaline material narrow but distinct. Rostrum moderately rounded in anterior margin, with 4 sensilla, moderately curved ventrally. First and second somites nearly same in size, as wide as cephalothorax. Third metasomal somite 0.83 times as short as preceding one, rounded laterodistally. Metasomal somite bearing leg 5 about 0.5 times as short as greatest width of body. Urosome (Fig. 5C) slightly tapering distally; ratio of length of urosome to prosome 1 : 2.1 in greatest dimension. Genital complex and following abdominal somite with sensilla on dorsal and ventral surface posteriorly. Genital and first abdominal somite fused but indistinctly subdivided by chitinous material; genital double somite shorter than following 2 abdominal somites. Genital field (Fig. 5C) with small orbicular receptaculum seminis. Caudal rami (Fig. 5C) moderately tapering posteriorly, about 1.76 times longer than wide in greatest dimension, with 6 setae. Single egg sac (Fig. 5D) with 8-15 eggs.

Antennule (Fig. 5E) long, slender, 7-segmented; second segment longest, about 2.65 times longer than wide; armature formula for each segment 1, 11, 8, 3+1 aesthetasc, 6, and 9.

Antenna (Fig. 5F and G) with allobasis; allobasis thick, 1.86 times longer than wide, with 1 medial seta. Endopod 1-segmented; lateral border with 3 stout spines and 2 pinnate setae; distal margin with 1 bipinnate and 4 geniculate setae (inner-most geniculate seta with spines on medial part) and 1 serrate spine. Exopod (Fig. 5G) narrow, 2-segmented; first segment longer than wide, with 1 bipinnate seta; second one moderately tapering distally, 2.8 times longer than wide, with 3 long and 1 short bipinnate setae.

Precoxa of mandible (Fig. 6B and C) relatively narrow; gnathobase (Fig. 6C) with 1 seta on dorsal corner, several teeth on cutting edge. Coxa-basis with setules on inner margin, hair-like spinules on outer border, and 4 bipinnate setae. Endopod unsegmented, with 3 medial and 4 terminal setae. Exopod narrow, 1.37 times longer than endopod, 2-segmented; first segment with 2 setae (each 1 seta on

