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Siphonostomatoid copepods (Crustacea) mainly associated with marine invertebrates from Korean waters

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Twelve species of siphonostomatoid copepods mainly associated with marine invertebrates are recorded from Korean waters. Nine species are new to science: *Arctopontius minutus* n. sp., *A. adelphus* n. sp, and *Dyspontius alatus* n. sp. in the family Artotrogidae; *Asterocheres horridus* n. sp., *A. cuspis* n. sp., *A. quadridens* n. sp., *Scottocheres mipoensis* n. sp., *Asteropontoides acutirostris* n. sp. and *Callomyzon macrocephalus* n. gen. n. sp. in the family Asterocheridae. The new genus *Callomyzon* is distinguished from other genera in the family by having six setae on the third endopodal segment of leg 3, four spines and three setae on the third exopodal segment of leg 4 and three setae on the third endopodal segment of leg 4. Three new records of Korea, *Asterocheres lilljeborgi* Boeck, 1859 and *A. simulans* (T. Scott, 1898) in the Asterocheridae, and *Parartotrogus arcticus* T. and A. Scott, 1901 in the Cancerillidae are redescribed as the circum-Arctic species.

Keywords: Artotrogidae, Asterocheridae, *Callomyzon* n. gen., Cancerillidae, new species

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Introduction

All siphonostomatoid copepods are parasites or associates of other animals and about one-third of them are parasites or associates of invertebrate hosts (Huys and Boxshall, 1991). Siphonostomatoid associates of marine invertebrates primarily utilize sponges, cnidarians, echinoderms, bryozoans, molluscs, and ascidians as hosts, but for many members of the families Asterocheridae and Artotrogidae the hosts are still unknown (Bandera and Huys, 2008).

Korean siphonostomatoid copepods associated with invertebrates have begun to be studied by Kim (1992) who reported *Scottomyzon gibberum* T. and A. Scott, 1894 as an associate of several species of sea stars in Korea. Subsequently, Kim (1996) reported 17 species of the family Artotrogidae including 15 new species, most of them as external associates of bryozoans and a tunicate. He (Kim, 1998a) described *Pulicitrogus compressus* as a new species of the Artotrogidae found as an external associate of the tunicate *Halocynthia igaboja* Oka. Kim (1998b) recorded 23 species of siphonostomatoids associated with invertebrates known until that time, including several new records of Korea. Since then, *Acontioporus pilosus* Kim and Je, 2000, *Asteropontius bifurcatus* Kim and Je, 2000, *Orecturus longicaudatus* Kim and Song, 2003, *O. similis* Kim and Song, 2003, *Collocheres brevipes* Shin and Kim, 2004, *C. solidus* Shin and Kim, 2004, and *C. tamladus* Shin and Kim, 2004 have been recorded (Kim and Je, 2000; Kim and Song, 2003; Shin and Kim, 2004).

In the present paper 12 species of siphonostomatoids are described, three species in the Artotrogidae, eight in the Asterocheridae, and one in the Cancerillidae. Three species of them are new records of Korea and remaining nine being new to science.

Materials and Methods

Copepod specimens examined in this study were collected by the author, unless otherwise mentioned. Hosts of these copepods were collected from the intertidal and sublittoral water or obtained as fisheries bycatches from fishing boats. All collected copepods were preserved in 80% ethanol. For microscopic observation, the copepods were immersed in lactic acid for at least 10 minutes and dissected. Dissected appendages were observed using

the reverse slide method of Humes and Gooding (1964). Drawings were made with the aid of a microscope equipped with a drawing apparatus. In the armature formula in the descriptions of species, Roman numerals indicate spines, and Arabic numerals represent setae. Lengths of copepod specimens and measurements of appendages are mostly based on a single dissected specimen of each species. Morphological terminology for the caudal setae follows Huys and Boxshall (1991). Type specimens have been deposited in the National Institute of Biological Resources (NIBR), Incheon, Korea.

Systematic Accounts

Order Siphonostomatoida Burmeister, 1835
Family Artotrogidae Brady, 1880
Genus *Arctopontius* G.O. Sars, 1915

Arctopontius minutus n. sp. (Figs. 1, 2)

Material examined. Two♀♀ from washings of a colony of bryozoan *Heteropora* sp., off Sacheon Port (37° 50′14″N, 128°52′32″E) in Gangneung, 12 August 2011. Holotype (♀, dissected and mounted on a glass slide, NIBRIV0000680686) has been deposited in NIBR, Incheon, Korea. Paratype (♀, dissected and mounted on a glass slide) is retained in the collection of the author.

Female. Body (Fig. 1A) flattened, 1.58 mm long. Prosome 4-segmented and 1.10 mm long. Tergites of somites ornamented with minute setules (or sensillae) and pores (Fig. 1D). Cepahlothorax large, 848 × 976 μm, laterally expanded, wider than long, with roundly pronounced rostral area, and blunt, only slightly posteriorly produced posterolateral corners, but without keel or crest on dorsal midline. Three metasomites much narrower than cephalothorax. Posterolateral corners of second and fourth pedigerous somites angular, but that of third pedigerous somite blunt. Urosome (Fig. 1B) 5-segmented. Fifth pedigerous somite 195 μm wide, tapering laterally. Genital double-somite 175 × 295 μm, consisting of laterally greatly expanded anterior part and narrower posterior part (152 μm wide across this narrower region). Three abdominal somites 68 × 117, 57 × 107, and 80 × 100 μm, respectively. Anal somite with parallel lateral margins. Caudal ramus (Fig. 1C) almost rectangular, 85 × 46 μm (length/width ratio 1.85 : 1), armed with 6 setae including 2 dorsal setae; outer distal and inner distal setae plumose, other setae naked; inner margin with several setules proximally.

Rostrum (Fig. 1E) small, tapering and highly sclerotized, with nipple-shaped posterior apex. Antennule (Fig. 1F) 8-segmented, 360 μm long; second segment longest and first segment second longest; armature formula 1, 14, 8, 2, 2, 2, 2, and 13 + aesthetasc; one of distal setae on terminal segment inserted on proximal part of longest terminal seta; aesthetasc on terminal segment 182 μm long, half as long as antennule. Antenna (Fig. 1G) consisting of syncoxa, basis, 1-segmented small exopod and 2-segmented endopod; syncoxa unarmed; basis longest among segments and unarmed; exopod 1-segmented, longer than wide, gradually broadened distally, with 2 proximally annulated, distal setae; first endopodal segment slightly longer than wide, unarmed; second endopodal segment about 2.2 times as long as wide and armed with 1 spiniform seta laterally, 2 spiniform setae and 1 long spine distally and ornamented with patches of setules in distal and lateral regions.

Oral siphon (Fig. 1H) 606 μm long, extending beyond base of maxilliped, distally with paired membranous extensions bearing marginal setules. Mandible represented by thin, thread-like stylet. Maxillule (Fig. 1I) bilobed; inner lobe 132 μm long, setulose along inner margin, and tipped with 2 unequal setae, one of them spiniform; outer lobe 71 μm long, setulose on distal part of outer margin, and tipped with 2 heavily spinulose, spiniform setae and 1 small seta. Maxilla (Fig. 2A) 2-segmented; syncoxa (proximal segment) unarmed; basis (distal segment) slightly curved, as long as syncoxa, with terminal claw, 1 small, stout spine at distal 1/5 and several spinules distally; terminal claw distinctly articulated from basis, with row of minute spinules laterally. Maxilliped (Fig. 2B) consisting of 6 segments and terminal claw; syncoxa with 1 inner seta distally and tuft of setules at outer distal corner; basis with 1 seta at midway of inner margin, numerous minute spinules on inner surface distal to midway seta, and stiff setules on outer margin; first to fourth endopodal segments armed with 2, 0, 1, and 1 setae, respectively (second endopodal segment apparently unarmed); terminal claw about 1.7 times as long as terminal endopodal segment, with minute spinules on concave inner margin.

Legs 1, 2 (Fig. 2C, D) and leg 3 with 3-segmented rami. Leg 4 (Fig. 2E) with 3-segmented exopod and 2-segmented small endopod. Outer seta on basis of legs 1-3 plumose, that of leg 4 naked. Inner seta on coxa of leg 1 expanded proximally; inner distal setae on basis extending to middle of second endopodal segment; outer spines on exopod each tipped with setule. Inner distal part of leg 2 basis strongly projected. Outer distal corner of second endopodal segments of legs 1-3 bifid. Leg 3 with same armature formula as that of leg 2, but inner seta on coxa smaller and inner distal projection of basis less prominent. Leg 4 coxa with small, naked inner seta; endopod (Fig. 2F) half as long as first exopodal segment; first endopodal segment armed with 1 naked inner seta; second endopodal segment shorter than first segment and armed with plumose distal seta. Armature formula

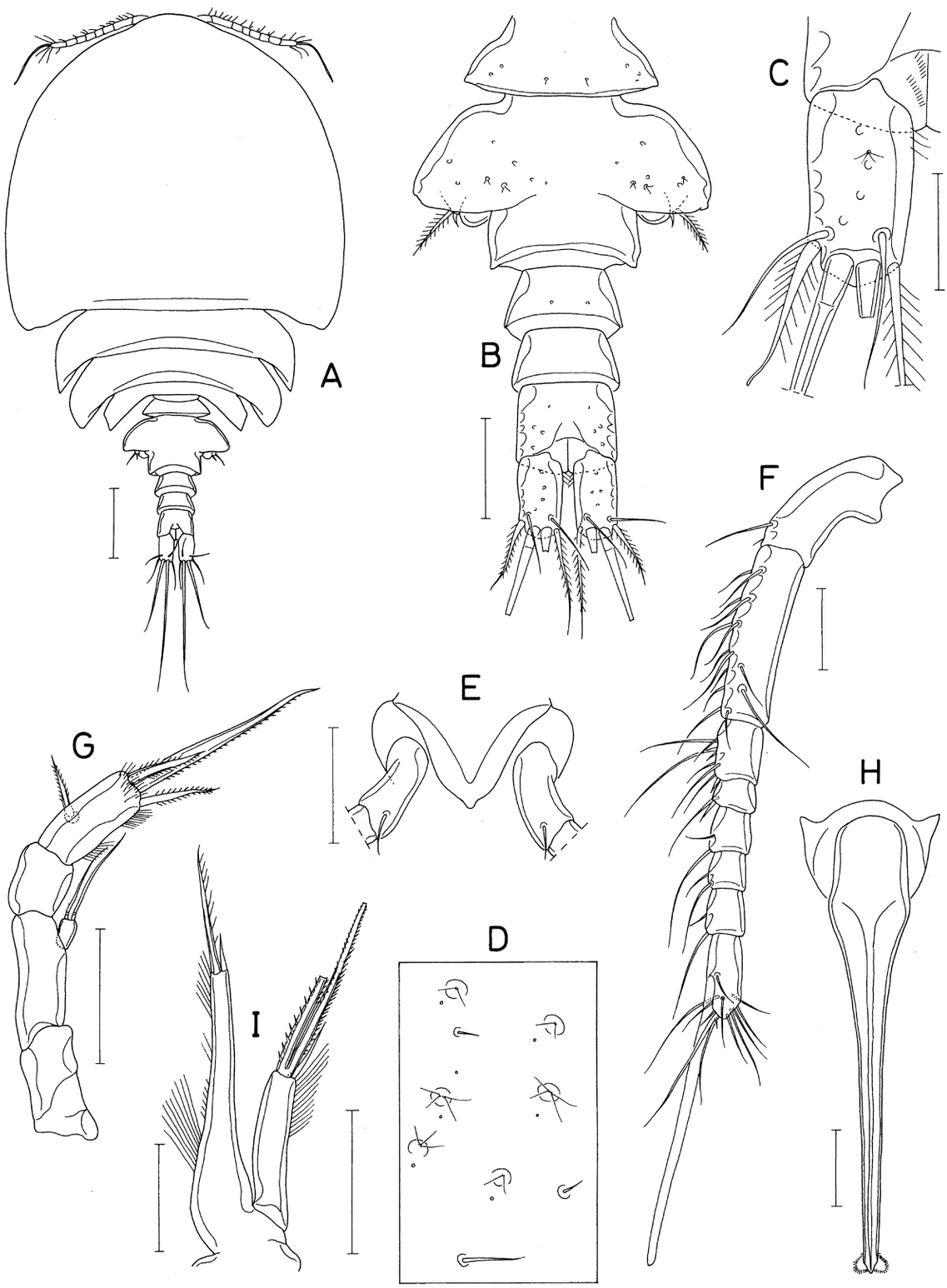

Fig. 1. *Arctopontius minutus* n. sp., female. A, habitus, dorsal; B, urosome, dosal; C, left caudal ramus, dorsal; D, tergal ornamentation of cephalothorax; E, rostral area, ventral; F, antennule; G, antenna; H, oral siphon; I, maxillule. Scale bars: A, 0.2 mm; B, E, H, 0.1 mm; C, D, F, G, I, 0.05 mm.

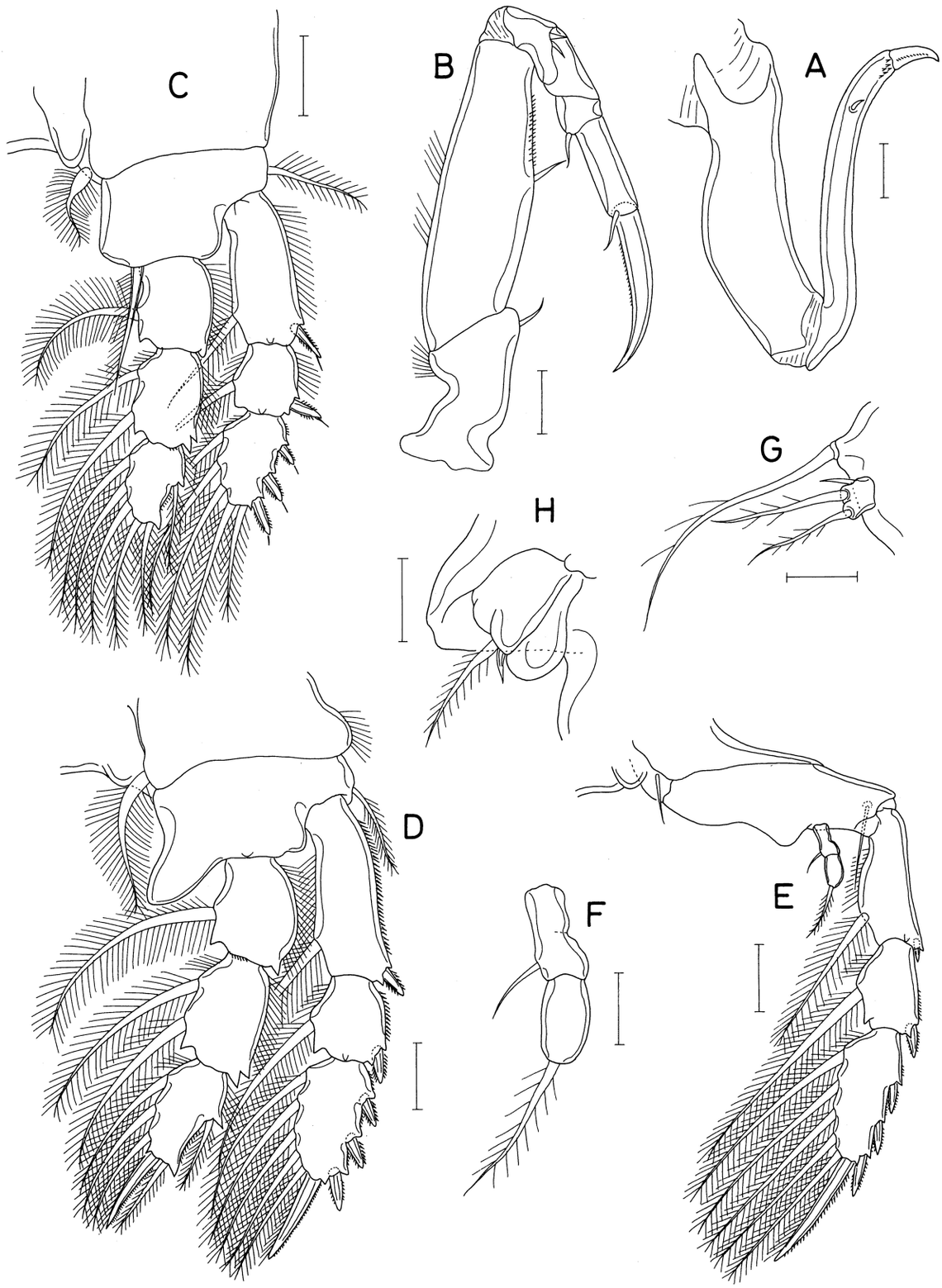

Fig. 2. *Arctopontius minutus* n. sp., female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, leg 4; F, leg 4 endopod; G, leg 5; H, left genital aperture, ventral. Scale bars: A-E, H, 0.05 mm; F, G, 0.02 mm.

for legs 1-4 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1:	0-1	1-1	I-1; I-1; III, 1, 4	0-1; 0-2; 1, 2, 3
Legs 2&3:	0-1	1-0	I-1; I-1; III, I, 5	0-1; 0-2; 1, 1+I, 3
Leg 4:	0-1	1-0	I-1; I-1; III, I, 5	01; 1

Leg 5 (Fig. 2G) consisting of 1 ventrolateral seta on fifth pedigerous somite and small, free exopod; exopod with 2 larger distal and 1 small anterior setae. Leg 6 (Fig. 2H) represented by 1 short spiniform seta and 1 longer plumose seta on genital operculum.

Male. Unknown.

Etymology. The specific name is derived from the relatively small body of the new species (*minutus*, the Latin, means "small").

Remarks. The genus *Arctopontius* G.O. Sars, 1915 contains three known species: *A. expansus* G.O. Sars, 1915 from northern waters of Norway, *A. hanseni* Eiselt, 1986 from the Arctic Alaskan coast, and *A. novenarius* Johnsson in Johnsson and Rocha (2002) from the Antarctic Ocean. The type species *A. expansus* has 2 spines and 5 setae on the third exopodal segment of leg 1 (G.O. Sars, 1915), but other two species have 3 spines and 5 setae on the same segment. The most characteristic feature of this genus may be the 2-segmented endopod of leg 4. It is armed with 1 seta on the first and second segment each, except for *A. novenarius* in which the distal segment is armed with 5 setae. *Arctopontius minutus* n. sp. differs from *A. expansus* in having a different armature condition on the third exopodal segment of leg 1 and from *A. novenarius* in having only 1 seta on the second endopodal segment of leg 4. According to Eiselt (1986), in *A. hanseni* the body length of the female is 2.1-2.3 mm (vs. 1.58 mm in *A. minutus* n. sp.), the caudal rami are slightly longer than wide (vs. distinctly longer than wide, 1.85 times as long as wide), and the second endopodal segment of leg 3 in the female is armed with only 1 seta (vs. 2 setae). Therefore, *A. minutus* n. sp. cannot be confused with *A. hanseni*.

Arctopontius adelphus n. sp. (Figs. 3, 4)

Material examined. Two ♀♀ from washings of a sponge attached to the alcyonacean coral *Melithaea japonica* (Verrill), off Sacheon Port (37°50′14″N, 128° 52′32″E) in Gangneung, 18 May 2000. Holotype (♀, NI BRIV0000680713) has been deposited in the NIBR, Incheon, Korea. Dissected paratype (♀) is retained in the collection of the author.

Female. Body (Fig. 3A) 1.71 mm long, with thick exoskeleton. All prosomal somites with pointed posterolateral corners. Cephalothorax 975 × 900 μm, longer than wide, with slightly produced posterolateral corners. Epimera of 3 metasomal somites markedly extended posteriorly. Urosome (Fig. 3B) 5-segmented. Fifth pedigerous somite 223 μm wide. Genital double-somite (Fig. 3C) 195 × 325 μm and consisting of broadened anterior and narrow posterior parts; anterior part markedly expanded, tapering laterally, but with blunt lateral apex; narrower posterior part 185 μm wide. Three abdominal somites 63 × 140, 57 × 117, and 90 × 123 μm, respectively. Caudal ramus 90 × 53 μm, 1.70 times as long as wide, with 6 setae; outer distal and inner distal setae plumose, other 4 setae naked.

Rostrum (Fig. 1D) small, tapering and highly sclerotized. Antennule (Fig. 3E) 417 μm long, 8-segmented; armature formula 1, 14, 6, 2, 2, 2, 2, and 13 + aesthetasc; first segment with 1 minute setule in addition to 1 seta; second segment longest, 1.5 times as long as first segment. Antenna (Fig. 3F), syncoxa unarmed; basis slightly longer than syncoxa and unarmed. Exopod small, 1-segmented, 12 × 5 μm, armed with 1 minute lateral and 2 longer distal setae. First endopodal segment unarmed, 35 × 20 μm; second endopodal segment 47 × 19 μm, armed with 1 seta laterally and 2 setae plus 1 long spine distally.

Oral siphon 740 μm long, extending to posterior margin of cephalothorx. Mandible represented by long, thread-like stylet bearing denticulate distal part (Fig. 3G). Maxillule (Fig. 3H) bilobed; inner lobe 155 μm long and setulose, with 1 small and 1 longer apical setae; outer lobe 77 μm long, with setules on distal part of outer margin and armed with 2 long and 1 small, apical setae. Maxilla (Fig. 3I), syncoxa unarmed; basis slender, with 1 spiniform seta subdistally and spinules distally; terminal claw distinctly articulated from basis. Maxilliped (Fig. 4A) 6-segmented; syncoxa distally with 1 inner seta and outer tuft of setules; basis with setules on outer margin, 1 seta at distal 2/5 of inner margin, and minute spinules on distal part of inner margin; 4 endopodal segments with 2, 0, 1, and 1 setae, repectively; terminal claw twice as long as terminal endopodal segment, with minute spinules along concave inner margin.

Legs 1-3 with 3-segmented exopod and endopod, but leg 4 with 3-segmented exopod and 2-segmented small endopod. Leg 1 (Fig. 4B) with 3 spines and 4 setae (formula III, 1, 3) on third exopodal segment, otherwise as in *A. minutus* n. sp. Leg 2 (Fig. 4C) and leg 3 with same armature formula, but leg 3 with smaller inner seta on coxa and less pronounced inner distal protrusion of basis. Leg 4 (Fig. 4D) as in *A. minutus* n. sp., but both setae on endopod plumose (Fig. 4E). Armature formula of legs 2-4 as in *A. minutus* n. sp.

Leg 5 (Fig. 4F) rudimentary, represented by 2 papillae bearing 1 and 2 naked setae, respectively. Leg 6 represented by 1 spiniform seta and 1 large, plumose seta on genital operculum (Fig. 4G).

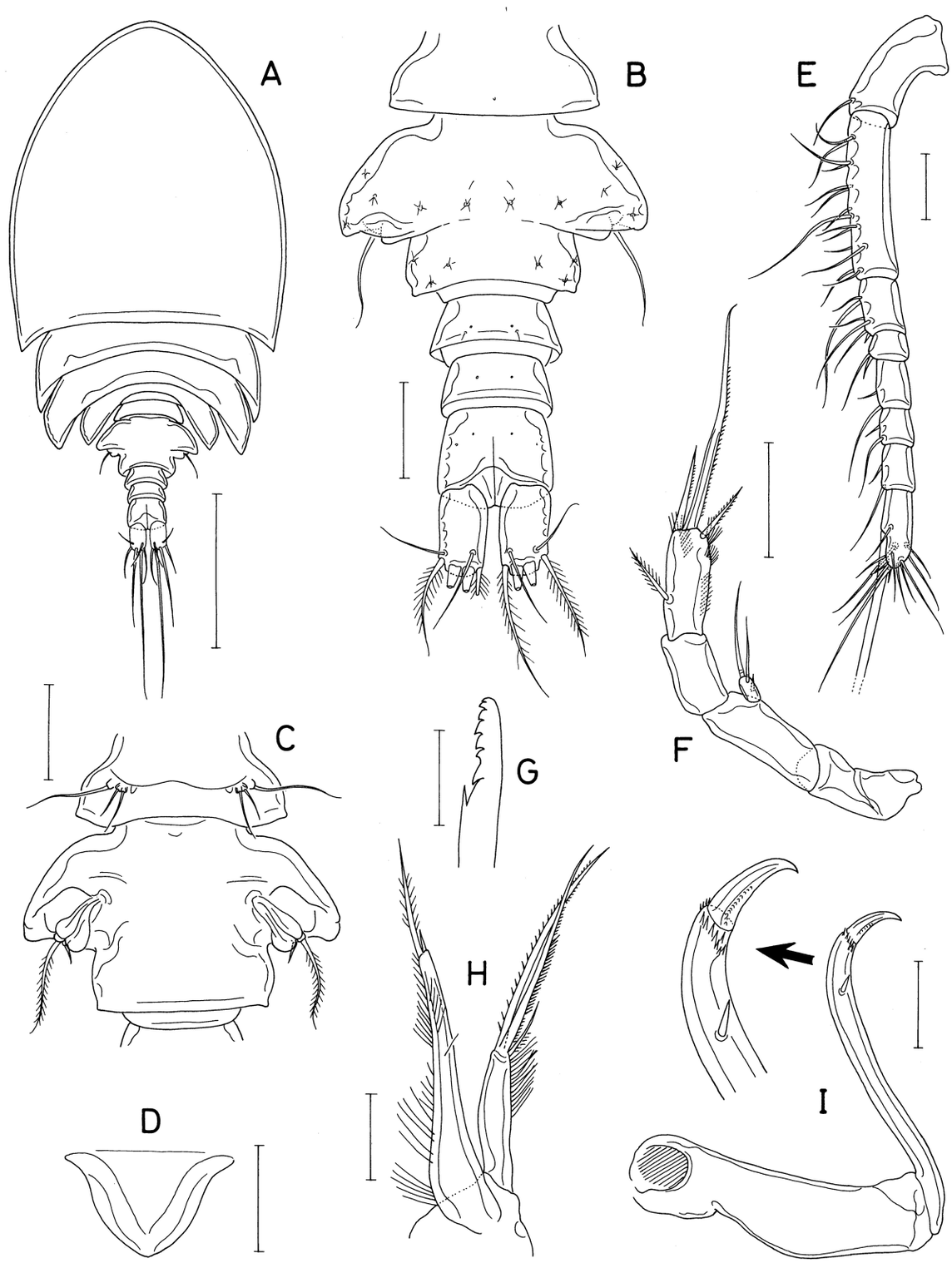

Fig. 3. *Arctopontius adelphus* n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, first two urosomal somites, ventral; D, rostrum; E, antennule; F, antenna; G, distal part of mandible; H, maxillule; I, maxilla. Scale bars: A, 0.5 mm; B-D, I, 0.1 mm; E, F, H, 0.05 mm; G, 0.02 mm.

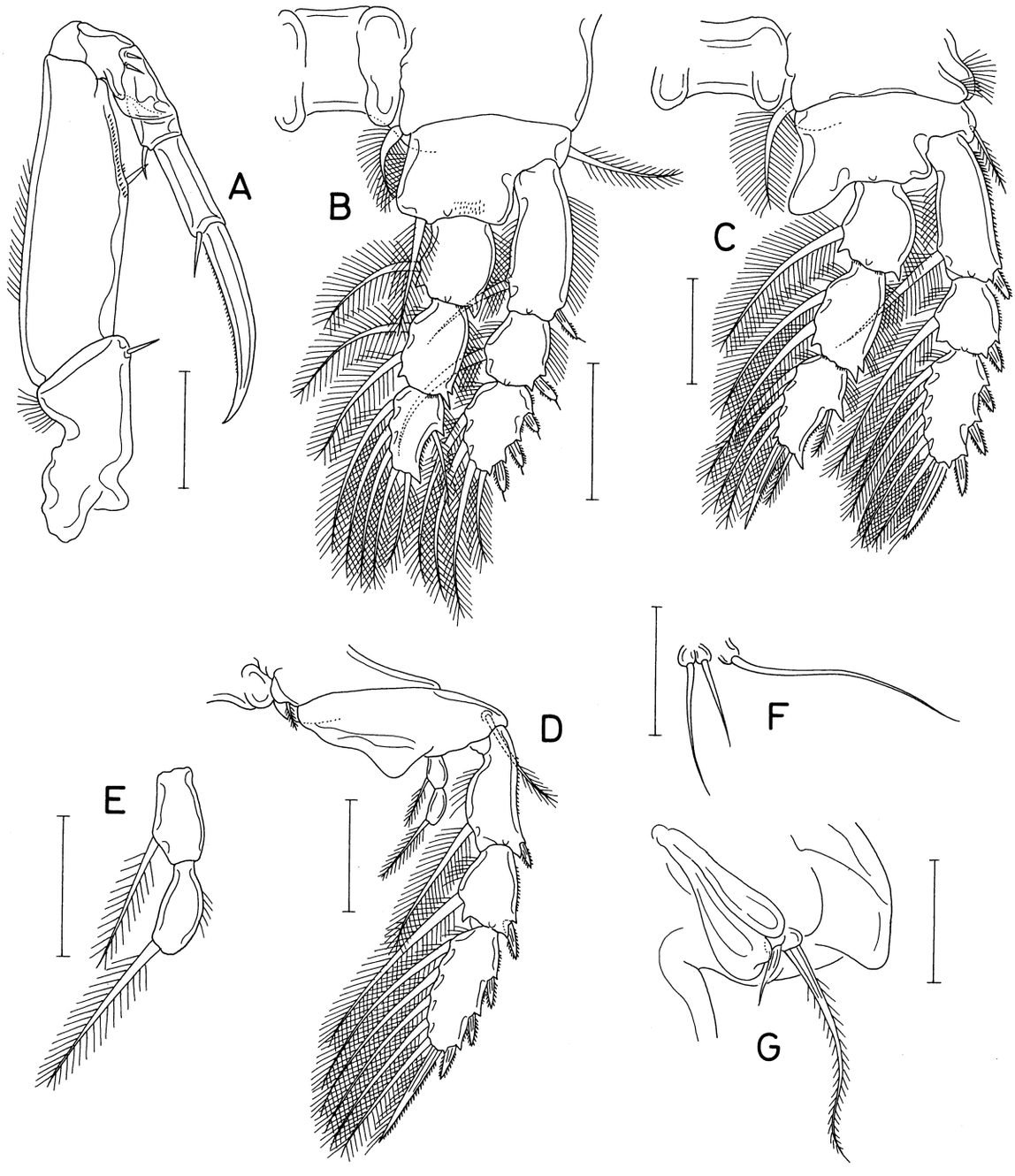

Fig. 4. *Arctopontius adelphus* n. sp., female. A, maxilliped; B, leg 1; C, leg 3; D, leg 4; E, leg 4 endopod; F, leg 5; G, leg 6. Scale bars: A-D, 0.1 mm; E-G, 0.05 mm.

Male. Unknown.

Etymology. The specific name *adelphus* is a Greek, meaning "brother". It alludes to similarity of the new species to *A. minutus* n. sp. in having a similar body length, the same type locality, and other similar morphological features.

Remarks. *Arctopontius adelphus* n. sp. is easily differentiated from its congeners by the characteristic armature condition (3 spines and 4 setae, formula III, 1, 3) of the third exopodal segment of leg 1. On the same segment in other species of the genus there are 2 spines and 5 setae (formula II, 1, 5) in *A. expansus* G.O. Sars, 1915 or 3 spines and 5 setae (formula III, 1, 4) in *A. hanseni* Eiselt, 1986, *A. novenarius* Johnsson, 2002 and *A. minutus* n. sp. (G.O. Sars, 1915; Eiselt, 1986; Johnsson and da Rocha, 2002; and this paper, respectively). *Arctopontius adelphus* n. sp. and *A. minutus* n. sp. are collected from the same locality and similar to each other in several respects. Noticeable differences between them, in addition to the difference in the armature condition of the third exopodal segment of leg 1, are as follows: the inner seta on the first endopodal segment of leg 4 is naked in *A. minutus* n. sp., but plumose in *A. adelphus* n. sp.; and the exopod of leg 5 is small but distinct and armed with 3 setae in *A. minutus* n. sp., while it is rudimentary, represented only by a papilla bearing 2 setae in *A. adelphus* n. sp.

Genus *Dyspontius* Thorell, 1860

***Dyspontius alatus* n. sp. (Figs. 5, 6)**

Material examined. One♀ (holotype) from a sponge, in the depth of 50 m, off Munseom in Seogwipo (approximately 33°12′40″N, 126°34′30″E), Jeju Island, 12 October 2013, collected by S.H. Kim. Holotype (♀, dissected and mounted on a glass slide, NIBRIV0000680700) has been deposited in NIBR, Incheon, Korea.

Female. Body (Fig. 5A) moderately broad and 838 μm long. Cephalothorax 461 × 482 μm, slightly wider than long, with weakly produced anterior apex (Fig. 5F) and pointed posterolateral corners. Dorsal tergites of somites ornamented with simple or 2-6-branched (5-branched one being most common) setules (Fig. 5C, D). Second and third pedigerous somites much narrower than cephalothorax, 72 × 338 and 61 × 294 μm, respectively, with their epimeral regions (Fig. 5C) markedly extending posterolaterally. Fourth pedigerous somite distinctly reduced, similar to fifth pedigerous somite in size and 136 μm wide. Urosome (Fig. 5B) 5-segmented. Fifth pedigerous somite 123 μm wide, tapering laterally, with pointed lateral apices. Genital double-somite 100 × 191 μm, consisting of expanded anterior and narrower posterior parts; anterior part characteristically with wing-like, broad epimera extended over posterior margin of somite; margins of epimera rounded. Three abdominal somites 31 × 72, 27 × 66, and 42 × 65 μm, respectively. Caudal ramus (Fig. 5E) 35 × 27 μm, 1.30 times as long as wide, armed with 6 setae and ornamented with setules on inner margin; inner dorsal seta (seta VII) naked, other 5 setae plumose.

Rostrum (Fig. 5F) longer than wide, strongly sclerotized, with rounded posterior margin. Antennule (Fig. 5G) 252 μm long and 9-segmented; first segment 54 μm long; second segment, longest, 61 μm long; armature formula 1, 9, 1, 6, 2, 2, 2, 2, and 11 + aesthetasc; aesthetasc on terminal segment slightly more than 1/3 times as long as antennular length. Antenna (Fig. 5H) with short, unarmed coxa; basis 35 × 17 μm, with fine setules at proximal region and on outer margin; exopod small, tipped with 2 unequal setae; first endopodal segment 31 × 14 μm, unarmed, but ornamented with setules on outer margin; second endopodal segment 29 × 13 μm, armed with 1 lateral and 2 distal setae, 1 elongate distal spine (67 μm long), and ornamented with rows of setules.

Oral siphon (Fig. 5I) relatively broad, 327 μm long, extending beyond base of maxilliped but not reaching leg 1; distal apex setulose. Mandbile represented by stylet bearing several teeth and spinules distally (Fig. 5J). Maxillule (Fig. 6A) bilobed; inner lobe 62 μm long, with 2 small naked apical setae of equal length (15 μm long); outer lobe 46 μm long, with 2 large, spinulose setae (larger one 59 μm long) and 1 small naked seta. Maxilla (Fig. 6B) 2-segmented; syncoxa unarmed; basis slender, with 1 small seta and row of minute spinules in distal region; terminal claw clearly defined from basis, with rows of spinules. Maxilliped (Fig. 6C) 6-segmented; armature formula 1, 1, 2, 0, 1, and 1 + claw; syncoxa (first segment) with nipple-shaped projection at inner distal corner; basis also with nipple-shaped projection at proximal third and with numerous minute spinules along distal third of inner surface; inner seta on basis small and located at distal third of segment; terminal claw more than twice as long as terminal endopodal segment, with fine spinules along inner margin.

Legs 1-3 biramous, with 3-segmented rami (Fig. 6D, E). Leg 4 (Fig. 6F) with 3-segmented exopod; endopod absent. Leg 1 (Fig. 6D) lacking inner element on basis; first exopodal segment with thick setules on outer margin; second exopodal segment characteristically lacking outer spine. Leg 2 (Fig. 6E) with dentiform process on posterior margin of basis between rami. Legs 3 and 4 lacking inner seta on coxa. Armature formula for legs 1-4 as follows:

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

Leg 5 (Fig. 6G) represented by 2 papillae tipped with 1 plumose and 2 small, naked setae, respectively, on ventral surface of fifth pedigerous somite. Leg 6 (Fig. 6G)

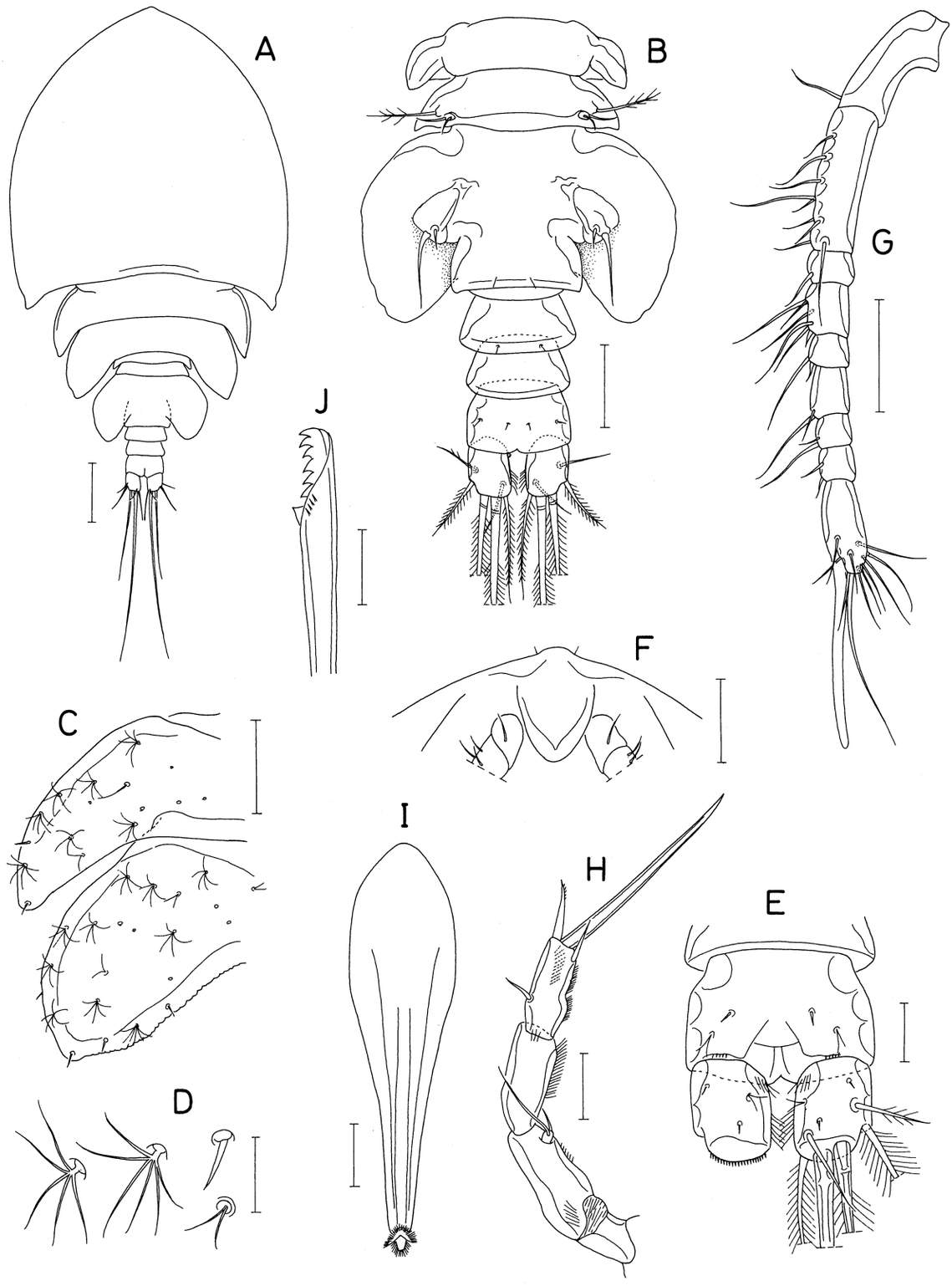

Fig. 5. *Dyspontius alatus* n. sp., female. A, habitus, dorsal; B, urosome, ventral; C, left epimera of second and third pedigerous somites, dorsal; D, ornamentations of tergites of somites; E, anal somite and caudal rami, dorsal; F, rostral area, ventral; G, antennule; H, antenna; I, oral siphon; J, distal part of mandible. Scale bars: A, 0.1 mm; B, C, F, G, I, 0.05 mm; E, H, 0.02 mm; D, J, 0.01 mm.

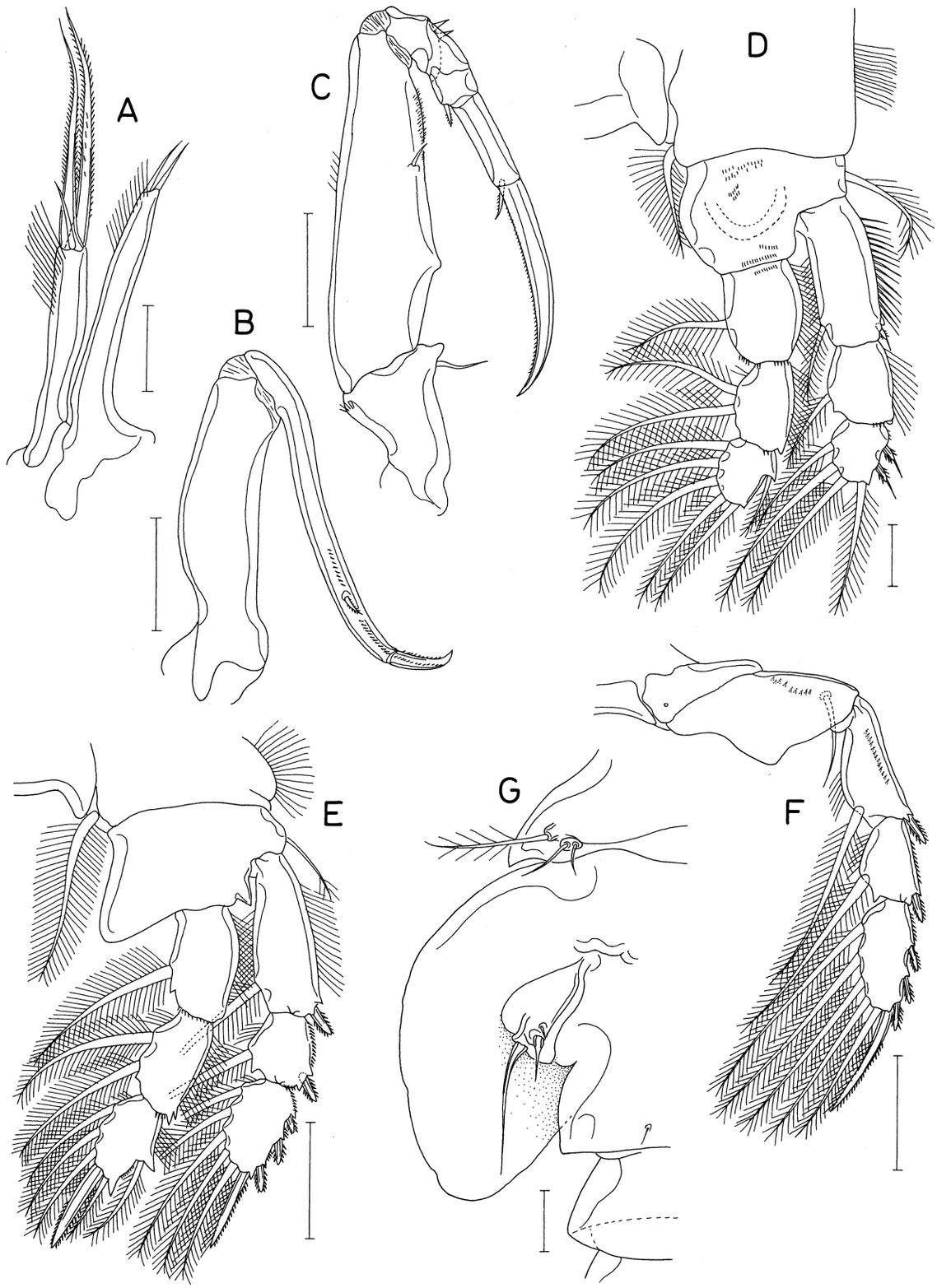

Fig. 6. *Dyspontius alatus* n. sp., female. A, maxillule; B, maxilla; C, maxilliped; D, leg 1; E, leg 2; F, leg 4; G, right side of proximal part of urosome, ventral. Scale bars: A, D, G, 0.02 mm; B, C, E, F, 0.05 mm.

represented by 3 unequal setae, including minute one, on genital operculum.

Male. Unknown.

Etymology. The specific name *alatus* is a Latin meaning "winged", alluding to the possession of the wing-like epimera of the genital double-somite.

Remarks. By having 2 spines plus 4 setae on the third exopodal segment of leg 1 and a well-developed exopod in uniramous leg 4, the new species is included in the genus *Dyspontius* Thorell, 1860. The new species reveals three outstanding morphological features that are not observable in six congeners, as follows: (1) the genital double-somite has well-developed, wing-like epimera; (2) the basis of leg 1 lacks an inner distal seta; and (3) the second exopodal segment of leg 1 lacks an outer spine. The presence of the wing-like epimera of the genital double-somite is a characteristic feature of the genus *Pteropontius* Giesbrecht, 1895, but the new species is not related to *Pteropontius*, because in this genus the segmentation and setation of leg 1 are reduced, with at most 2-segmented exopod.