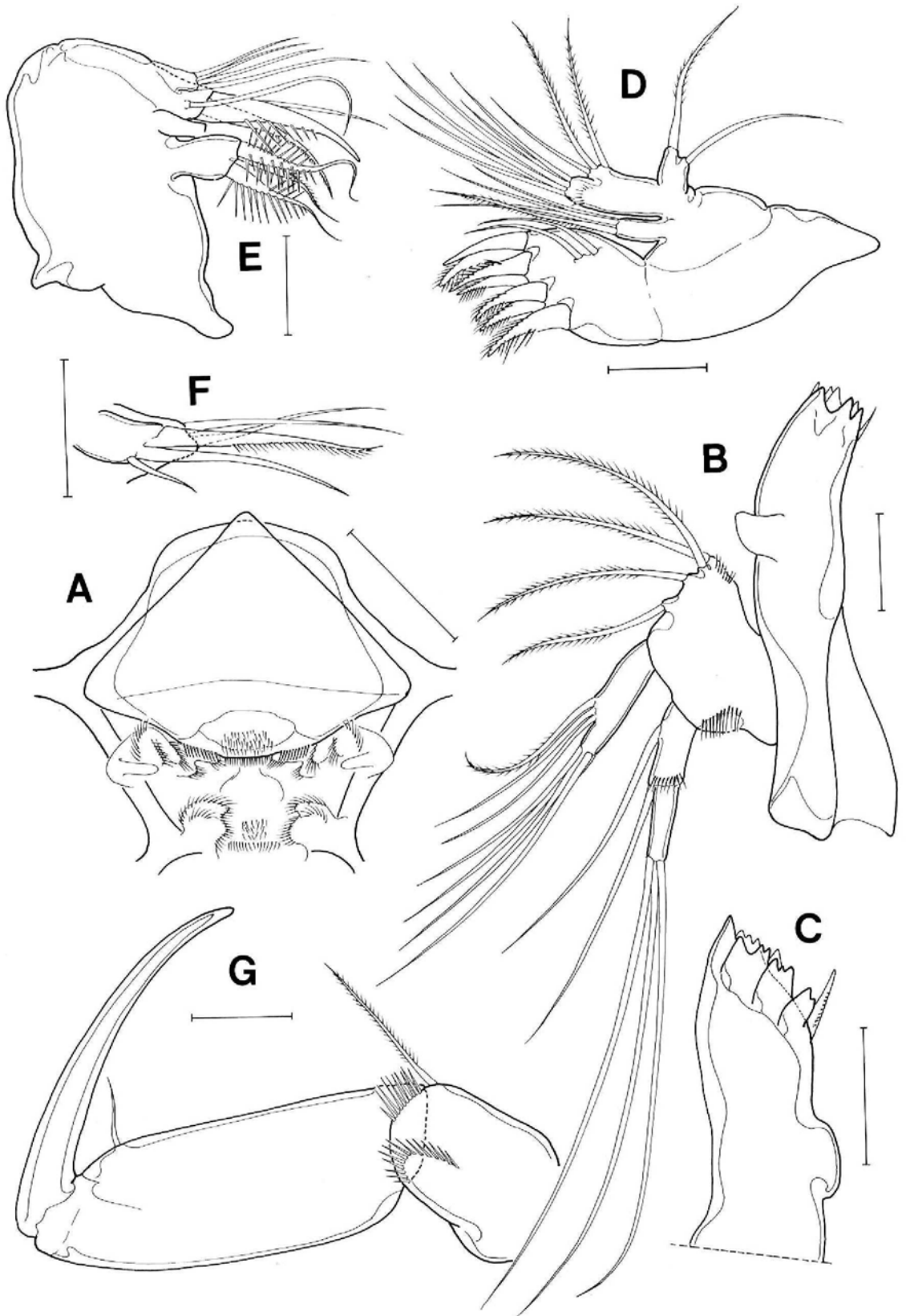


Fig. 6. *Xylora longiantennulata* n. sp. Female. A, labrum and paragnaths; B, mandible; C, gnathobasis of mandible; D, maxillule; E, maxilla; F, proximal rami of syncoxa of maxilla; G, maxilliped. Scales: 0.025 mm in all.