Family Asterocheridae Giesbrecht, 1899
Genus *Asterocheres* Boeck, 1859

Asterocheres lilljeborgi Boeck, 1859 (Figs. 7-9)

Asterocheres lilljeborgi Boeck, 1859, p. 176, pl. 2, figs. 1-11; Giesbrecht, 1899, p. 99, pl. 3, figs. 21-26; Wilson, 1944, p. 547, pl. 30, figs. 161, 162; Röttger *et al*., 1972, p. 259, figs. 1-9; Barel and Kramers, 1977, p. 60; Ivanenko and Ferrari, 2003, p. 672, figs. 9-18.

Ascomyzon asterocheres G.O. Sars, 1914, p. 85, pls. 51, 52.

Nec *Asterocheres lilljeborgi*: Canu, 1892, p. 264, pl. 27, figs. 1-6.

Material examined. All specimens were obtained from washings of the sea star *Henricia leviuscula* (Stimpson) caught as fisheries bycatch from shallow water: Nine♀♀, off Sacheon Port (37°50′14″N, 128°52′32″E) in Gangneung, 11 August 2011; 2♀♀, 1♂, Gisamun Port (38°00′30″N, 128°43′51″E), 23 August 2011; 7♀♀, 4♂♂, Gangneung Port (37°46′14″N, 128°57′10″E), 27 August 2011; 13♀♀, 7♂♂, Gangneung Port, 12 November 2011; 8♀♀, 2♂♂, Sacheon Port, 28 March 2012; 10♀♀, 5♂♂, Sacheon Port, 08 April 2012; 34♀♀, 60♂♂, Daejin Port (38°30′00″N, 128°43′51″E), 10 July 2012.

Female. Body (Fig. 7A) consisting of broad, dorsoventrally flattened prosome and small urosome. Body length 1.42 mm. Prosome 1.03 mm long and comprising cephalothorax and 3 free pedigerous somites. Cephalothorax 0.75 × 1.03 mm, with angular posterolateral corners. Epimera of second to fourth pedigerous somites with blunt posterolateral corners. Fourth pedigerous somite much smaller and narrower than preceding somites. Urosome (Fig. 7B) 5-segmented. All urosomal somites ornamented with patches or transverse rows of minute spinules on dorsal surface (Fig. 7B). Fifth pedigerous somite as wide as genital double-somite and tapering posterolaterally. Genital double-somite nearly octagonal, 177 × 206 μm, with row of more than 40 spinules on posterior part of lateral margins posterior to genital areas. Genital areas located laterally in middle of lateral margins. Two abdominal somites 63 × 104 and 90 × 85 μm, respectively. Caudal rami (Fig. 7C) almost close to each other, rectangular, 65 × 32 μm (length/width ratio 2.03 : 1), directed backward straightly, with numerous spinules on dorsal surface, and with 2 naked dorsal setae and 4 distal plumose setae. Posteroventral margin of caudal ramus with row of minute spinules (Fig. 7C).

Rostrum obscure, without distinct outline (Fig. 7A). Antennule (Fig. 7D) 634 μm long and 20-segmented; articulation between penultimate and terminal segments incomplete; armature formula: 2, 2, 2, 2, 2 / 2, 2, 2, 7, 2 / 2, 2, 2, 2, 2 / 2, 2, 2 + aesthetasc, 2, and 11; tenth segment small; largest terminal seta on terminal segment with small subsidiary seta at base; all setae naked except weakly pinnate one on 13th segment. Antenna (Fig. 7E) biramous; coxa unarmed, with few spinules; basis unarmed, with row of fine spinules near base of exopod. Exopod 1-segmented, 29 × 8 μm, with 1 small proximal and 2 unequal terminal setae. Endopod 3-segmented; first segment 129 × 34 μm, ornamented with fine spinules on distal half of outer margin; second segment short, with 1 inner distal seta; third segment with 2 setae; terminal claw 146 μm long, distinctly longer than first endopodal segment.

Oral siphon (Fig. 7F) 288 μm long, rather stout, gradually tapering, extending to middle of insertion of maxilliped, with slightly uneven lateral margins. Mandible (Fig. 8B) consisting of stylet and palp. Stylet 254 μm long, with several minute teeth distally. Palp 2-segmented; proximal segment 108 μm long; distal segment 51 μm long, with 2 weakly plumose apical setae (318 and 166 μm long, respectively). Maxillule (Fig. 8C) bilobed; inner lobe 109 × 28 μm, with 5 distal setae, one of them minute, and largest one 125 μm long; outer lobe 65 × 17 μm, with 4 large, naked apical setae. Maxilla (Fig. 8D) 2-segmented; syncoxa (proximal segment) with short, transparent, flexible tube of maxillary gland at base; basis (distal segment) being a claw bearing 1 small seta near proximal fourth and transverse row of setules near midlength. Maxilliped (Fig. 8E) 6-segmented; syncoxa with 1 small inner seta distally; basis with 1 minute seta in middle of medial margin. Endopod 4-segmented; first segment with 2 distal setae; second to terminal segments

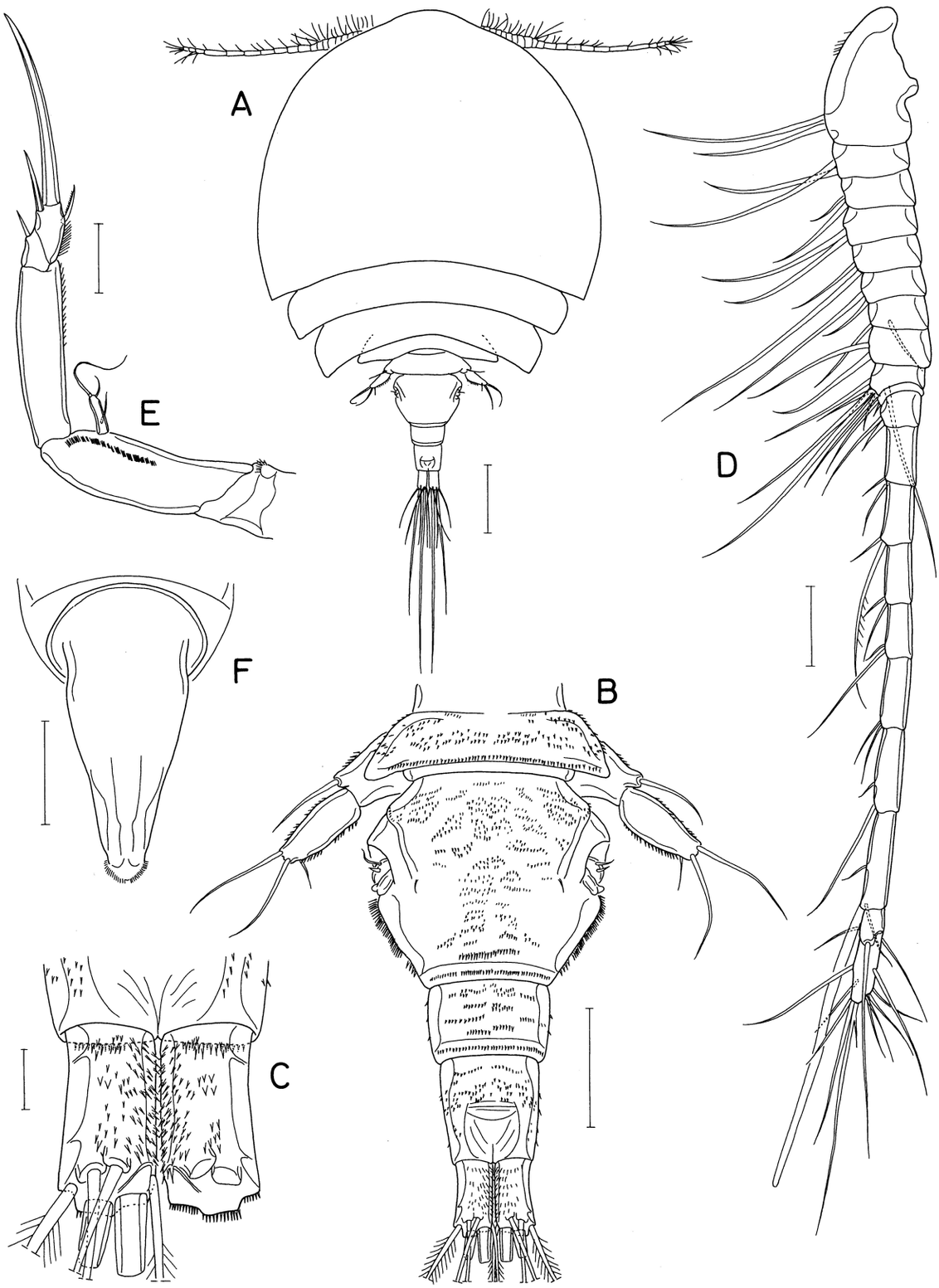

Fig. 7. *Asterocheres lilljeborgi* Boeck, female. A, habitus, dorsal; B, urosome, dorsal; C, caudal rami, dorsal; D, antennule; E, antenna; F, oral siphon. Scale bars: A, 0.2 mm; B, F, 0.1 mm; C, 0.02 mm; D, E, 0.05 mm.

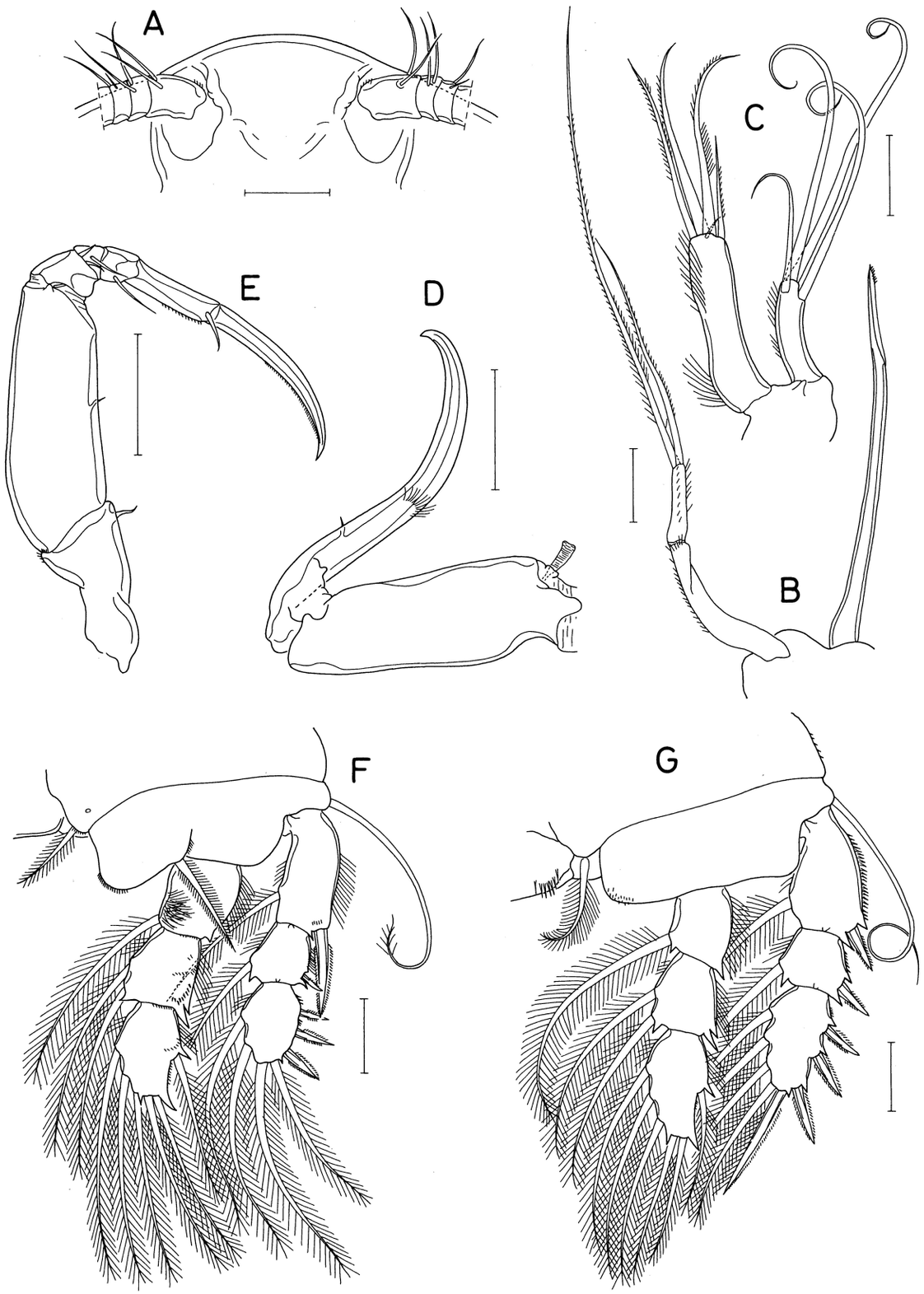

Fig. 8. *Asterocheres lilljeborgi* Boeck, female. A, rostral area, ventral; B, mandible; C, maxillule; D, maxilla; E, maxilliped; F, leg 1; G, leg 2. Scale bars: A, D, E, 0.1 mm; B, C, F, G, 0.05 mm.

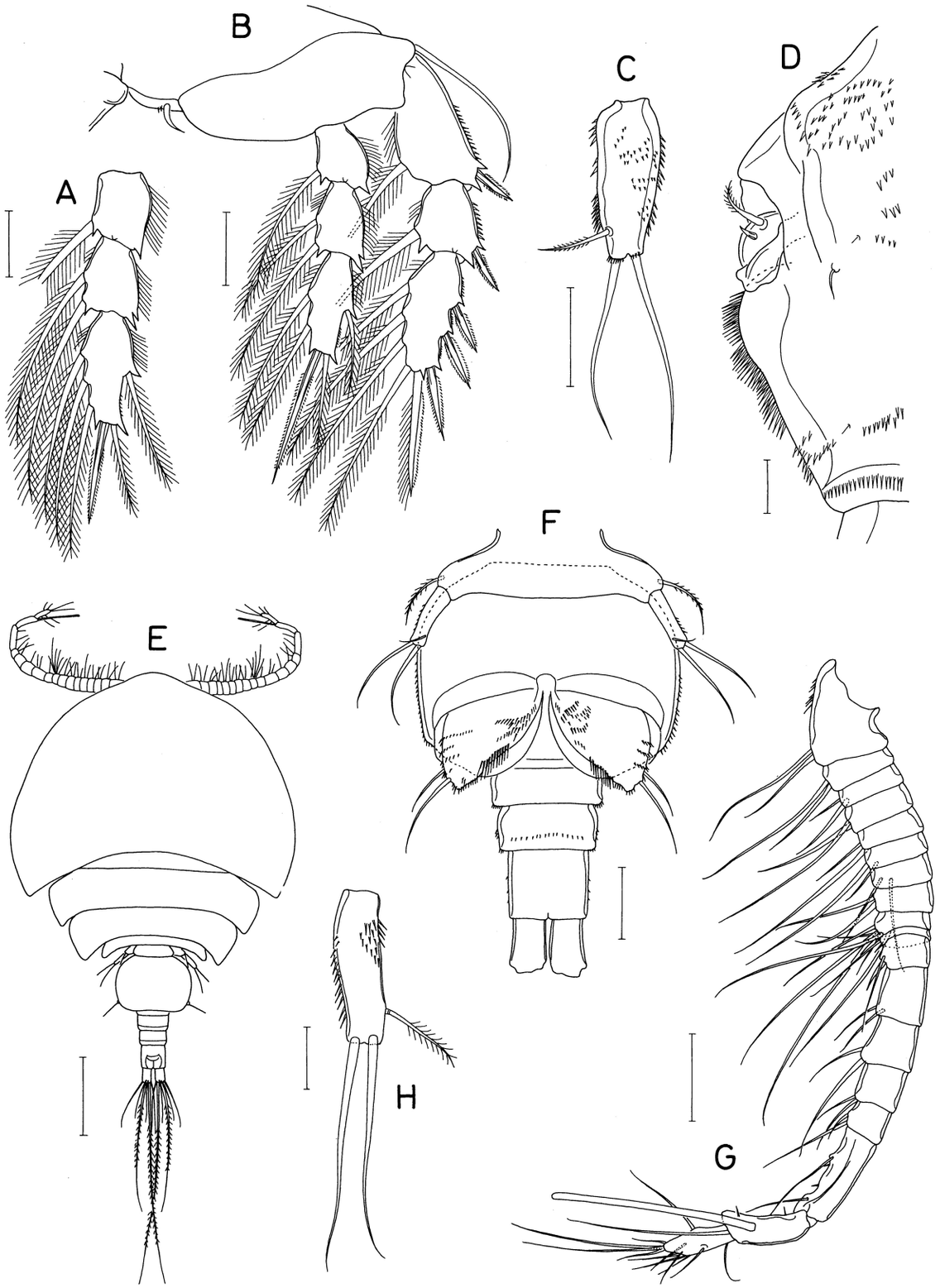

Fig. 9. *Asterocheres lilljeborgi* Boeck. Female: A, leg 3 endopod; B, leg 4; C, leg 5 exopod; D, left side of genital double-somite, dorsal. Male: E, habitus, dorsal; F, urosome, ventral; G, antennule; H, leg 5 exopod. Scale bars: A-C, F, G, 0.05 mm; D, E, H, 0.02 mm.

each with 1 seta; terminal segment 77 μm long; terminal claw 162 μm long, with fine spinules along distal 2/3 of concave inner margin.

Legs 1-4 with 3-segmented rami; second endopodal segment of these legs with bicuspid outer distal corner (Figs. 8F, G, 9A, B). Outer seta on basis large, extending over second exopodal segment in legs 1 and 2 but smaller in legs 3 and 4. Outer spine on first exopodal segment of leg 1 (Fig. 8F) 61 μm long, extending to proximal outer spine on third exopodal segment; first endopodal segment with tuft of fine setules near mediodistal area of ventral surface. Outer margin of proximal 2 exopodal segments of leg 1 with setules but that of legs 2-4 with spinules. Inner seta on coxa of leg 4 small and naked (Fig. 9B), but that of leg 1-3 larger and pinnate. Armature formula for legs 1-4 as follows:

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

Leg 5 2-segmented; protopod with 1 outer dorsal seta; exopod (Fig. 9C) 80 × 32 μm (length/width ratio 2.50 : 1), with fine spinules scattered on all surfaces, 1 weakly pinnate subdistal seta on medial margin and 2 naked distal setae. Leg 6 represented by 1 pinnate and 1 small naked setae in genital aperture (Fig. 9D).

Male. Body (Fig. 9E) shaped as in female, 1.08 mm long. Urosome (Fig. 9F) 5-segmented, with numerous fine spinules on dorsal surface as in female. Genital somite 131 × 182 μm, with fine spinules on genital operculum. Three abdominal somites 31 × 77, 31 × 69, and 54 × 57 μm, respectively. Caudal ramus 42 × 32 μm.

Rostrum as in female. Antennule (Fig. 9G) 424 μm long, 18-segmented, and geniculate between penultimate and antepenultimate segments; armature: 7 setae on ninth segment, 4 setae on sixteenth segment, 3 setae and 1 aesthetasc on penultimate segment, 12 setae on terminal segment, and 2 setae each on remaining segments; all setae naked.

Antenna as in female. Maxilliped with blunt proximal process on inner margin of basis. Other mouth organs as in female.

Leg 2 with spinules on ventral surface of third endopodal segment. Legs 1, 3, and 4 as in female. Leg 5 with protopod completely fused with somite; free exopod (Fig. 9H) rectangular and 49 × 15 μm (length/width ratio 3.27 : 1). Leg 6 represented by 2 posterolateral setae on genital operculum (Fig. 9F).

Remarks. In the North Atlantic, *Asterocheres lilljeborgi* has been discovered from six species of sea stars (Barel and Kramers, 1977): *Henricia sanguinolenta* (O.F. Müller, 1776), *Asterias rubens* Linnaeus, 1758, *Crossaster papposus* (Linnaeus, 1767), *Luidia atlantidea* Madsen, 1950 (as *Luidia sarsi* Studer, 1884 by Bresciani and Lutzen, 1962), *Antedon petasus* (Düben and Koren, 1846), and *Echinaster sepositus* (Retzius, 1783). In contrast, it has been known only from *Henricia leviuscula* (Wilson, 1944 and the present record) in North Pacific. The present author have examined various sea stars, including *Crossaster papposus* which is known as a host of *A. lilljeborgi* in Europe, and sea urchins from the Sea of Japan for *A. lilljeborgi*, but found this copepod species only from *H. leviuscula*.

Asterocheres lilljeborgi has been relatively frequently reported from European waters and the description by G.O. Sars (1914) seems to be the most reliable taxonomic record of this species. Several inconsistencies are noticeable between the G.O. Sars' description and Korean specimens. He described 18-segmented female antennule, but certainly overlooked the small tenth segment and the indistinct articulation between the penultimate and terminal segments. The distal setae on the outer lobe of the maxillule is naked in Korean specimens, compared to the plumose condition in G.O. Sars' illustration. The outer seta on the basis of legs 1 and 2 in the specimens from Korea is markedly larger than G.O. Sars illustrated. The transparent tube of maxillary gland on the proximal part of maxillary syncoxa was not mentioned by G.O. Sars (1914).

Asterocheres horridus n. sp. (Figs. 10-12)

Material examined. 23♀♀, 8♂♂ from a sponge genus *Poecillastra*, off Mumseom in Seogwipo (approximately 33°12′35″N, 126°34′10″E), Jeju Island, in the depth of 45 m, 03 October 2013, collected by S.H. Kim. Holotype (♀, NIBRIV0000680732), allotype (♂, NIBRIV0000680787), and paratypes (20♀♀, 6♂♂, NIBRIV0000680788) have been deposited in NIBR, Incheon, Korea. Dissected paratypes (2♀♀, 1♂) are retained in the collection of the author.

Female. Body (Fig. 10A) small and moderately broad. Length of dissected and described paratype 621 μm (other 3 measured specimens 615, 646, and 669 μm long, respectively). Prosome oval, 434 μm long. Cephalothorax wider than long, 282 × 332 μm, with angular posterolateral corners. Second and third pedigerous somites with narrow marginal membrane along lateral margins. Urosome (Fig. 10B) 4-segmented. All urosomal somites heavily ornamented with spinules and scales on all surfaces (Fig. 10B, C). Fifth pedigerous somite 77 μm wide, with row of fine spinules along posterodorsal margin. Genital double-somite as long as wide, 88 × 88 μm, with lateral, postgenital protrusion bearing about 10-12 spinules (5-6 longer anterior and 5-6 shorter posterior spinules) (Fig.

11H); genital area located dorsolaterally slightly anterior to halfway of lateral margin of double-somite. Two abdominal somites 23 × 46 and 26 × 44 μm, respectively. Anal region distinct. Caudal ramus almost rectangular, 23 × 20 μm, 1.15 times as long as wide, and armed with 6 plumose setae.

Rostrum (Fig. 10D) small, indistinct, and abruptly narrowing in middle, with obscure posterior apex. Antennule (Fig. 10E) 343 μm long and 21-segmented; armature formula 2, 2, 2, 2, 2 / 2, 2, 2, 7, 2 / 2, 2, 2, 2, 2 / 2, 2, 2 + aesthetasc, 2, 3, and 7 + aesthetasc; about half of setae on proximal segments plumose, some of them truncate and tipped with 2 or 3 fine spinules. Antenna (Fig. 10F) with short, unarmed coxa. Basis about 55 μm long, with 2 longitudinal rows of needle-like spinules near base of exopod. Exopod small 12 × 5 μm, armed with 1 proximal and 2 unequal, distal setae. Endopod 3-segmented; first segment 57 μm long, with spinules and setules; second segment short, with 1 seta distally; terminal segment armed with 2 setae and 1 spiniform claw of 60 μm long.

Oral siphon (Fig. 10G) narrow, 254 μm long, 55 μm wide at widest proximal region, and extending to intercoxal plate of legs 1. Mandibular stylet (Fig. 10H) slender, 177 μm long, with about 10 fine teeth distally. Mandibular palp (Fig. 10I) 2-segmented; proximal segment setulose, 38 μm long; distal segment about 1/3 as long as proximal segment, 12 μm long, with 2 unequal apical setae of 138 and 74 μm long, respectively. Combined length of palp and longer seta 188 μm, slightly longer than stylet. Maxillule (Fig. 10J) bilobed; inner lobe 70 × 18 μm, setulose, widest at proximal third, and distally armed with 5 setae (including minute one), 3 of which being elongate, equal in length, 169 μm long, about 2.4 times as long as inner lobe; small outer lobe 20 × 6.5 μm and armed with 4 setae distally, all of them being distinct, longest one of them 92 μm long. Maxilla (Fig. 11A) consisting of syncoxa and basis; syncoxa with transparent tube of maxillary gland proximally; basis narrow and claw-like, with 1 linguiform extension proximally, 1 minute seta at proximal third, and spinules along distal 2/5. Maxilliped (Fig. 11B) 6-segmented; syncoxa with 1 thin, inner distal seta and outer distal patch of setules; basis with 1 minute seta at proximal 0.44 region of inner margin, row of spinules on inner margin distal to inner seta, and several spinules near middle of outer margin; endopod 4-segmented and armed with 2, 1, 1, and 1 + claw, respectively; terminal claw 68 μm long, more than twice as long as terminal segment.

Legs 1-4 (Fig. 11C-F) with 3-segmented, spinulose rami; outer distal corner of second endopodal segment bicuspid. Inner seta on coxa of legs 1-3 plumose, that of leg 4 rudimentary and naked. Intercoxal plate of legs 1-4 with thick setules on lateral sides. Outer margin of first and second exopodal segment of leg 1 setulose but that of legs 2-4 spinulose. Outer spine of first exopodal segment of leg 1 large, 35 μm long. Terminal spine on leg 3 endopod 44 μm long, that of leg 4 59 μm long. Armature formula for legs 1-4 as in *A. lilljeborgi*.

Leg 5 bimerous; protopod with 1 dorsolateral seta; exopod (Fig. 11G) 44 × 16 μm, 2.75 times as long as wide, heavily spiniferous on all surfaces, and armed with 3 (2 distal and 1 subdistal) plumose setae. Leg 6 represented by 2 small setae in genital aperture (Fig. 11H).

Male. Body (Fig. 12A) 547 μm long and narrower than that of female. Prosome 385 μm long. Cephalothorax 265 × 274 μm. Urosome (Fig. 12B) 5-segmented. Fifth pedigerous somite 70 μm wide. Genital somite nearly circular, 75 × 95 μm, with spinules (or scales) on all surfaces. Three abdominal somites spinulose along posteroventral and posterodorsal margins, 13 × 42, 10 × 39, and 21 × 39 μm, respectively. Caudal ramus 18 × 18 μm, as long as wide.

Rostrum as in female. Antennule (Fig. 12C) 18-segmented; armature formula 2, 2, 2, 2, 2 / 2, 2, 2, 8, 2 / 2, 2, 2 + aesthetasc, 2, 2 / 3, 2 + aesthetasc, and 12. One of 2 setae on first to fourth and sixth segments blunt and tipped with 2-4 fine spinules. Thirteenth segment characteristically with 1 small aesthetasc. Penultimate segment with beak-like anterodistal process. One of seta on terminal segment inserted on proximal part of terminal seta. Antenna as in female.

Oral siphon, mandible, maxillule, and maxilla as in female. Maxilliped (Fig. 12D) with beak-like inner proximal process; inner seta on this segment minute and inserted on conical process.

Legs 1-4 as in female, except for narrowed and curved outer and outer distal processes of third endopodal segment of legs 2 and 3 (Fig. 12E).

Leg 5 exopod (Fig. 12F) 29 × 10 μm. Leg 6 represented by 2 unequal setae on genital operculum (Fig. 12B).

Etymology. The specific name *horridus* is from the Latin *horrid*, meaning prickly, and alluding to the densely spinules-covered body surface.

Remarks. *Asterocheres horridus* n. sp. displays two outstanding features. First, the thirteenth segment of the male antennule has an aesthetasc. Second, three of five setae on the inner lobe of the maxillule are equally elongate, more than twice as long as the lobe.

The first outstanding feature of the new species is shared by four congeners: *A. spinosus* Kim and Min, 2013; *A. urabensis* Kim, 2004; *A. walteri* Kim, 2004; and *A. boecki* sensu Giesbrecht (1899). Of these *A. boecki* sensu Giesbrecht is particularly noticeable, because, according to the illustration of Giesbrecht (1899), the genital double-somite in the female of his specimen has an inflated area on the lateral margins posterior to genital area, as in the new species. But Stock (1960) already

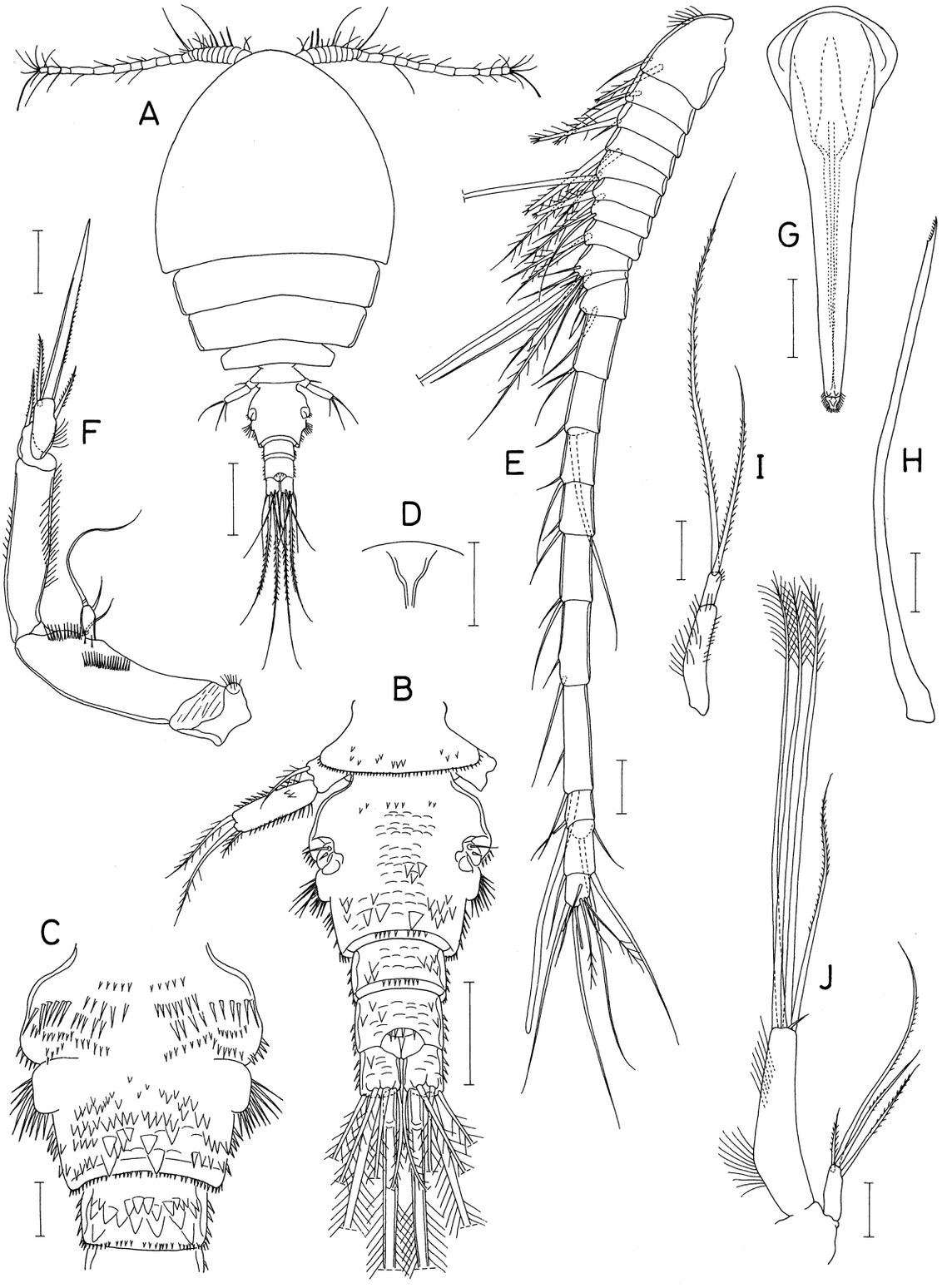

Fig. 10. *Asterocheres horridus* n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, genital double-somite and first abdominal somite, ventral; D, rostrum; E, antennule; F, antenna; G, oral siphon; H, mandibular stylet; I, mandibular palp; J, maxillule. Scale bars: A, 0.1 mm; B, D, G, 0.05 mm; C, E, F, H-J, 0.02 mm.

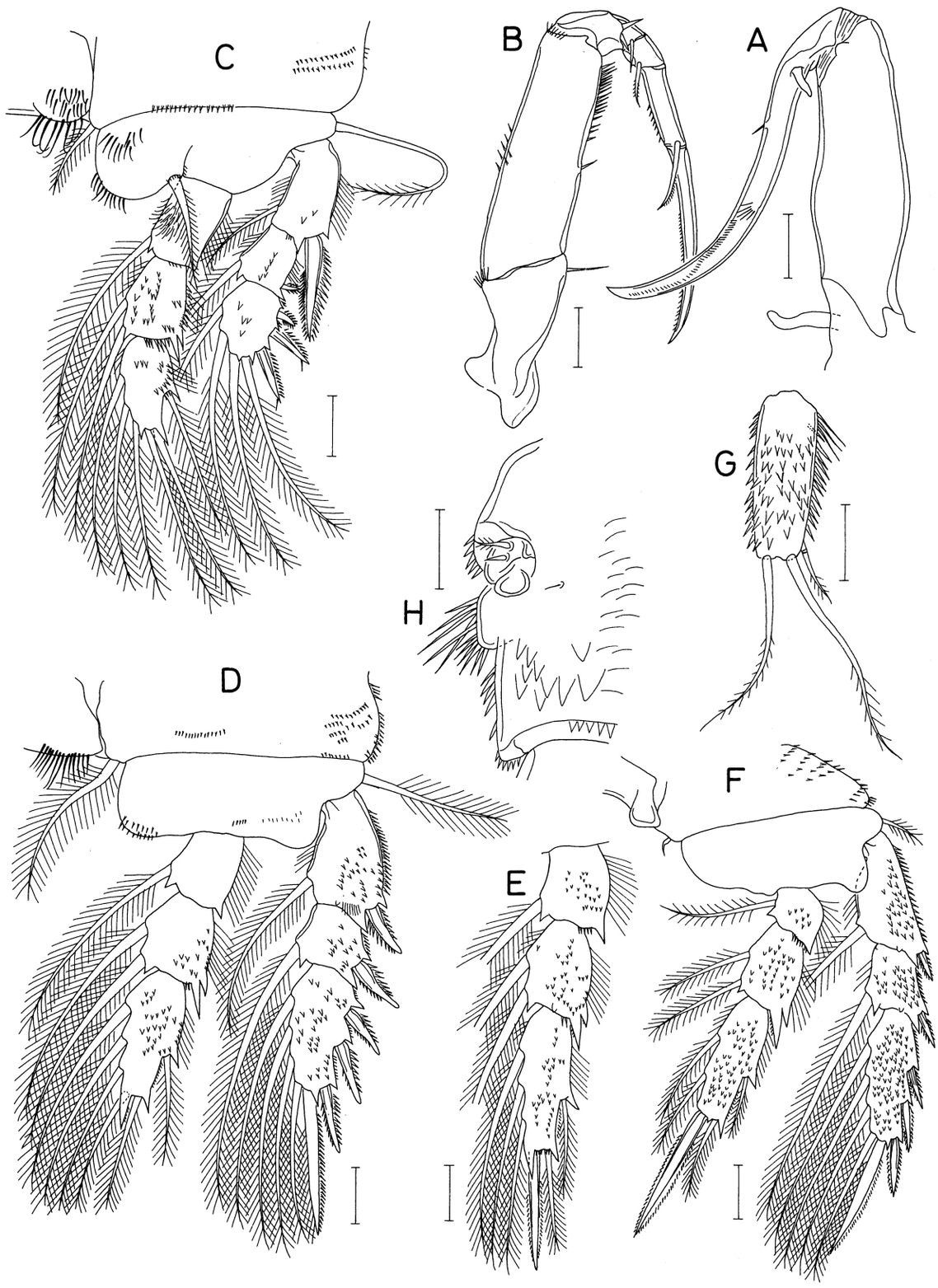

Fig. 11. *Asterocheres horridus* n. sp., female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, leg 3 endopod; F, leg 4; G, leg 5 exopod; H, left side of genital double-somite, dorsal. Scale bars: 0.02 mm.

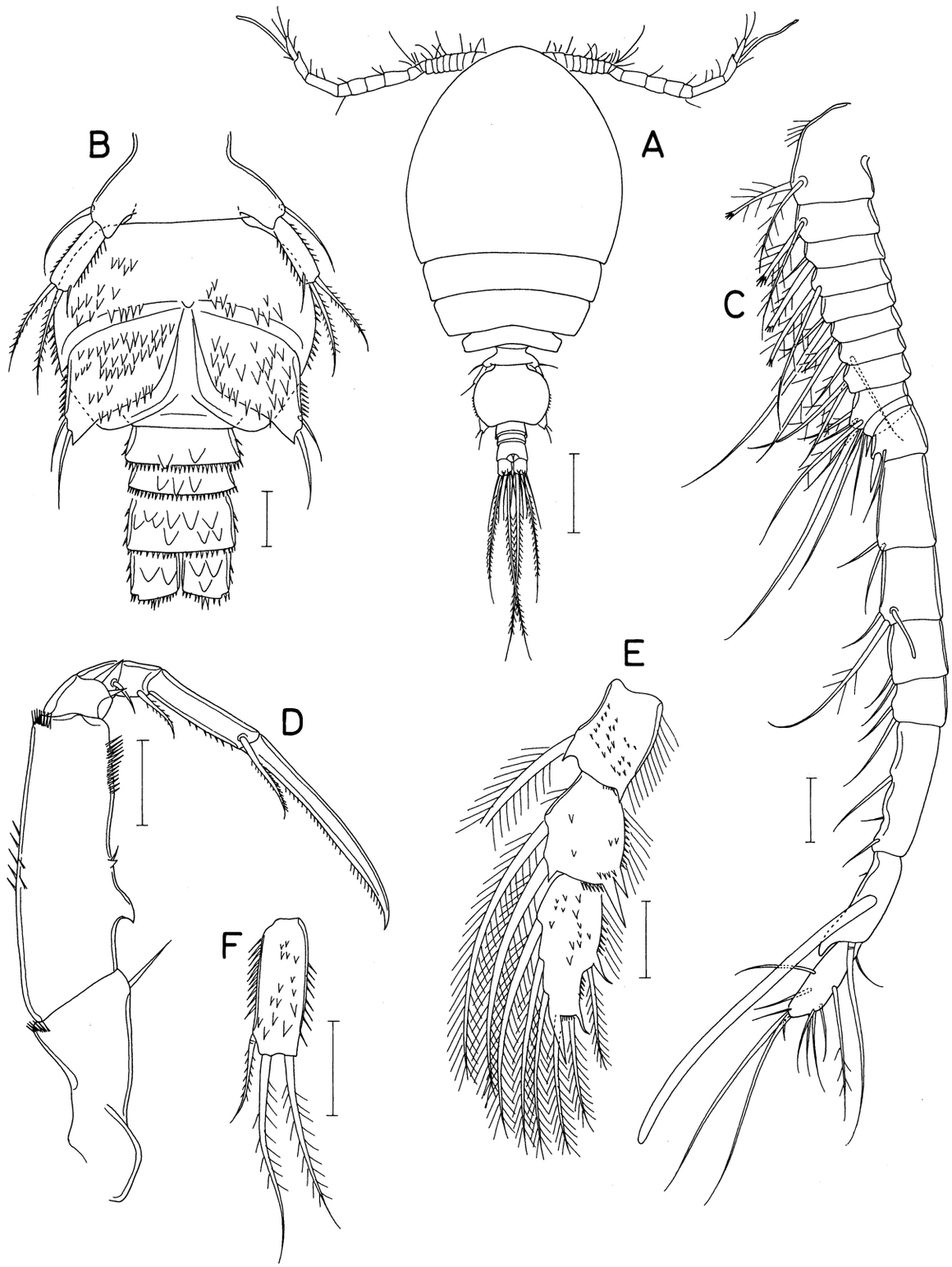

Fig. 12. *Asterocheres horridus* n. sp., male. A, habitus, dorsal; B, urosome, ventral; C, antennule; D, maxilliped; E, leg 2 endopod; F, leg 5 exopod. Scale bars: A, 0.1 mm; B-F, 0.02 mm.

treated *A. boecki* sensu Giesbrecht (1899) as non-conspecific with *A. boecki* (Brady, 1880) and gave a new name *A. complexus* Stock, 1960 for it. Recently, Bandera and Conradi (2014) re-examined the type specimens of *A. complexus*. In their illustration of the mandible, the stylet has five relatively large teeth, a condition quite different from that of *A. horridus* n. sp. Other three species are easily differentiated from *A. horridus* n. sp., because *A. spinosus* has a caudal ramus which is distinctly longer than wide (1.88 time as long as wide in the female, according to Kim and Min, 2013), *A. urabensis* has an elongate exopod of leg 5, which is 3.65 times as long as wide in the female (Kim, 2004), and *A. walteri* has four enlarged setae on the outer lobe of the maxillule (Kim, 2004).

The second outstanding feature is shared by *A. genodon* Stock, 1966 (See Kim 2010), *A. stimulans* Giesbrecht, 1897 (See Giesbrecht, 1899), and probably *A. boecki* (Brady, 1880). As differences from *A. horridus* n. sp., *A. genodon* has a caudal ramus bearing a ventral seta, as mentioned by Kim (2010) and Bandera and Conradi (2013), *A. boecki* has a prominent rostrum bearing rounded distal apex and a tapering exopod of leg 5 in the female, according to the illustrations of G.O. Sars (1914). *Asterocheres stimulans* is difficult to be compared with *A. horridus* n. sp. because of its incomplete description. Giesbrecht (1899) illustrated some morphological features for the female and male of *A. stimulans*, but Bandera and Huys (2008) explains that the male *A. stimulans* of Giesbrecht (1899) is in reality the male of *A. mucronipes* which is the type species of the genus *Stockmyzon* Bandera and Huys, 2008 they established. The morphological informations of *A. stimulans* given by Giesbrecht (1899) are only of the habitus, urosome, antennule, maxillule, maxilla, and maxilliped of the female. Of these, only the maxilliped seems to reveal characteristic feature usable to differentiate it from *A. horridus* n. sp. In this appendage of *A. stimulans* the inner margin of basis (second segment) is smooth, without any seta or spinules (a seta and a row of spinules present in *A. horridus* n. sp.), and the terminal claw is much longer and more slender than that of *A. horridus* n. sp., about three times as long as terminal segment (less than 2.5 times in *A. horridus* n. sp.).

Asterocheres cuspis n. sp. (Figs. 13-15)

Material examined. One ♀, 1♂ from a sponge of the genus *Myxilla*, off Nogok (37°12′02″N, 129°20′38″E) in Samcheok on the eastern coast of Korea, 22 December 2005. Holotype (♀, NIBRIV0000723569 dissected and mounted on a glass slide) has been deposited in NIBR, Incheon, Korea. Dissected paratypes (1♂) is retained in the collection of the author.

Female. Body (Fig. 13A) tapering distally, 1.00 mm long. Prosome 704 μm long, with greatest width of 530 μm. Cephalothorax expanded, spherical, with rounded anterior and lateral margins. Third pedigerous somite (second metasomite) with nipple-shaped posterolateral corners. Fourth pedigerous somite tapering laterally, with nipple-shaped lateral apices. Urosome (Fig. 13B) 4-segmented. Fifth pedigerous somite 138 μm wide. Genital double-somite 117 × 133 μm, with broader anterior half bearing rounded lateral margins and narrower, weakly tapering posterior half; lateral margin near genital area with about 15 spinules, several posterior ones of which being longer than anterior ones. First and second abdominal somites 60 × 72 and 50 × 63 μm, respectively. Anal somite with spinules along posteroventral margin. Genital double-somite and abdominal somites covered by scales on dorsal and ventral surfaces. Caudal ramus (Fig. 13C) 31 × 30 μm, nearly as long as wide, with spinules along posterior margin, longer outer margin and shorter inner margin, and armed with 6 setae; inner dorsal seta naked, other 5 setae plumose.

Rostrum absent. Antennule (Fig. 13D) 442 μm long and 20-segmented; armature formula 2, 2, 2, 2, 2 / 2, 2, 2, 7, 2 / 2, 2, 2, 2, 2 / 2, 2, 2 + aesthetasc, 2, and 11; first segment with several minute spinules on anterior margin and armed with 2 unequal, plumose setae; terminal segment with indistinct transverse line as rudiment of articulation. Antenna (Fig. 13E) with short, umarmed coxa; basis 100 μm long, with longitudinal row of minute pectens along distal 3/5 of basis. Exopod 17 × 7 μm, 2.43 times as long as wide, narrow proximally, with 1 small lateral and 2 unequal distal setae. Endopod 3-segmented; first segment 75 μm long, unarmed, but ornamented with fine spinules along outer margin; short second segment with 1 blunt seta distally. Terminal segment with 2 distal setae and terminated by claw of 70 μm long.