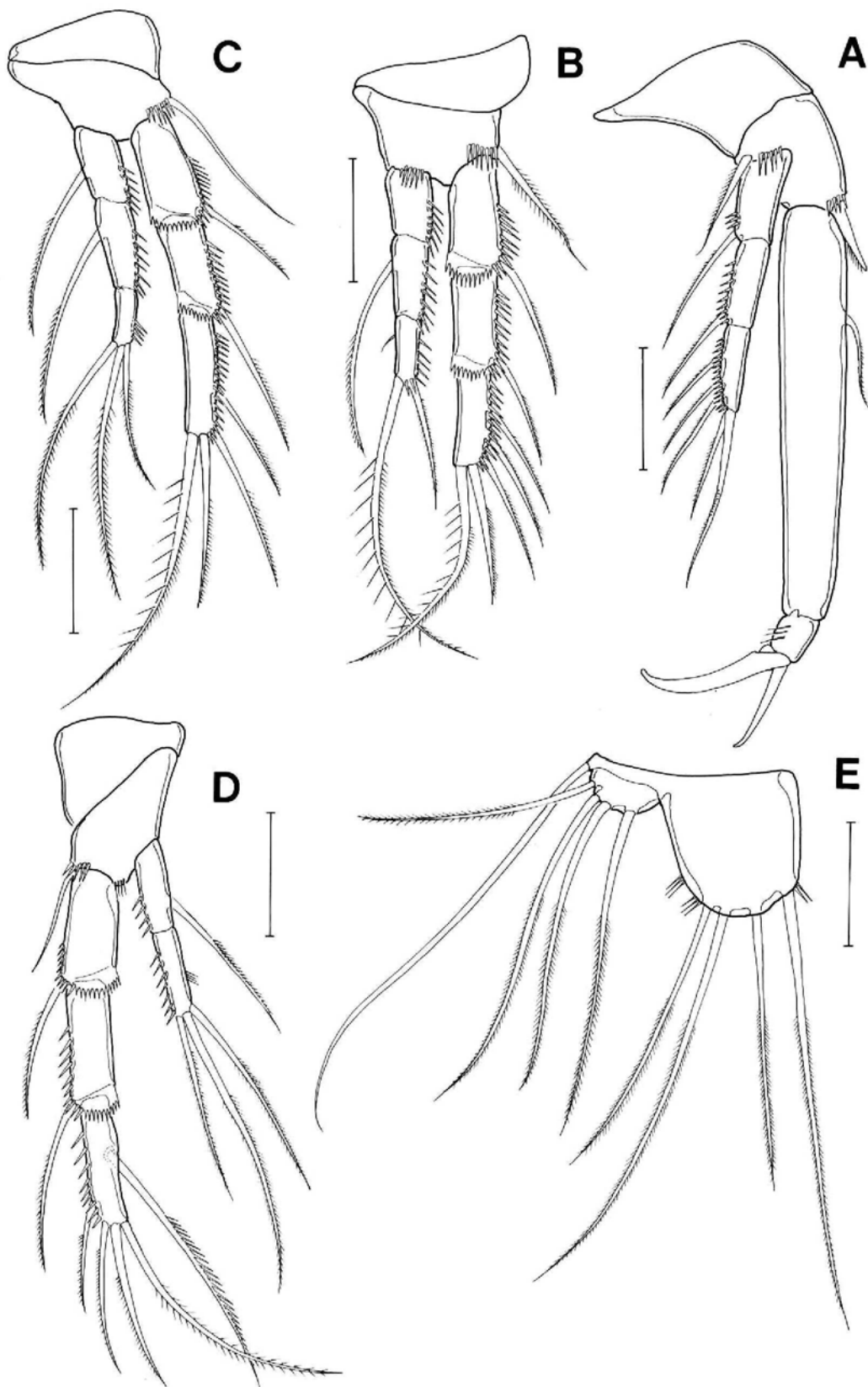


Fig. 7. *Xylora longiantennulata* n. sp. Female. A, leg 1; B, leg 2; C, leg 3; D, leg 4; E, leg 5. Scales: 0.05 mm in all.