Oral cone (Fig. 13F) evenly tapering, 188 × 100 μm, extending to base of maxilliped. Mandible (Fig. 13G) consisting of stylet and palp. Stylet 170 μm long, distally bifurcated, with finely denticulated tips. Palp indistinctly 2-segmented; first segment 55 μm long; second segment 28 μm long, with 2 unequal setae distally, longer one of them 165 μm long and shorter one 55 μm long; palp, together with longer seta, distinctly longer than stylet. Maxillule (Fig. 13H) bilobed. Inner lobe 74 × 29 μm, about 2.6 times as long as outer lobe and armed distally with 5 larger setae: 1 minute seta, 1 medium-sized seta (53 μm long), and 3 larger, setules-tipped setae of equal length (about 83 μm long). Outer lobe 29 × 10 μm, with 4 setae distally (108, 104, 67, and 30 μm long, respectively). Maxilla (Fig. 13I) 2-segmented; syncoxa with transparent tube and row of spinules proximally; basis represented by claw bearing minute spinules in distal region. Maxilliped (Fig. 14A) 6-segmented. Syncoxa with

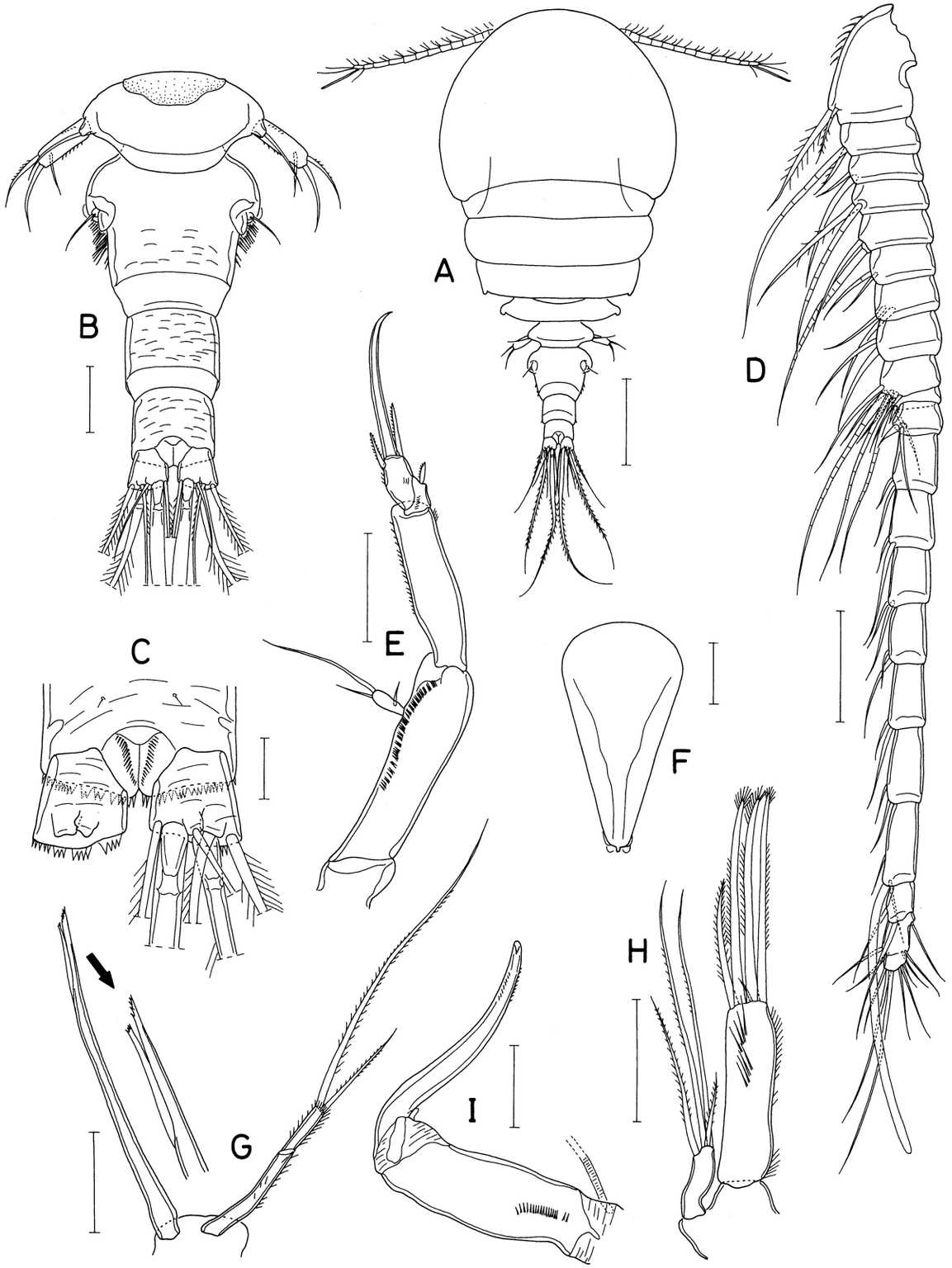

Fig. 13. *Asterocheres cuspis* n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, caudal rami, dorsal; D, antennule; E, antenna; F, oral cone; G, mandible; H, maxillule; I, maxilla. Scale bars: A, 0.1 mm; B, D-I, 0.05 mm; C, 0.02 mm.

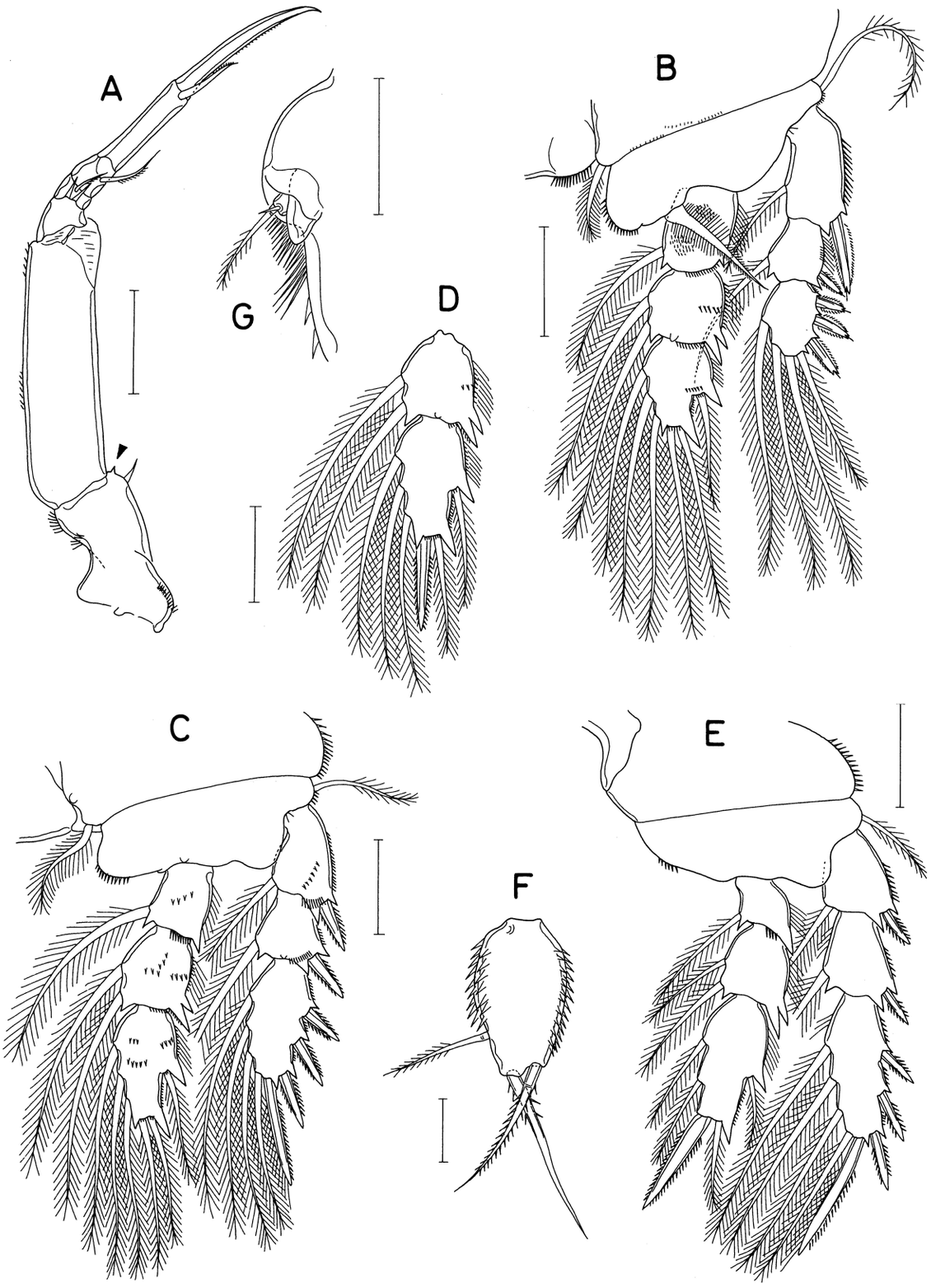

Fig. 14. *Asterocheres cuspis* n. sp., female. A, maxilliped; B, leg 1; C, leg 2; D, second and third segments of leg 3 endopod; E, leg 4; F, leg 5 exopod; G, left side of genital double-somite, dorsal. Scale bars: A-E, G, 0.05 mm; F, 0.02 mm.

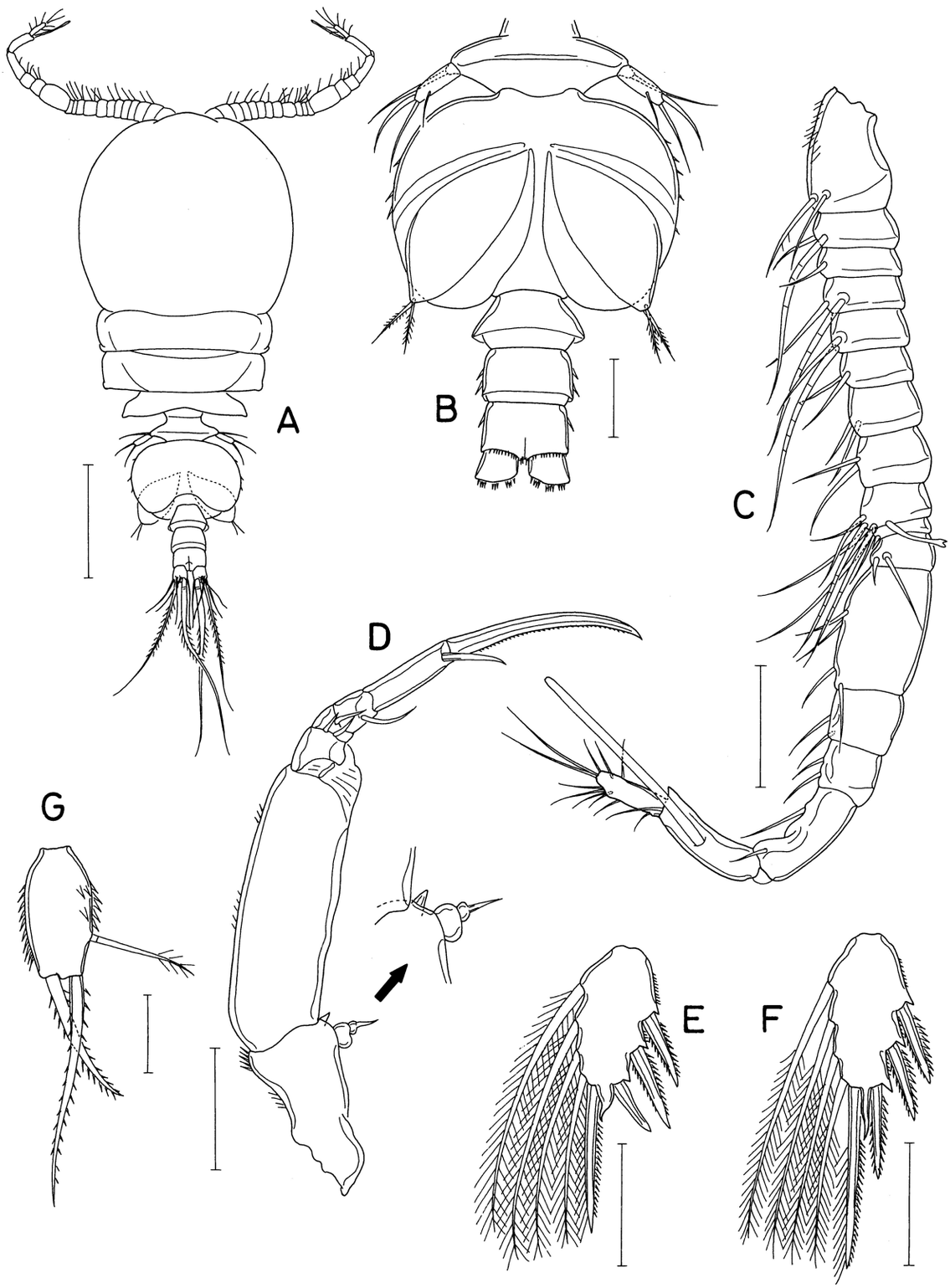

Fig. 15. *Asterocheres cuspis* n. sp., male. A, habitus, dorsal; B, urosome, ventral; C, antennule; D, maxilliped; E, third exopodal segment of leg 2; F, third exopodal segment of leg 3; G, leg 5 exopod. Scale bars: A, 0.2 mm; B-F, 0.05 mm; G, 0.02 mm.

1 small, subdistal seta, 1 small, pointed process at inner distal corner, and row of fine spinules on outer distal and inner proximal regions. Basis 122 × 38 μm, with few spinules on outer margin. Endopod 4-segmented and armed with 2, 1, 1, and 1 setae, on first to fourth segments, respectively; terminal claw 80 μm long.

Legs 1-4 with 3-segmented rami. Second endopodal segment of legs 1-4 with bicuspid outer distal corner (Fig. 14B-E). Legs 1-3 with inner setae on coxa (Fig. 14B, C), but leg 4 lacking this seta (Fig. 14E). Intercoxal plate of leg 1 with spinules on both sides of distal margin, but that of legs 2-4 unornamented. Inner distal corner of basis of legs 1-4 with spinules. Leg 3 different from leg 2 in armature of third endopodal segment (Fig. 14C, D). Leg 4 without inner seta on coxa, otherwise, armature formula for legs 1-4 as typical for genus.

Leg 5 represented by dorsolateral seta on fifth pedigerous somite and free exopod; exopod (Fig. 14F) suboval, 49 × 29 μm, 1.69 times as long as wide, heavily spinulose on both dorsal and ventral margins, and armed with 2 distal setae (58 and 48 μm long, respectively) and 1 ventral seta (34 μm long). Leg 6 represented by 2 unequal setae in genital aperture (Fig. 14G).

Male. Body (Fig. 15A) similar in shape to that of female, 830 μm long. Cephalothorax 346 × 377 μm. Urosome (Fig. 15B) 5-segmented. Fifth pedigerous somite 113 μm wide. Genital somite 128 × 183 μm, wider than long, with several spinules on lateral margin. Three abdominal somites equal in length, 35 × 72, 35 × 58, and 35 × 50 μm, respectively. Caudal ramus 25 × 27 μm, slightly wider than long.

Rostrum absent as in female. Antennule 410 μm long, 17-segmented, and geniculate between antepenultimate and penultimate segments; armature formula 2, 2, 2, 2, 2 / 2, 2, 2, 7, 2 / 2, 4, 2, 2, 2 / 1 + aesthetasc, and 11; one of setae on nineth segment truncated and bifurcated at tip; twelfth segment slightly swollen. Antenna as in female.

Oral cone, mandible, maxillule, maxilla as in female. Maxilliped (Fig. 15D) shaped as that of female, but inner distal seta on syncoxa mounted on prominent, papilla-like swelling; basis without any process on inner margin.

Leg 1 as in female. Legs 2 and 3 different from those of female in having slightly enlarged and curved distal process on third exopodal segment (Fig. 15E, F). Leg 4 as in female.

Leg 5 exopod 33 × 17 μm, 1.94 times as long as wide; two distal setae spinulose, 60 and 37 μm long, respectively; ventral seta 28 μm long and distally plumose. Leg 6 represented by 2 equal setae on genital operculum (Fig. 15B).

Etymology. The scientific name is taken from *cuspis* (Latin, meaning a point), alluding to the pointed distal process on the syncoxa of the maxilliped.

Remarks. *Asterocheres cuspis* n. sp. has a unique feature that allows it to differentiate from all congeners: the possession of a small cusp at inner distal corner of the syncoxa of the maxilliped in both sexes. No species in *Asterocheres* has been reported to have this cusp.

The new species can be compared with congeners in different ways. It has, as a combination of three diagnostic features, 2-segmented mandibular palp, no inner seta on the coxa of leg 4, and a relatively short oral cone extending only to the base of the maxilliped. Thus, species having 1-segmented mandibular palp or an inner seta on the coxa of leg 4 or a longer oral cone (or siphon) which is extended beyond the base of the maxilliped are excluded from a comparion with the new species. After this screening, 17 species are remained. The caudal ramus of *A. cuspis* n. sp. is slightly longer than wide. Thus the species having a caudal ramus which is distinctly longer than wide (more than 1.2 times as long as wide) or distinctly shorter than wide (less than 0.9 times as long as wide) can be further excluded from the comparison with the new species. There are three finally remaining species: *A. dysideae* Humes, 1996, *A. honkongensis* Malt, 1991, and *A. nudicoxus* Kim, 2010. Differences of these three species from *A. cuspis* n. sp. are follows:

In *A. dysideae* recorded from the Moluccas, the caudal ramus has a ventral seta, the prosome and oral cone are very broad, and the caudal ramus has a large pointed hyaline posteroventral process (Humes, 1996).

In *A. hongkongensis* recorded from Hong Kong, the body is small (0.50 mm long in the female), the antennule of the female is 19-segmented with an aesthetasc on the penultimate segment, and the exopod of leg 5 is extending beyond the level of the genital aperture (Malt, 1991).

In *A. nudicoxus* known from Madagascar, the oral cone is very broad, the exopod of leg 5 is elongate, more than 6 times as long as wide in the female, the posteroventral margins of the genital double-somite and abdominal somites are crenate (Kim, 2010)

Asterocheres simulans (T. Scott, 1898) (Figs. 16-18)

Ascomyzon simulans T. Scott, 1898, p. 270, pl. 13, figs. 1-9. pl. 14, fig. 22; G.O. Sars, 1914, p. 89, pl. 55.
Asterocheres simulans: Giesbrecht, 1899, pp. 70, 115, 119; Ivanenko, 1997, p. 1119, figs. 1-6.

Material examined. 11♀♀, 1 damaged ♂ from an unidentified sponge, off Gisamun Port (38°00′30″N, 128° 43′51″E), in Yangynag on the eastern coast of Korea, in the depth of about 10 m, 23 September 2006.

Female. Body (Fig. 16A) 1.08 mm long in dissected and figured specimen. Mean body length 0.90 mm (0.80-1.08 mm), based on 9 specimens. Prosome oval, 738 μm long. Cephalothorax 453 × 585 μm, with angular posterolater-

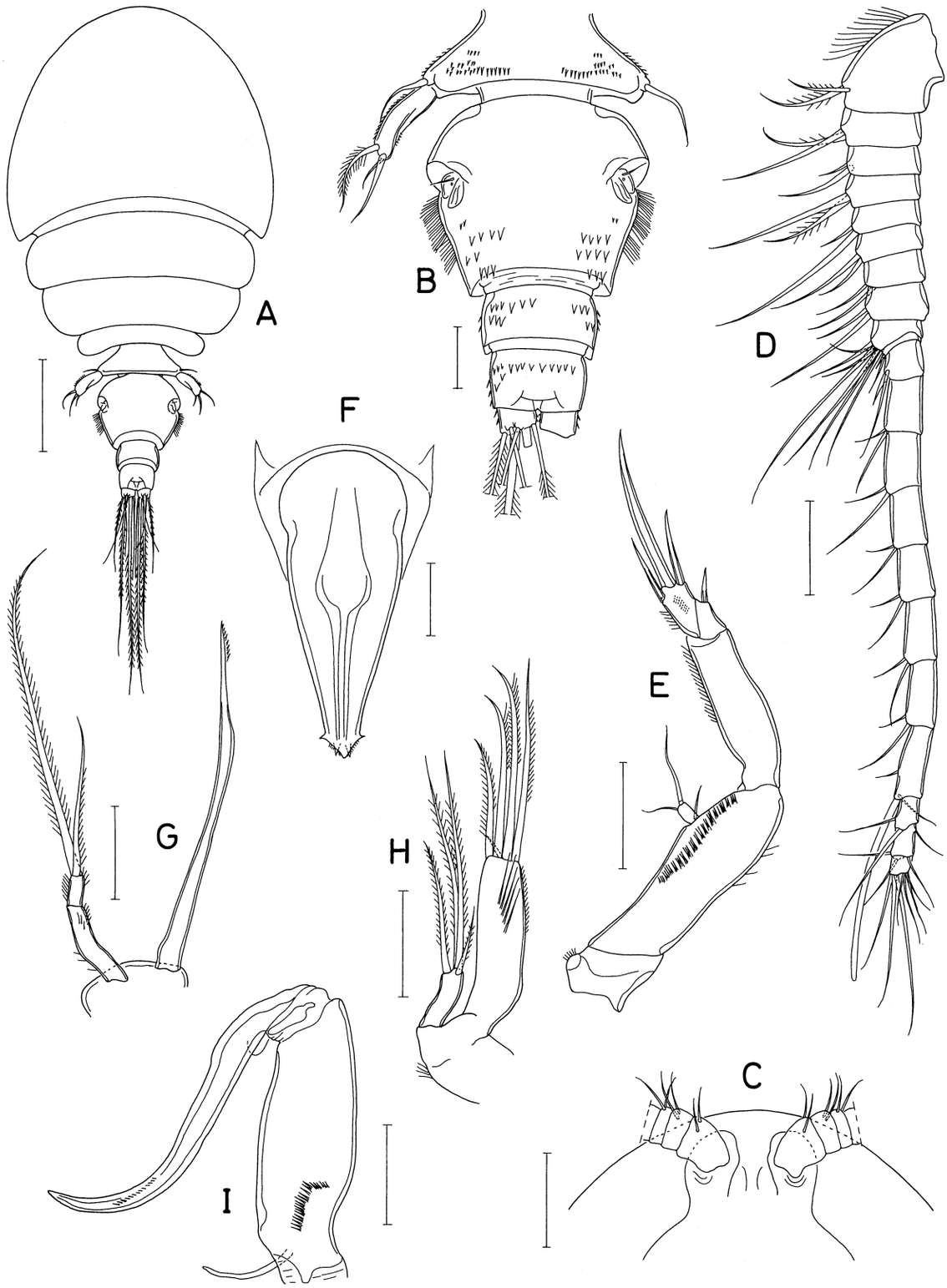

Fig. 16. *Asterocheres simulans* (T. Scott), female. A, hatitus, dorsal; B, urosome, dorsal; C, rostral area, ventral; D, antennule; E, antenna; F, oral cone; G, mandible; H, maxillule; I, maxilla. Scale bars: A, 0.2 mm; B, D-I, 0.05 mm; C, 0.1 mm.

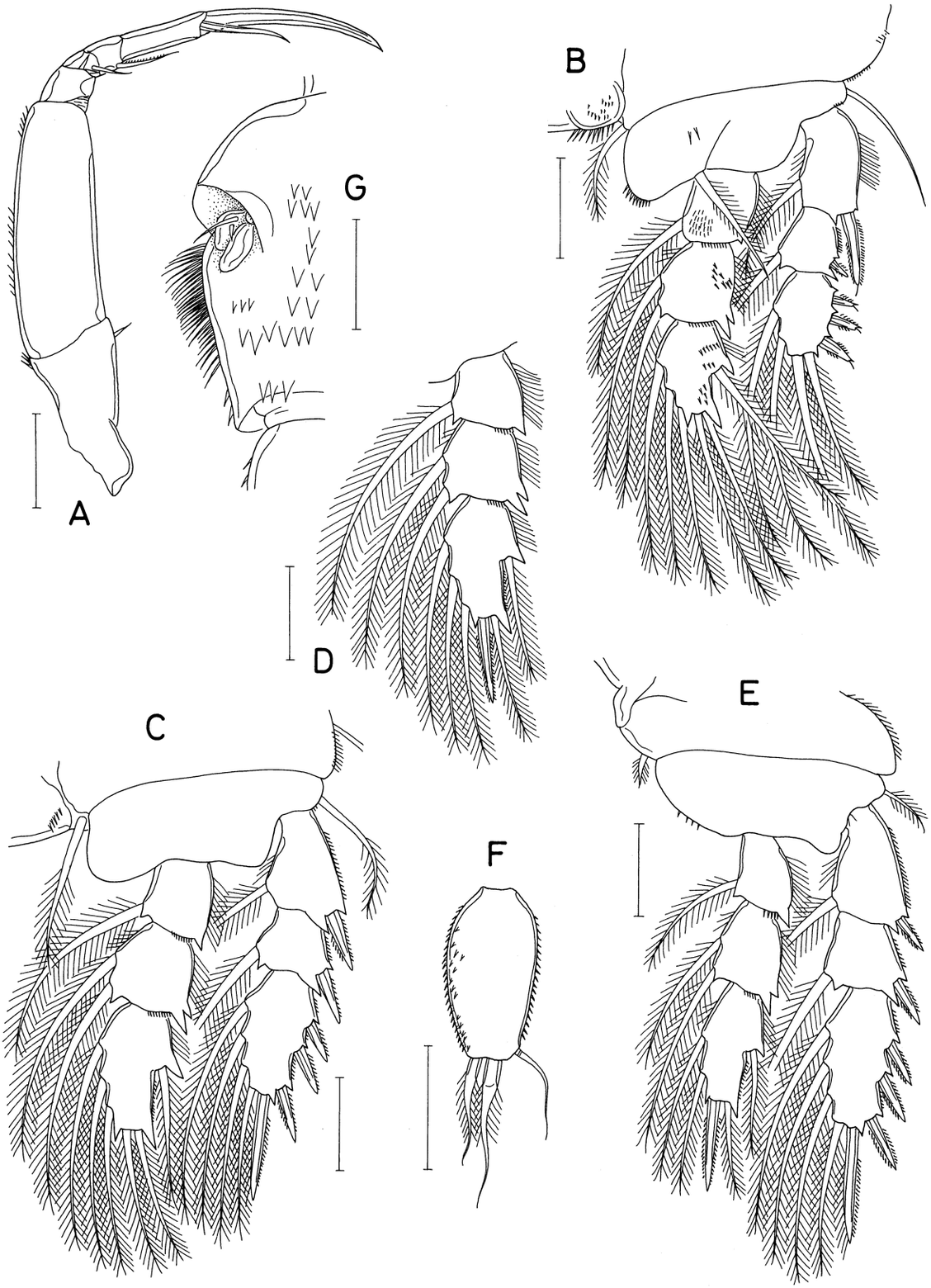

Fig. 17. *Asterocheres simulans* (T. Scott), female. A, maxilliped; B, leg 1; C, leg 2; D, leg 3 endopod; E, leg 4; F, leg 5 exopod; G, left side of genital double-somite, dorsal. Scale bars: A-G, 0.05 mm.

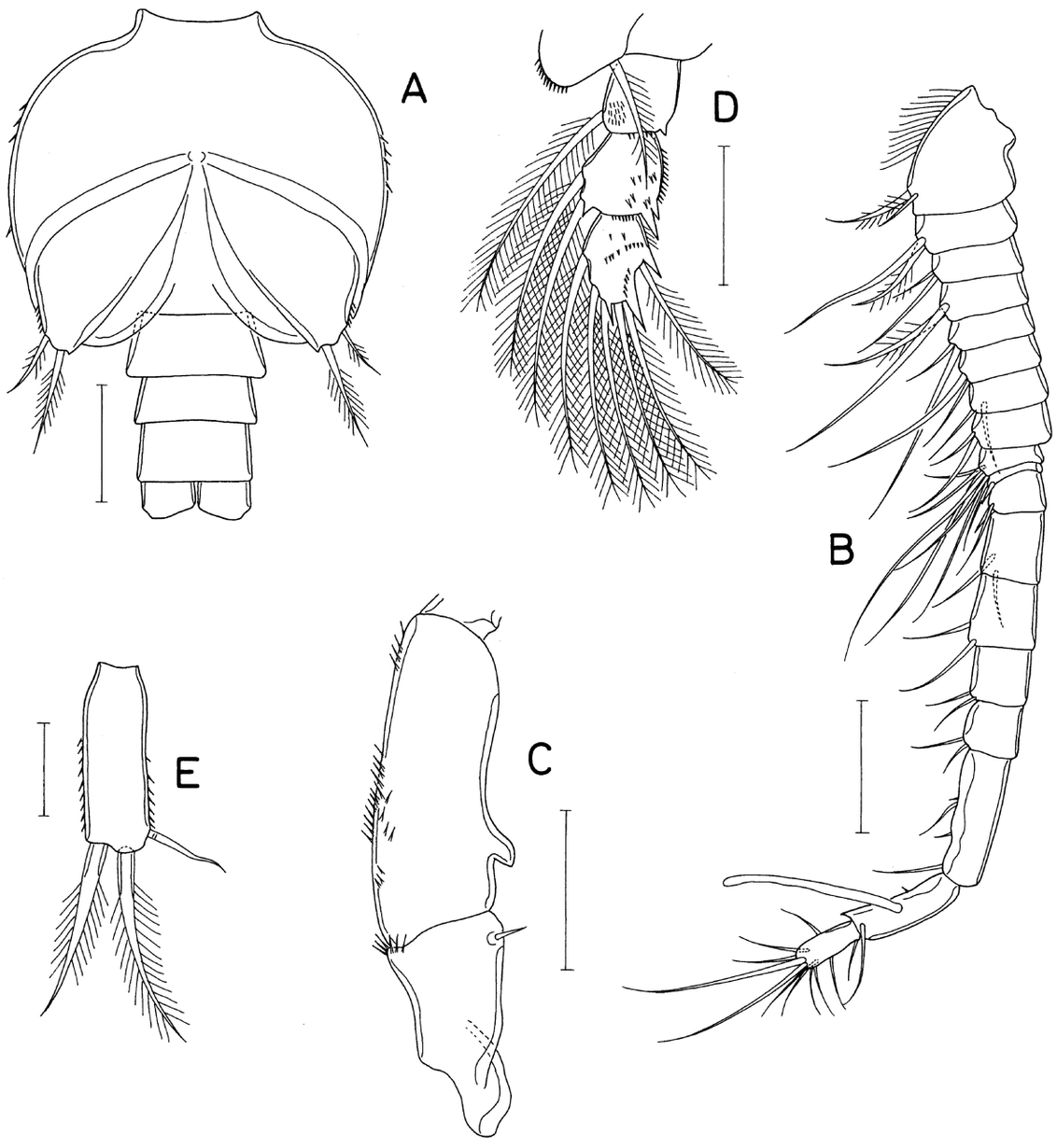

Fig. 18. *Asterocheres simulans* (T. Scott), male. A, urosome except for fifth pedigerous somite, ventral; B, antennule; C, proximal part of maxilliped; D, leg 1 endopod; E, leg 5 exopod. Scale bars: A-D, 0.05 mm; E, 0.02 mm.

al corners. Three metasomites with rounded posterolateral corners. Urosome (Fig. 16B) 4-segmented, tapering posteriorly. Fifth pedigerous somite 181 μm wide, tapering laterally, with spinules on dorsal surface. Genital double-somite 154 × 177 μm, gradually tapering distally, with scales scattered on posterior half of dorsal surface, and about 30 stiff setules on lateral margin posterior to genital aperture (Fig. 17G). Genital aperture located dorsolaterally at 0.43 region of double-somite length. First and second abdominal somites 50 × 94 and 48 × 77 μm, respectively, with scales on dorsal surface. Anal somite (second abdominal somite) with smooth posterior margin. Caudal ramus short, 21 × 30 μm, 1.43 times as wide as long, with 6 setae and smooth distal margin. Setae IV and V longer than urosome.

Rostrum indistinct, without posterior apex (Fig. 17C).

Antennule (Fig. 16D) 21-segmented, 458 μm long; armature formula 2, 2, 2, 2, 2 / 2, 2, 2, 7, 2 / 2, 2, 2, 2, 2 / 2, 2, 2 + aesthetasc, 2, 4, and 7; first segment with long setules on anterior margin; several setae on proximal segments plumose. Antenna (Fig. 16E) with short, unarmed coxa. Basis 103 μm long, with longitudinal row of minute pectens along distal 3/5. Exopod small, 10 × 6 μm, with 1 lateral and 2 unequal, distal setae. Endopod 3-segmented; first segment 76 μm long, with setules on outer margin; short second segment with 1 small seta; terminal segment with 2 spiniform setae (inner one 36 μm long and outer one 33 μm long) and terminated by spiniform claw of 77 μm long.

Oral cone (Fig. 16F) evenly tapering, 201 μm long, 88 μm wide proximally, extending to base of maxilliped, with paired lateral points subdistally. Mandible (Fig. 16G) consisting of stylet and palp. Stylet 188 μm long, with fine teeth at distal region. Palp 2-segmented; first segment 46 μm long, and second segment 16 μm long; 2 distal setae plumose, 187 and 97 μm long, respectively. Palp, together with longer seta, distinctly longer than stylet. Maxillule (Fig. 16H) bilobed. Inner lobe 83 × 22 μm, with 5 distal setae; lengths of these setae 96, 94, 77, 58, and 16 μm, respectively. Outer lobe 30 × 10 μm, with 4 distal setae of 103, 100, 64, and 33 μm long, respectively. Maxilla (Fig. 16I) 2-segmented; syncoxa with slender tube and row of minute spinules at proximal region; basis represented by claw bearing row of minute spinules in distal region. Maxilliped (Fig. 17A) 6-segmented. Syncoxa with 1 small seta near inner distal corner. Basis 130 × 46 μm, with spinules on outer margin. First to fourth endopodal segments with 2, 1, 1, and 1 setae, respectively; terminal segment 45 μm long; terminal claw 100 μm long, 2.2 times as long as terminal segment.

Legs 1-4 (Fig. 17B-E) with 4-segmented rami. Leg 4 with small, plumose inner seta on coxa, otherwise armature formula as typical for genus. Outer spines on exopod of leg 1 tipped with small setule, that of first segment 36 μm long.

Leg 5 consisting of dorsolateral seta on fifth pedigerous somite and free exopod (Fig. 16B); exopod (Fig. 17F) 69 × 37 μm, 1.86 times as long as wide, and armed with 2 distal and 1 subdistal setae; lateral margins of exopod slightly convex and spinulose; 2 distal setae broadened proximally, plumose, 61 and 46 μm long, respectively; subdistal seta naked, 41 μm long. Leg 6 represented by 2 small setae on genital operculum (Fig. 17G).

Male. Urosome 5-segmented. Genital somite (Fig. 18A) 128 × 164 μm, wider than long, with few spinules on lateral margin. First to third abdominal somites 26 × 60, 19 × 53, and 26 × 50 μm, respectively. Caudal ramus 16 × 23 μm, 1.45 times as wide as long.

Rostrum as in female. Antennule (Fig. 18B) 368 μm long, 18-segmented, and geniculate between sixteenth and seventeenth segments; armature formula: 2, 2, 2, 2, 2 / 2, 2, 2, 6, 2 / 2, 2, 2, 2, 2 / 4, 2 + aesthetasc, and 11; aesthetasc on penultimate segment relatively small, but extending over distal tip of terminal segment. Antenna as in female.

Oral cone, mandible, maxillule, and maxilla as in female. Maxilliped similar to that of female, but its basis with prominent proximal process on inner margin (Fig. 18C).

Leg 1 slightly different from that of female in having more acutely pointed outer and inner distal processes on third endopodal segment (Fig. 18D). Legs 2-4 as in female.

Leg 5 exopod (Fig. 18E) rectangular, 2.89 times as long as wide, with parallel lateral margins. Leg 6 represented by 2 distal plumose setae on genital operculum (Fig. 18A).

Remarks. Ivanenko (1997) redescribed this species, based on the specimens from the White Sea. A careful comparison of Korean specimens with Ivanenko's illustrations resulted in that the forms from the two different zoogeographic regions revealed no significant differences. The length combinations of setae on the lobes of the maxillule are, in particular, almost identical between them. The presence of a row of setules on the medial margin of the genital operculum in the male from the White Sea, which is absent in the male from the Sea of Japan, is not considered important to differentiate them on the species level.

Asterocheres quadridens n. sp. (Figs. 19, 20)

Material examined. Two ♀♀ from washings of intertidal invertebrates, at Seogwipo (33°14′20″N, 126°33′33″E) in Jeju Island, 17 September 2005. Holotype (♀, legs 5 detached, NIBRIV0000681226) has been deposited in NIBR, Incheon, Korea. Dissected paratype (1♀) is retained in the collection of the author.

Female. Body (Fig. 19A) broad and 941 μm long. Prosome expanded laterally. Cephalothorax 220 × 586 μm, much wider than long, with angular posterolateral corners and rounded anterior and lateral margins. Second and third pedigerous somites 105 × 468 and 109 × 423 μm, respectively, with blunt posterolateral corners. Third pedigerous somite 275 μm wide, with deeply concave posterior margin. Urosome (Fig. 19B) 4-segmented. Fifth pedigerous somite 157 μm wide. Dorsal and ventral surfaces of genital double-somite and abdominal somites ornamented with scales. Genital double-somite 140 × 155 μm, with 1 prominent dentiform process at distal fifth of lateral margin and about 12, rather thick setules on lateral margin near genital aperture; genital aperture located dorsolaterally slightly posterior to halfway of

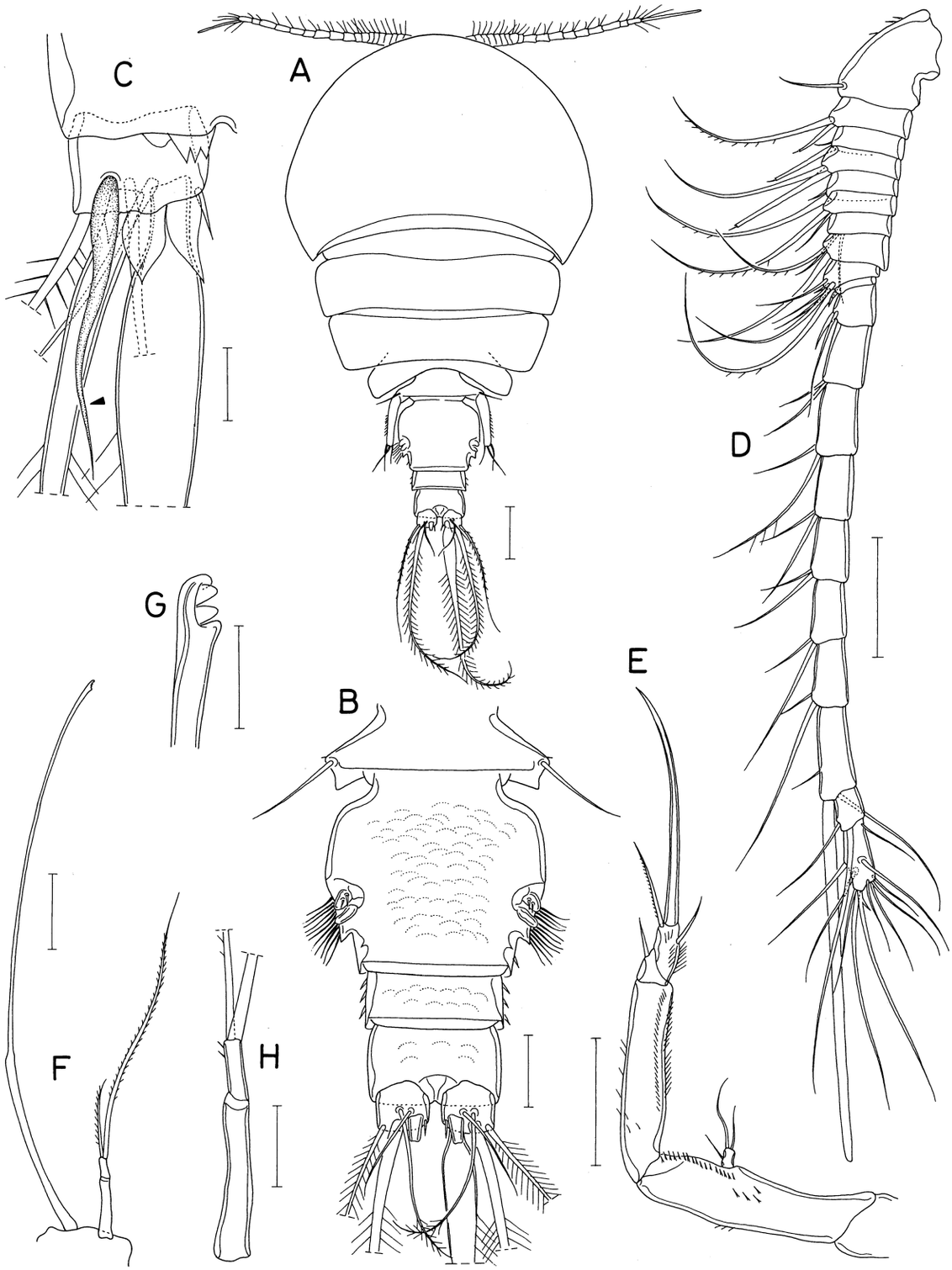

Fig. 19. *Asterocheres quadridens* n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, right caudal ramus, ventral; D, antennule; E, antenna; F, mandible; G, distal part of mandibular stylet; H, mandibular palp. Scale bars: A, 0.1 mm; B, D-F, 0.05 mm; C, H, 0.02 mm; G, 0.01 mm.

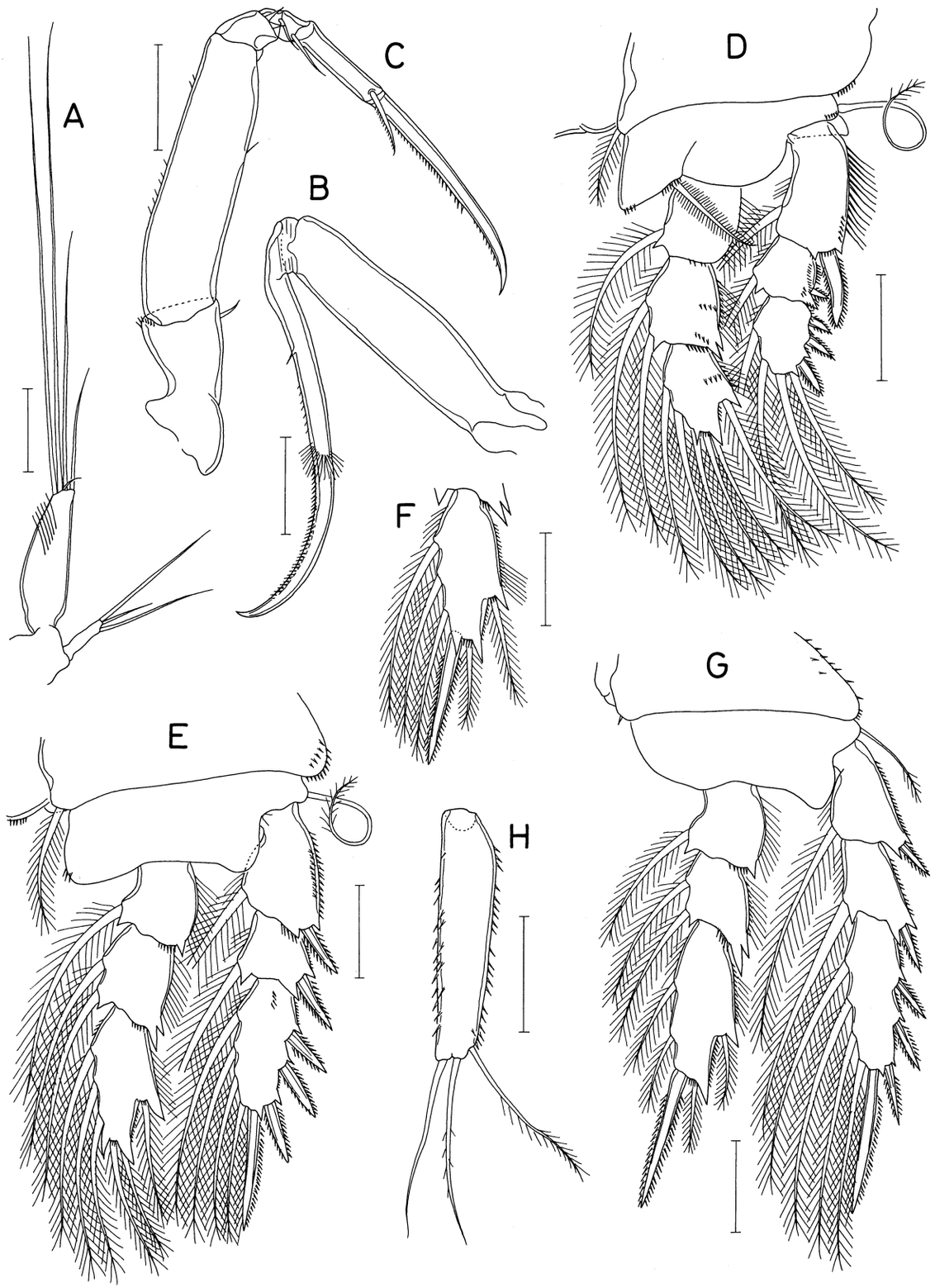

Fig. 20. *Asterocheres quadridens* n. sp., female. A, maxillule; B, maxilla; C, maxilliped; D, leg 1; E, leg 2; F, third endopodal segment of leg 3; G, leg 4; H, leg 5 exopod. Scale bars: 0.05 mm.

lateral margin. First and second abdominal somites 38 × 98 and 53 × 94 μm, respectively. Anal somite with serrate membrane on inner side of ventrodistal margin (Fig. 19C). Caudal ramus (Fig. 19C) wider than long, 28 × 39 μm (length/width ratio 0.72 : 1), characteristically armed with 7 setae including 1 naked, large whip-like seta on ventral surface (indicated by arrowhead in Fig. 19C), and ornamented with 2 large, transparent, leaf-like lamellae on ventrodistal margin. Largest inner median distal seta (seta V) distinctly expanded proximally. Innermost distal seta (seta VI) markedly reduced, spinule-like.