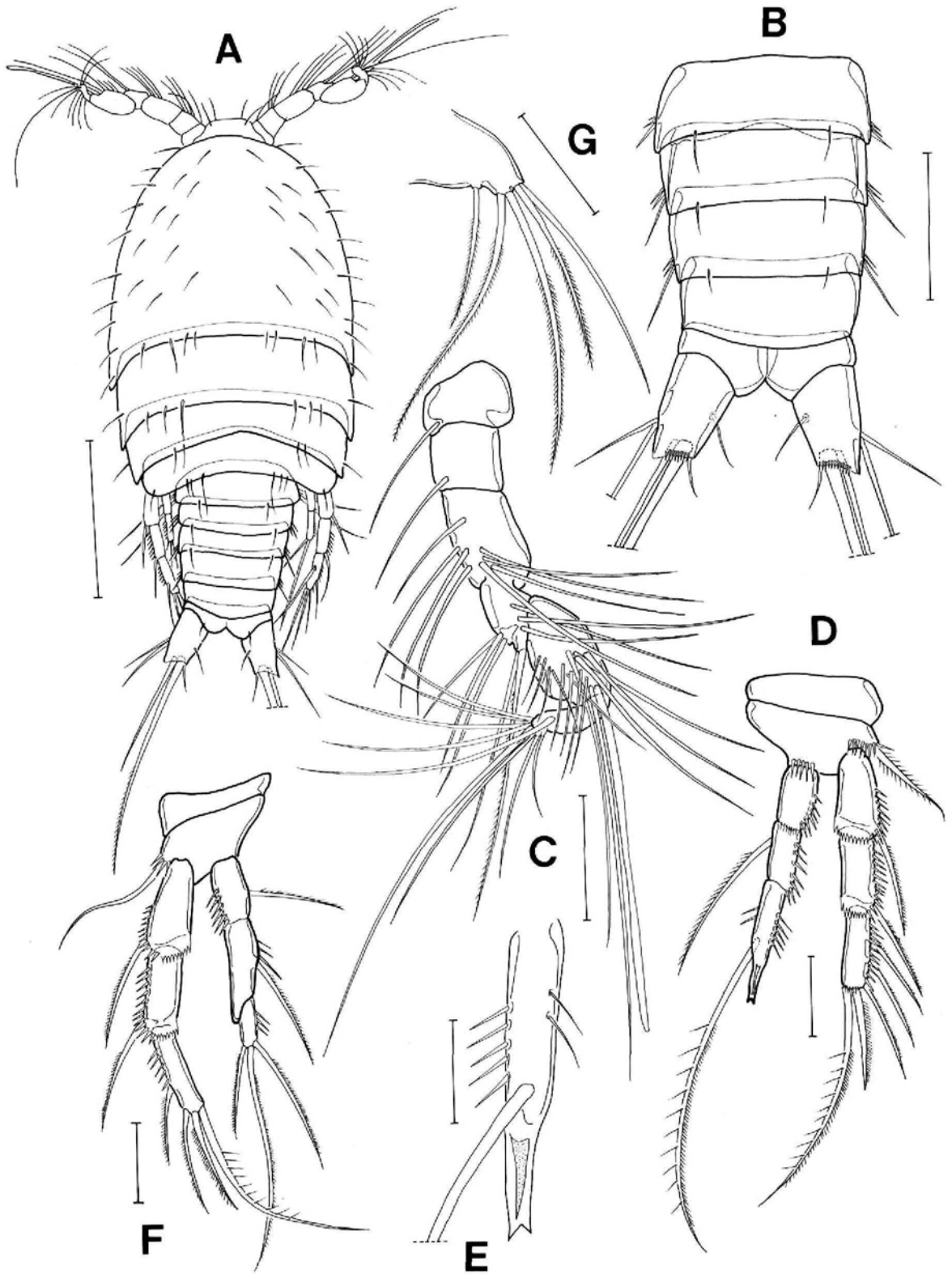


Fig. 8. *Xylora longiantennulata* n. sp. Female. A, habitus, dorsal; B, urosome, ventral; C, antennule; D, leg 2; E, third endopodal segment of leg 2; F, leg 3. Scales: A=0.2 mm; B=0.1 mm; D, F, G=0.05 mm; C, E=0.025 mm.

anterior and distal margin) and fine setules on distal margin; second segment narrower than preceding one, with 3 long distal setae.

Precoxa of maxillule (Fig. 6D) with 7 claw-like spines on cutting edge, 2 surface setae. Division of coxa and basis indistinct; coxal endite with 4 distal setae; basal endite with 6 setae and fine setules near distal surface. Endopod indistinct, fused to basal endite, with 3 distal setae. Exopod unsegmented, with 2 setae.

Syncoxa of maxilla (Fig. 6E and F) with 3 endites; distal-most with 3 stout spinulose setae; proximal-most (Fig. 6F) bilobed, with 3 and 2 setae, respectively. Basis with 1 strong spinulose claw and 3 setae (1 seta strong and unipinnate). Endopod small, unsegmented, with 4 simple setae.

Maxilliped (Fig. 6G) prehensile. Basis with 1 plumose seta and spinules. First endopod 2.67 times longer than wide; inner margin straight, with 1 small seta near distal corner; outer margin smooth, moderately rounded. Second endopod represented by 1 strong and simple claw.