Rostrum short, much wider than long, with rounded posterior margin. Antennule (Fig. 19D) 374 μm long and 20-segmented; armature formula 1, 2, 2, 2, 2 / 2, 2, 2, 6, 2 / 2, 2, 2, 2, 2 / 2, 2, 2 + aesthetasc, 2, and 12; one of setae on terminal segment inserted on proximal part of terminal seta. One of 2 setae on third and fifth segments minute, setule-like. One of 2 setae on second to fourth segments truncate and tipped with setule. Antenna (Fig. 19E) with short, unarmed coxa. Basis unarmed but spinulose in distal half. Exopod small, 7 × 5 μm, armed with 1 lateral and 2 distal setae. Endopod 3-segmented; first segment 75 × 17 μm, unarmed but spinulose; short second segment with 1 distal seta; distal segment with 2 setae and slender, spiniform terminal claw of 97 μm long.

Oral siphon 395 μm long, slender, and extending beyond intercoxal plate of legs 1 but not reaching leg 2. Mandible consisting of stylet and palp. Stylet (Fig. 19F) slender, 384 μm long, consisting of broader proximal 1/3 and thread-like distal 2/3, with 4 broad teeth or tooth-like processes distally (Fig. 19G). Palp (Fig. 19F, H) 2-segmented; proximal segment 40 μm long; distal segment 15 μm long, tipped with 2 unequal setae of 193 and 54 μm long, respectively. Combined length of palp and longer distal seta distinctly shorter than stylet. Maxillule (Fig. 20A) bilobed. Inner lobe 88 × 28 μm with row setules laterally and 5 naked distal setae, including 1 minute seta; remaining 4 setae 287, 280, 158, and 75 μm long, respectively. Small outer lobe 28 × 8 μm and armed with 3 naked setae of 87, 75, and 35 μm long, respectively. Maxilla (Fig. 20B) slender, consisting of unarmed syncoxa and claw like basis bearing 1 minute seta at proximal fourth, transverse row of setules near middle, and row of fine spinules along distal 2/3 of concave margin. Maxilliped (Fig. 20C) 6-segmented; syncoxa with 1 inner seta distally; basis with 1 minute seta at 0.6 region of inner margin and few spinules on outer margin; endopod armed with 2, 1, 1, and 1 setae on first to terminal segment, respectively; terminal segment 48 μm long; terminal claw 110 μm long, more than twice as long as terminal segment, with fine spinules along concave margin.

Legs 1-4 with 3-segmented rami, with armature formula as in preceding species. Inner seta on coxa well-developed and plumose in legs 1-3, but rudimentary in leg 4 (Fig. 20G). Inner distal corner of leg 1 basis projected and tapered (Fig. 20D). Second endopodal segment of legs 1-4 with bicuspid outer distal corner (Fig. 20D-G). Distal spine on third endopodal segment of legs 3 and 4 slightly shorter than segment (Fig. 20F, G).

Leg 5 consisting of 1 naked dorsolateral seta on fifth pedigerous somite and free exopod; exopod (Fig. 20H) elongate, 109 × 24 μm (length/width ratio 4.54 : 1), gradually narrowing distally, with spinules along both margins and 2 distal and 1 subdistal setae of subequal lengths, all of these setae shorter than exopod segment. Leg 6 represented by 2 minute setae on genital operculum (Fig. 19B).

Male. Unknown.

Etymology. This specific name *quadridens* is from Latin words *quadr* (= four) and *dens* (= tooth), alluding to the presence of the four distal teeth on the mandibular stylet.

Remarks. *Asterocheres quadridens* n. sp. is very similar to *A. genodon* Stock, 1966 which was recorded from the Indian Ocean and Red Sea (Stock, 1966a; 1966b). It was redescribed by Kim (2010), based on the specimens from Madagascar, and Bandera and Conradi (2013) reexamined type specimens. *Asterocheres quadridens* n. sp. and *A. genodon* share several features that are unusual for *Asterocheres*, as follows: (1) the caudal ramus has a ventral seta (*A. dysideae* Humes, 1996 also has a ventral seta on the caudal ramus); (2) the mandibular stylet consists of broader proximal third and thin distal two-thirds, with four distal teeth (or tooth-like processes); (3) the genital double-somite in the female with tooth-like process on the lateral margin posterior to the genital aperture; and (4) the exopod of leg 5 is elongate. Nevertheless, they are different species, because, according to Kim (2010), in *A. genodon* (1) the caudal ramus is longer than wide (vs. wider than long in *A. quadridens* n. sp.), with outer margin longer than inner margin (vs. both margins similar in length); (2) the antennule is 21-segmented (vs. 20-segmented) and its first segment is armed with 2 setae (vs. 1 seta); (3) the outer lobe of the maxillule is armed with 4 setae (vs. 3 setae); (4) the inner distal corner of the basis of leg 1 is rounded (vs. tapered); and (5) the exopod of leg 5 is 3.77 times as long as wide (vs. 4.54 times) and armed with 3 unequal setae (vs. 3 subequal setae).

Genus *Scottocheres* Giesbrecht, 1897

Scottocheres mipoensis n. sp. (Figs. 21-23)

Material examined. Two ♀♀, 1♂ from a sponge (as a fisheries bycatch), off Mipo (35°09′29″N, 129°10′17″E) in Pusan, 11 December 2014. Holotype (♀, intact, NIBR

IV0000681227) has been deposited in NIBR, Incheon, Korea. Dissected paratypes (1♀, 1♂) are retained in the collection of the author.

Female. Body (Fig. 21A) narrow, 1.01 mm long. Prosome 629 μm long. Cephalothorax 327 × 295 μm, longer than wide. Second and third pedigerous somites 276 and 269 μm wide, respectively, only slightly narrower than cephalothorax, with rounded anterolateral and posterolateral corners. Fourth pedigerous somite 131 μm wide. Urosome (Fig. 21B) 4-segmented. Fifth pedigerous somite nearly as wide as genital double-somite. Genital double-somite 185 × 133 μm, slightly tapering in distal half, with pointed, tooth-like process on lateral margin near genital aperture; lateral sides of dorsal surface depressed, thus forming dorsal ridge along midline; genital aperture located dorsally at anterior 0.3 region. Minute paired gonopores present on ventral surface at anterior fourth of double-somite (Fig. 21C). First abdominal somite 73 × 69 μm, gradually broadened distally. Anal somite 42 × 62 μm, distinctly wider than long, shorter than preceding somite. Caudal ramus (Fig. 21D) small, 19 × 19 μm, broadened distally, with few setules on distal part of inner margin, and armed with 6 setae; seta V longest, 173 μm long; seta IV second longest, 111 μm long; seta VII (dorsal seta) inserted on papilliform extention of caudal ramus.

Rostrum absent. Antennule (Fig. 21E) 289 μm long, 18-segmented, but articulation between third and fourth segments incomplete; armature formula 1, 2, 2, 2, 2 / 2, 2, 2, 5, 2 / 2, 1, 2, 1, 1 / 1, 1 + aesthetasc, and 13; first segment with several minute spinules on anterior surface; all setae short and naked; aesthetasc on penultimate segment about 0.28 times as long as antennule. Antenna (Fig. 21F) consisting of syncoxa, basis, small exopod and 2-segmented endopod. Syncoxa short and unarmed. Basis 72 μm long. Exopod 12 × 6 μm, twice as long as wide, located at distal 1/3 of basis length, and armed with 3 small setae. Proximal endopodal segment about 45 μm long and unarmed; distal endopodal segment about 23 μm long, armed with 4 setae and terminal claw; inner distal one of setae minute; terminal claw 58 μm long.

Oral siphon (Fig. 21G) thin, 636 μm long, and extending to level of leg 5. Mandible (Fig. 21G) fibril-like. Maxillule (Fig. 21H) bilobed; inner lobe tapering, 41 × 19 μm, armed distally with 3 setae (144, 133, and 68 μm, respectively); outer lobe small, 11 × 5 μm, armed with 1 distal and 1 subdistal setae. Maxilla (Fig. 22A) with unarmed, 100 μm-long syncoxa; basis also 100 μm long, slender; terminal claw 68 μm long, gently curved, and clearly articulated from basis. Maxilliped (Fig. 22B) 5-segmented; syncoxa with 1 small inner distal seta; basis 91 × 25 μm, unarmed, but with several minute spinules in middle of outer margin; endopod slender, 3-segmented, armed with 2, 1, and 1 setae on first to third segments, respectively; terminal endopodal segment 41 μm long; terminal claw 72 μm long, 1.76 times as long as terminal endopodal segment.

Legs 1-4 (Fig. 22C-F) with 3-segmented exopod and endopod. Leg 1 with monocuspid outer distal corner of second endopodal segment, but that of legs 2-4 bicuspid. Leg 1 lacking inner seta on coxa; inner distal corner of basis with spinules; distal spine 16 μm long; outer spines on exopod usually tipped with setule. Terminal spine on exopods of legs 2-4 curved outwards. Distal seta on third endopodal segment of leg 3 short and rod-shaped. Armature formula for legs 1-4 as follows:

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

Leg 5 (Fig. 23A) consisting of free protopod and exopod. Protopod 59 × 84 μm and armed with 1 outer and 1 minute inner setae. Exopod 108 × 50 μm, 2.16 times as long as wide, gradually narrowed distally, and armed with 3 small setae (2 distal and 1 subdistal). Leg 6 represented by 2 setae and 1 spine in genital area (Fig. 23B).

Male. Body (Fig. 23C) resembling that of female. Body length 825 μm. Prosome 524 μm long. Cephalothorax 309 × 269 μm. Urosome (Fig. 23D) 5-segmented. Fifth pedigerous somite 107 μm wide, much narrower than genital somite. Genital somite 121 × 156 μm. Three abdominal somites 43 × 67, 36 × 58, and 35 × 55 μm, respectively. Caudal ramus 19 × 19 μm.

Rostrum as in female. Antennule (Fig. 23E) 299 μm long, 16-segmented, with geniculation between 14th and 15th segments; armature formula 1, 2 + aesthetasc, 1, 2 + aesthetasc, 2 / 2, 2, 2, 5, 2 + aesthetasc / 4 + aesthetasc, 2, 2 + aesthetasc, 2, 3 + aesthetasc, and 11. Articulation incomplete between third and fourth segments. Eleventh segment with 2 transverse rows of spinules on posterior side. All of setae small and naked. Antenna as in female.

Oral siphon, mandible, maxillule, maxilla as in female. Maxilliped with 1 blunt, proximal process on inner margin of basis.

Leg 1 as in female. Leg 2 endopod (Fig. 23G) with 3 distal dentiform processes on terminal segment (Fig. 23G). Leg 3 endopod (Fig. 23H) with 1 large dentiform process at outer distal corner of second segment and wrinkles on ventral surface of same segment; third segment with curved, large terminal process and armed with 1 outer seta, 1 stout terminal spine, and 3 inner setae (armature formula 1, I, 3). Leg 4 as in female.

Leg 5 (Fig. 23I) consisting of free protopod and exopod; protopod 29 × 67 μm, much wider than long, with

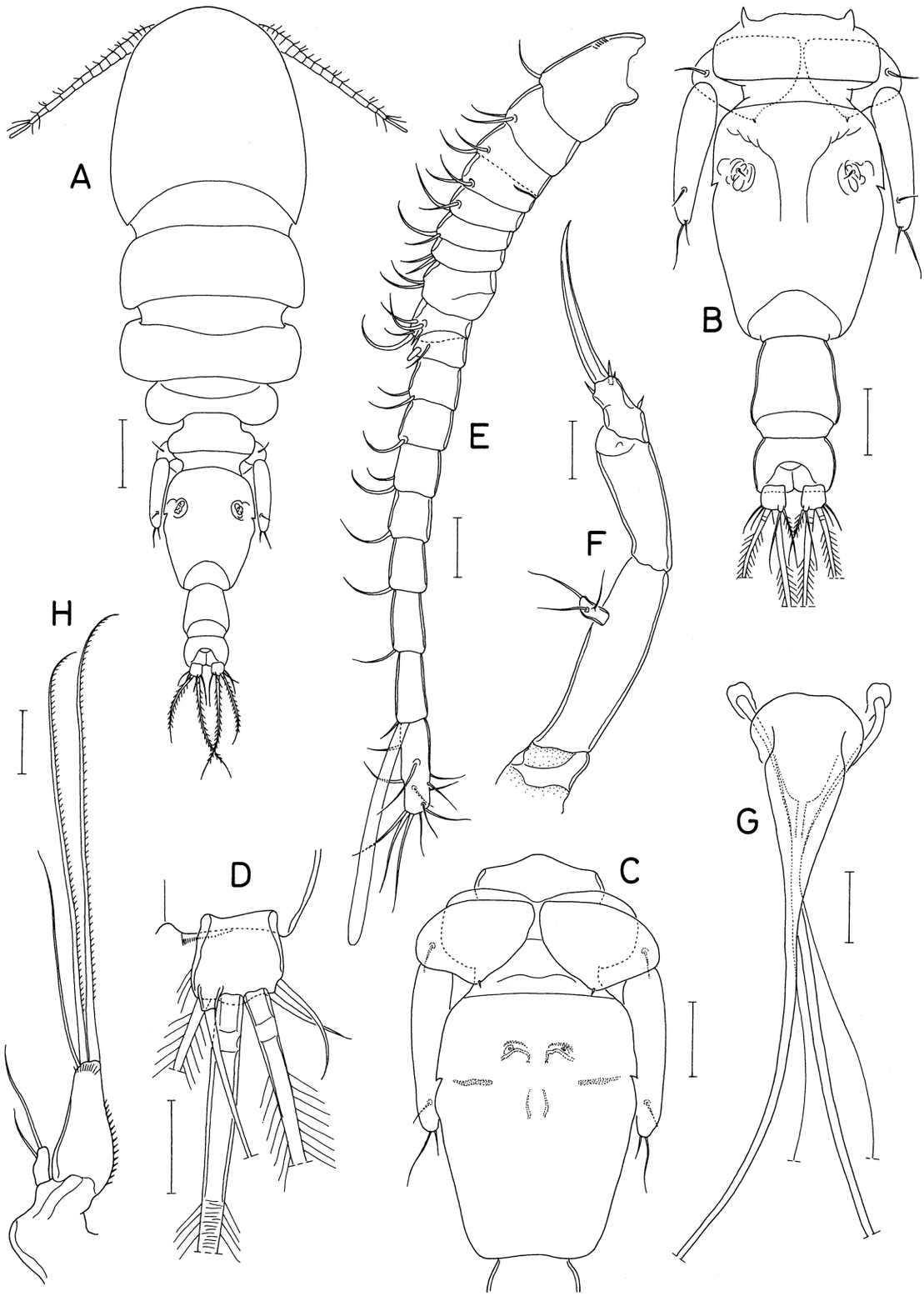

Fig. 21. *Scottocheres mipoensis* n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, first 2 urosomal somites, ventral; D, right caudal ramus, dorsal; E, antennule; F, antenna; G, oral siphon and mandible; H, maxillule. Scale bars: A, 0.1 mm; B, C, G, 0.05 mm; D-F, H, 0.02 mm.

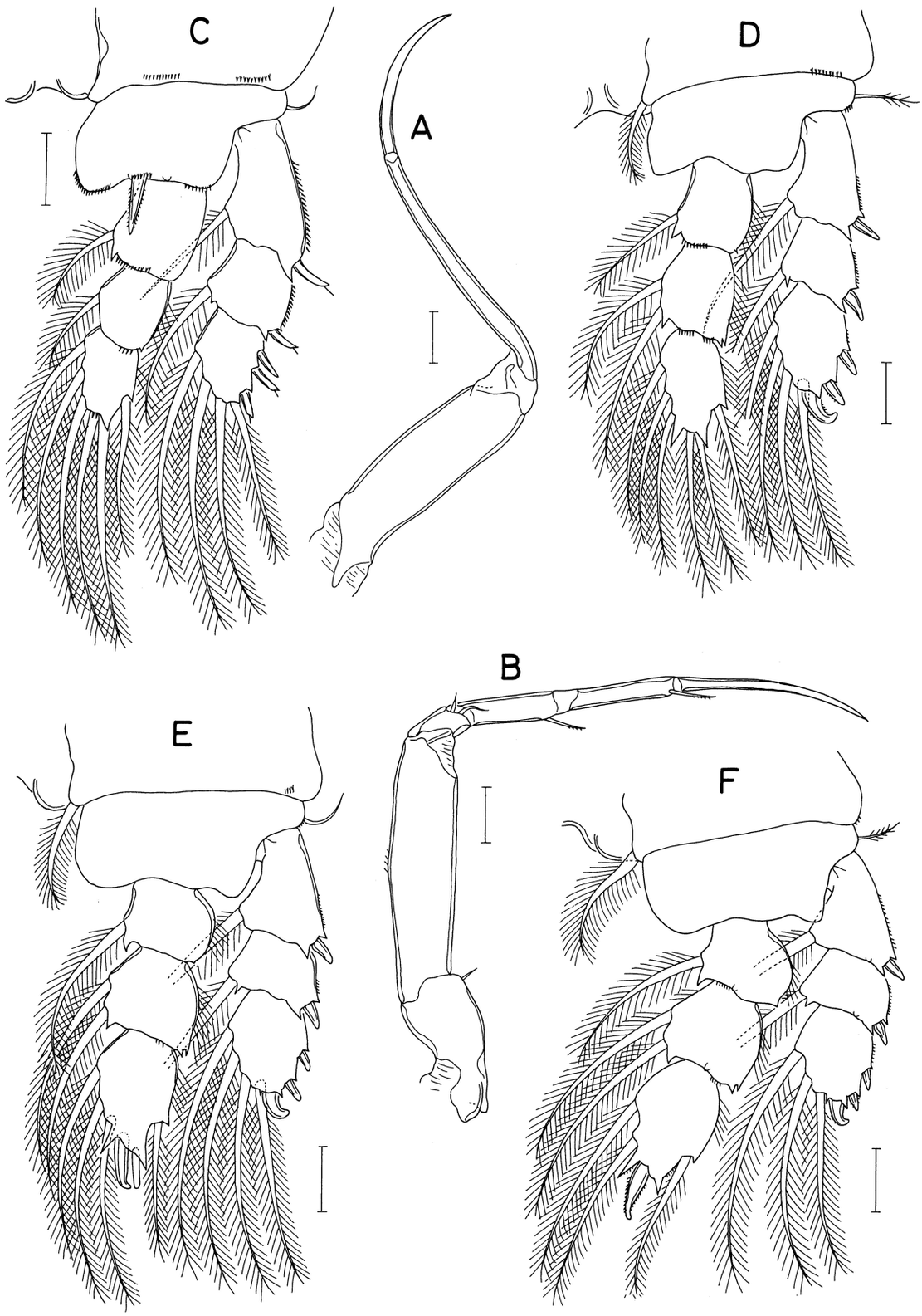

Fig. 22. *Scottocheres mipoensis* n. sp., female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, leg 3; F, leg 4. Scale bars: 0.02 mm.

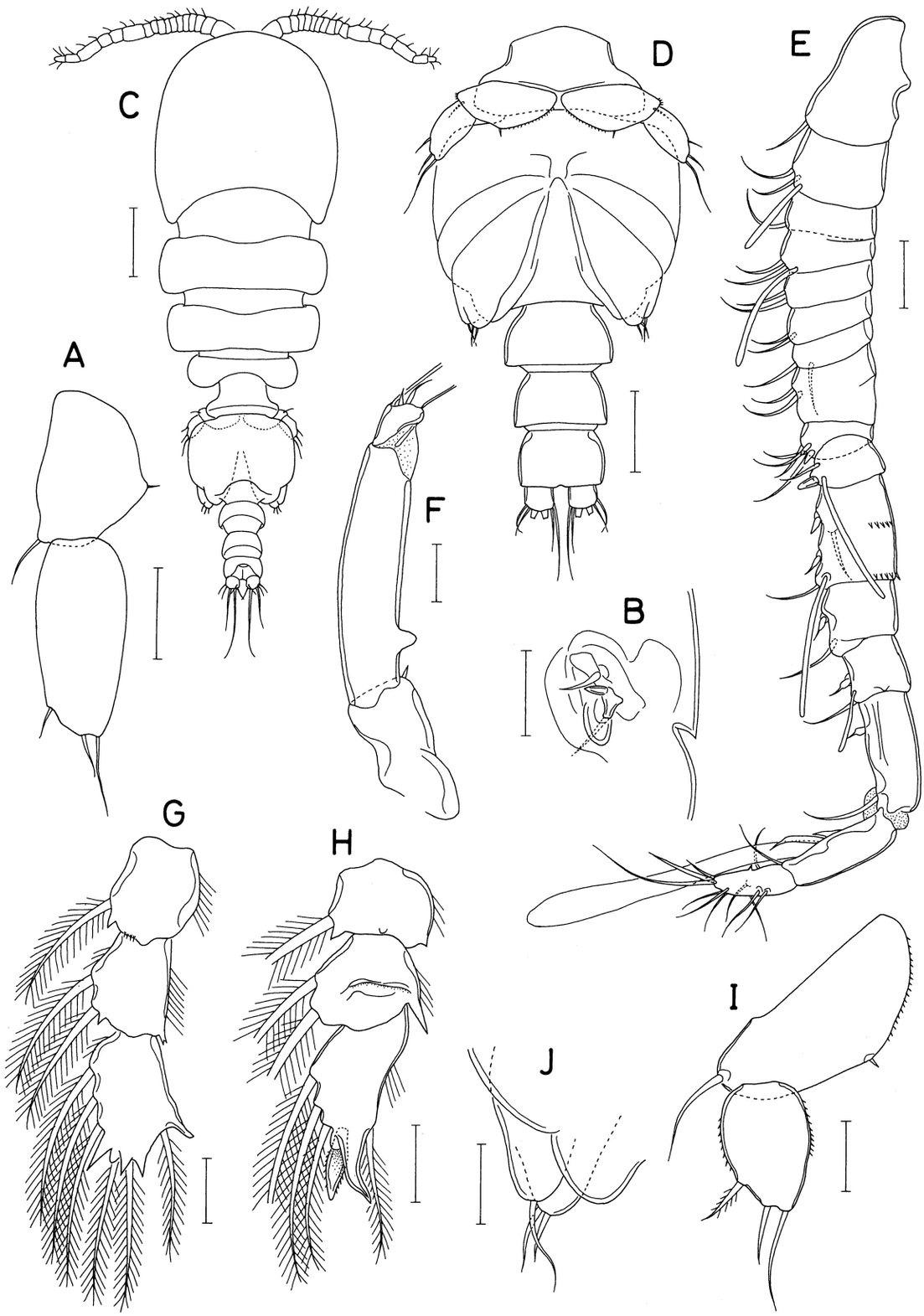

Fig. 23. *Scottocheres mipoensis* n. sp. Female: A, leg 5; B, genital aperture. Male: C, habitus, dorsal; D, urosome, ventral; E, antennule; F, proximal part of maxilliped; G, leg 2 endoped; H, leg 3 endopod; I, leg 5; J, leg 6. Scale bars: A, D, 0.05 mm; B, E-J, 0.05 mm; C, 0.1 mm.

fine spinules along inner part of distal margin; exopod sub-oval, 36 × 25 μm, with fine spinules on both margins and armed with 1 plumose subdistal and 2 naked distal setae. Leg 6 (Fig. 23J) represented by 2 lobes tipped by 1 and 2 naked setae, respectively, on genital operculum.