Legs 1-4 (Figs. 7A-D) with 3-segmented exopod and endopod except for endopod of first and fourth legs. Endopod of leg 1 (Fig. 7A) 2-segmented, about 1.6 times longer than exopod; first segment naked, about 6.1 times longer than wide, with a pinnate seta on 3/4 distance from distal margin; second segment nearly rectangular, with fine setules and 2 terminal claws. Endopod of legs 2 and 3 reaching over distal margin of second exopodal segment. Endopod of leg 2 biarticulated, narrow, and 0.42 times as short as exopod. Each segment of legs 1-4 exopods and endopods excluding endopod of leg 1 armed with spinules on lateral and distal margin. Armature formulae for legs 2-4 as follows:

- leg 2 basis 1-0 exp. 1-0; 1-0; IV, 1
enp. 0-0; 0-1; 2
leg 3 basis 1-0 exp. 1-0; 1-0 III, 1
enp. 0-1; 0-1; 3
leg 4 basis 1-0 exp. 1-0; 1-0; III, 1, 1
enp. 0-1; 3

Baseoendopod of leg 5 (Fig. 7E) broad, nearly rectangular; moderately rounded in distal margin, with fine setules and 4 setae on distal margin; outer expansion with 1 bipinnate seta. Exopod rudimentary, with 4 bipinnate setae.

Leg 6 represented by 3 setae.

Adult Male: Body (Fig. 8A) 690 μm (640-710 μm) long, 290 μm (270-300 μm) wide, ratio of length to width about 2.38:1. Abdomen (Fig. 8B) somewhat longer than that of female, ratio of length to width 1.62:1. Genital somite free. Genital somite and following 2 abdominal somites with sensilla on dorsal and ventral surface posteriorly. Caudal ramus with a low of

spinules along distal margin.

Antennule (Fig. 8C) prehensile, and 6-segmented; third segment longest, about 1.52 times longer than wide; distal segment narrow, relatively long, curved outward. Setal formula for each segment: 1, 1, 8, 8, 13+1 aesthetasc, and 9.

Third endopodal segment of leg 2 (Fig. 8D and E) as long as first and second ones, with spinules on both side of lateral margin, 1 long medial seta, and 1 bifurcate distal process.

Second endopodal segment of leg 3 (Fig. 4F) 2.8 times longer than wide, with 1 pinnate and 1 small setae on lateral margin, and extended process on outer distal corner.

Leg 5 (Fig. 8G) uniramous with 5 setae.

Leg 6 represented by 1 bipinnate seta.

Etymology: The present species of specific name *longiantennulata* (Latin meaning long antennule) is taken from the long antennule of the new species.

Remarks: In the genus *Xylora*, only two species were known in association with wood-boring isopod. These are *X. bathyalis* Hicks, 1988 and *X. nertica* Hicks, 1988 from New Zealand. At first glance the new species closely resembles *X. nertica* in general body form and in the oral and thoracic appendages in both sexes. However, *X. longiantennulata* differs from *X. nertica* as follows. The second to fourth segments of antennule are 2.65, 2.57, and 2.74 times longer than wide respectively in *X. longiantennulata*, but those of *X. nertica* are 1.48, 1.67, and 1.50 times longer than wide. The baseoendopod of leg 5 bears 4 setae in *X. longiantennulata*, while 3 setae in *X. nertica*. The caudal ramus is 1.78 times longer than wide and comparable to 1.2 times in *X. nertica*. In male, third endopodal segment of leg 2 has a bifurcated process distally (curved strong nail in *X. nertica*), and leg 5 bears 5 setae (4 setae in *X. nertica*).

The materials examined in this study reveal 2 types of abdomen in female. Type 1 is relatively long and 1.76 times longer than wide, and type 2 is shorter than that of type 1 and 1.45 times longer than wide.

Acknowledgements

This study was supported by the grants from the Ministry of Education (96-0184) and by KOSEF through SRC for Cell Differentiation (96K3-0401-04-02-1).

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[Received January 5, 1997; accepted February 17, 1997]