Etymology. The type locality of the new species, Mipo in Pusan, is taken for the name of the species.

Remarks. Eight known species of *Scottocheres* show variabilities with species in the armatures of the third exopodal segment of leg 1 and the third exopodal and endopodal segments of legs 2-4. *Scottocheres mipoensis* n. sp. share a same armature formula of legs 1-4 with only one congener, *S. laubieri* Stock, 1969. In these two species, the armature formula of the third exopodal segments of legs 2-4 are II, I, 4; II, I, 4; II, I, 4; and II, I, 3, respectively, and those of the third endopodal segments of legs 1-4 are 1, 2, 3; 1, 2, 3; 1, 1 + I, 3; and 1, I, 2, respectively.

Scottocheres laubieri has, as originally described by Stock (1967), the following features, unlike *S. mipoensis* n. sp.: (1) the antennule is 17-segmented (vs. 18-segmented in *S. mipoensis*) in the female and 15-segmented (vs. 16-segmented) in the male; (2) the outer lobe of the maxillule with 2 distal setae (vs. 3 distal setae); (3) the exopod of leg 5 in the female is less than twice as long as wide (vs. more than twice as long as wide); (4) spines on the exopods of legs 2-4 are large (vs. small); and (5) the third endopodal segment of leg 3 in the male with 2 dentiform distal process (vs. 1 large distal process) and the terminal spine on the same segment is elongate (vs. stout).

Genus *Asteropontoides* Stock, 1975

***Asteropontoides acutirostris* n. sp. (Figs. 24-26)**

Material examined. One ♀ and 2♂♂ from washings of invertebrates on the sandy bottom in the depth of 25 m, Dogdo Island, 24 August 2016, collected by J.M. Lee.

Holotype (♀, NIBRIV0000681228) and allotype (♂, NIBRIV0000681229), both intact, will be deposited in NIBR, Incheon, Korea. Dissected paratype (1♂) is retained in the collection of the author.

Other material examined. One ♀ from washings of invertebrates from a soft bottom, in the depth of 82 m, East China Sea (32°00′N, 126°00′E), 02 June 2015, collected by J.M. Lee; 1♀ (dissected and figured), from washings of invertebrates from a soft bottom, in the depth of 30 m, South of Geoje Island, 34°25′N, 128°30′E, Korea Strait, 08 June 2015, collected by J.M. Lee. Holotype has been deposited in NIBR, Incheon, Korea. Dissected paratype is retained in the collection of the author.

Female. Body (Fig. 24A) narrow, 1.03 mm long, with dorsal surface covered by numerous minute spinules (Fig. 24C). Prosome fusiform, 673 μm long. Cephalothorax 414 × 298 μm, slightly longer than wide, with acutely pointed posterolateral corners. Second and third pedigerous somites also with pointed posterolateral corners. Fourth pedigerous somite with deeply concave posterior margin, with rounded posterolateral corners. Urosome (Fig. 24B) 4-segmented. Fifth pedigerous somite 118 μm wide. Genital double-somite 136 × 104 μm, consisting of wider anterior half and narrower posterior half (69 μm wide in this region); genital aperutres located dorsally near anterior third of double-somite. Two abdominal somites 64 × 64 and 49 × 61 μm, respectively. Anal somite with row of spinules along posterodorsal and posteroventral margins; anal region large (Fig. 24C). Caudal rami slightly divergent (Fig. 24C); each ramus 64 × 27 μm, 2.37 times as long as wide, with parallel lateral margins, and armed with 4 distal and 2 dorsal, subdistal setae; outer dorsal seta (seta II) naked, but other 5 setae plumose; distal margin of ramus finely spinulose and inner margin setulose on distal half.

Rostrum (Fig. 24D) tapering, longer than wide, with acutely pointed distal apex, and minute setule at proximal third of lateral margin. Antennule (Fig. 24E) 405 μm long and 20-segmented; armature formula 1, 2, 2, 2, 2 / 2, 2, 2, 7, 2 / 2, 2, 2, 2, 2, / 2, 2, 1 + aesthetasc, 6, and 8; 2 setae on second segment plumose, other setae naked; aesthetasc on antepenultimate segment large, 235 μm long, more than half as long as antennule, and as broad as penultimate segment. Antenna (Fig. 24F) slender; coxa short and unarmed; basis also unarmed, but with fine spinules on margins. Exopod small, 16 × 8 μm, armed with 3 setae. Endopod 3-segmented; first segment 97 μm long, unarmed; small second segment with 1 seta; third segment with 3 small setae and terminated by thin, elongate, spiniform claw of 160 μm long.

Oral siphon (Fig. 24G) 329 μm long, styliform, and extending slightly beyond intercoxal plate of legs 1. Mandible (Fig. 24H) consisting of stylet and 1-segmented palp; stylet articulated at proximal third, with 10 fine teeth distally; palp 27 × 8 μm, with circle of setules near middle and tipped by 2 plumose setae of unequal length. Maxillule (Fig. 24I) bilobed; inner lobe slightly longer than outer lobe, with 4 apical setae, including 1 minute one; outer lobe also with 4 apical setae, smallest one of which being plumose. Maxilla (Fig. 25A) slender and 2-segmented; syncoxa unarmed, but with 1 flexible tube proximally and numerous, minute spinules on inner surface; basis arched, thin, and elongate, with 1 seta in middle and tipped by thin terminal claw. Maxilliped (Fig. 25B) also slender, 5-segmented; syncoxa with 1 inner seta subdistally; basis 128 μm long, with parallel margins, setulose outer margin and fine spinules near middle of inner margin; endopod elongate, with 2, 2, and 1 setae on first to third segments, respectively; lengths of

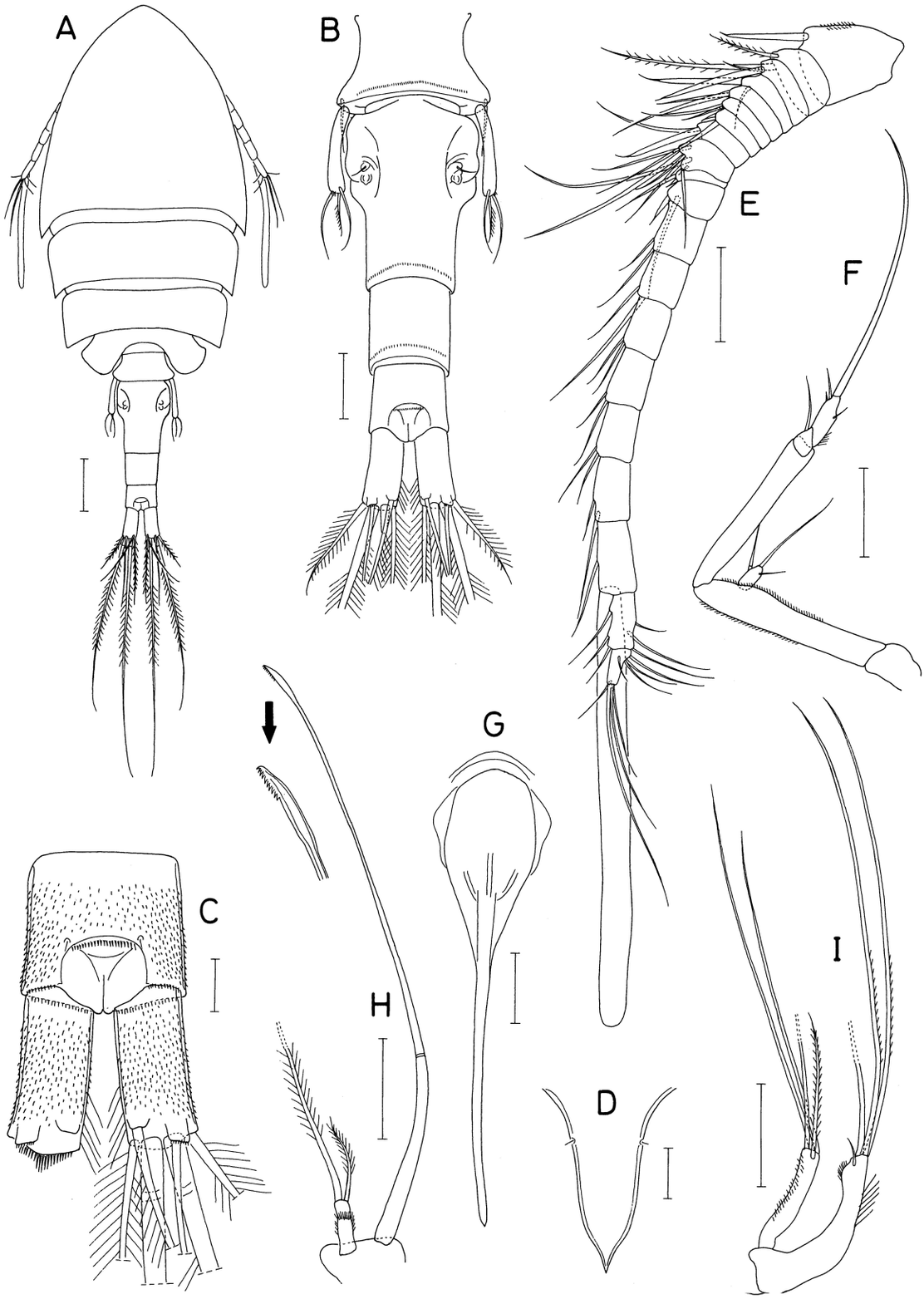

Fig. 24. *Asteropontoides acutirostris* n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, anal somite and caudal rami, dorsal; D, rostrum; E, antennule; F, antenna; G, oral siphon; H, mandible; I, maxillule. Scale bars: A, 0.1 mm; B, E-I, 0.05 mm; C, D, 0.02 mm.

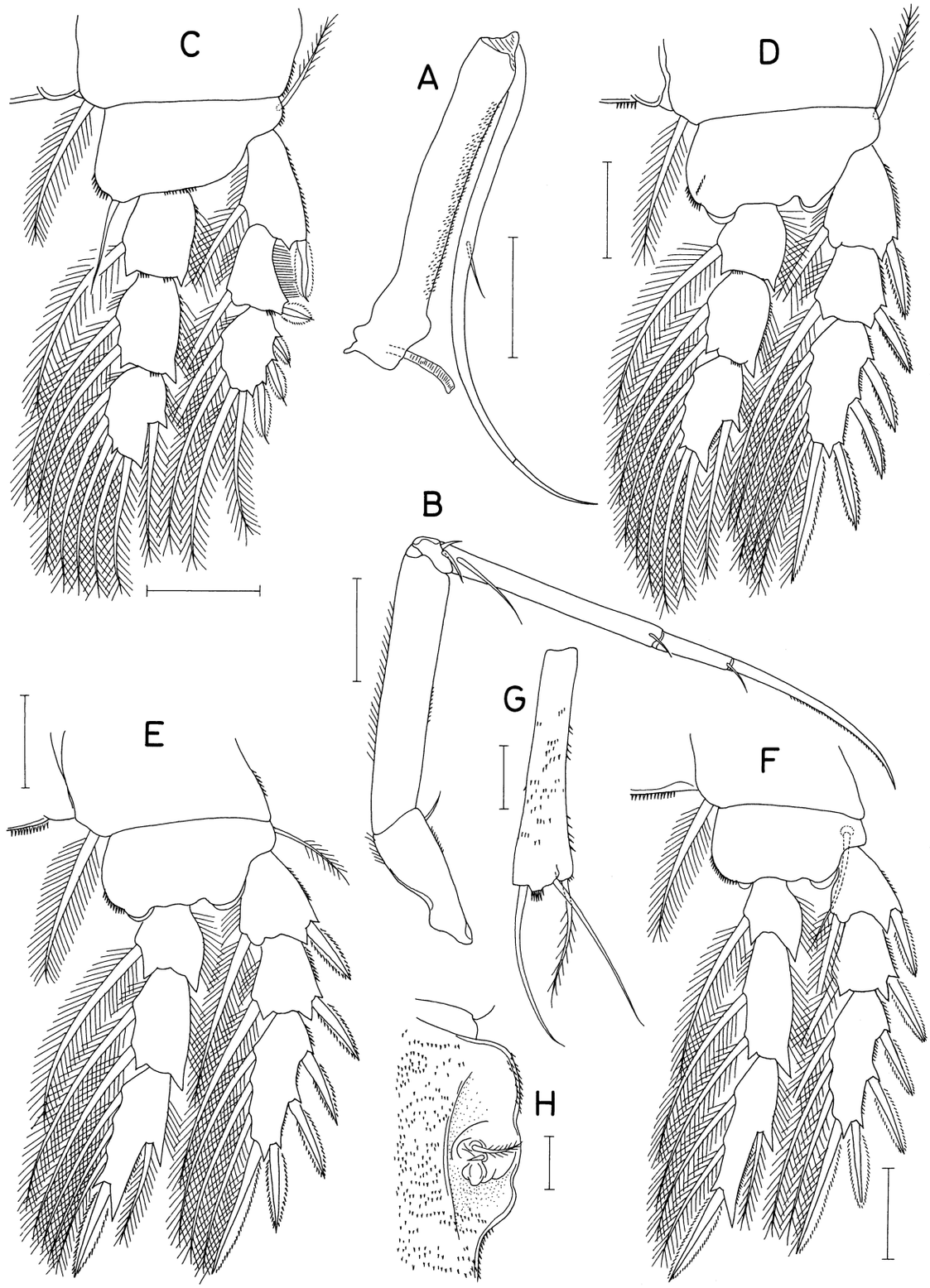

Fig. 25. *Asteropontoides acutirostris* n. sp., female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, leg 3; F, leg 4; G, leg 5 exopod; H, right side of genital double-somite, dorsal. Scale bars: A-F, 0.05 mm; G, H, 0.02 mm.

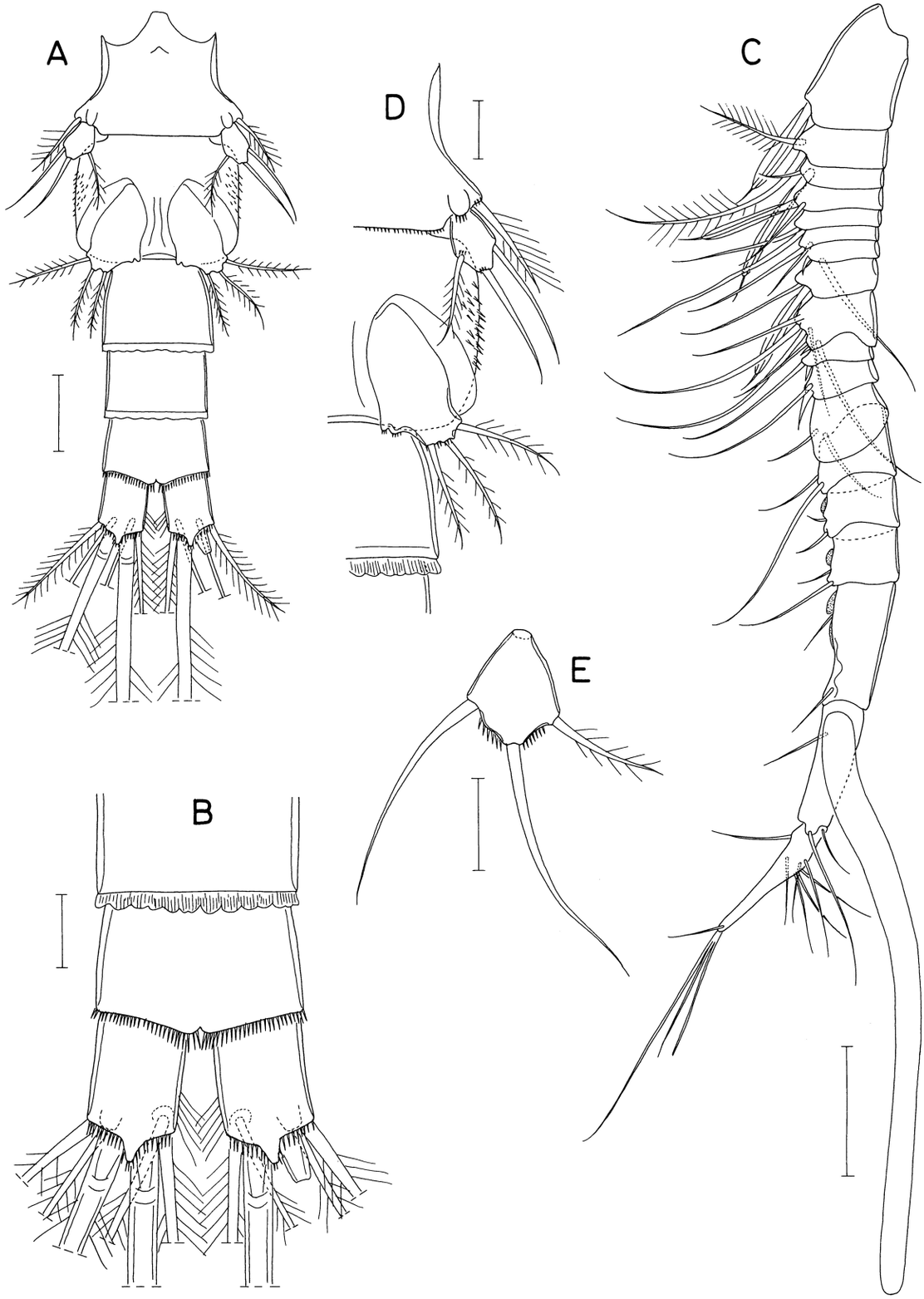

Fig. 26. *Asteropontoides acutirostris* n. sp., female. A, urosome, ventral; B, anal somite and caudal rami, ventral; C, antennule; D, left legs 5 and 6, ventral; E, exopod of leg 5. Scale bars: A, C, 0.05 mm; B, D, E, 0.02 mm.

these segments 10, 110, and 37 μm, respectively; terminal claw 103 μm long, about 2.8 times as long as terminal segment, weakly curved, with fine spinules along concave margin.

Armature formula for legs 1-4 as follows:

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

Legs 1-3 (Fig. 25C-E) with 3-segmented rami. Leg 4 (Fig. 25F) with 3-segmented endopod and probably with 3-segmented exopod (distal segments not observed due to their damage). Distal margin of intercoxal plate of leg 1 smooth, but that of legs 2-4 spinulose. Inner distal corner of basis of legs 1-4 with row of spinules. Inner distal seta on basis of leg 1 naked. Outer margin of second exopodal segment concave, with row of long setules. Legs 2-4 with membranes on distal margin of basis at place medial to base of endopod and between bases of rami. Inner seta on coxa of legs 1-4 well-developed and plumose.

Leg 5 represented by lateral seta on fifth pedigerous somite and free exopod; exopod (Fig. 25G) elongate, 76 × 18 μm, gradually broadened distally with scattered minute spinules on surfaces, and distally armed with 3 setae, one of which being plumose, and with tuft small spinules on distal margin. Leg 6 represented by 1 small naked seta and 1 longer, plumose seta in genital aperture (Fig. 25H).

Male. Body 0.79 mm long. Prosome similar to that of female. Urosome (Fig. 26A) 5-segmented. Fifth pedigerous somite 93 μm wide, with small, spinules-tipped lamella at ventrolateral region, near base of leg 5 exopod (Fig. 26D). Genital somite 76 × 91 μm, nearly quadrangular, with fine spinules on lateral surface. Three abdominal somites 45 × 61, 38 × 56, and 36 × 58 μm, respectively. First and second abdominal somites with membranous fringe along ventrodistal margin. Anal somite with (Fig. 26B) with row of spinules along ventrodistal margin. Caidal ramus 34 × 25 μm, 1.36 times as long as wide, with tapering process and spinules on ventrodistal margin.

Rostrum as in female. Antennule (Fig. 26C) 18-segmented, geniculate between antepenultimate and penultimate segments; armature formula I, 2, I + 1, I + 1, 2, 2, 2, I + 1, 7, 2, 2, 2, 2, 2, 2, 2, 2 + aesthetasc, and 11 + aesthetasc; first, third, fourth, eighth segments each armed with 1 compound spine (bilaterally membranous and tipped by setule) and 1 seta; aesthetasc on penultimate segment large; terminal segment slender and tapering, its distal aesthetasc setiform, Antenna as in female.

Mouthparts and legs 1-4 as in female. Leg 5 (Fig. 26D) consisting of 1 plumose lateral seta on fifth pedigerous somite and free exopod; exopod (Fig. 26E) rhomboidal, 24 × 21 μm, slightly longer than wide, armed with 3 setae (inner one smallest and plumose; outer and distal one naked) and with spinules on distal margin. Leg 6 (Fig. 26D) represented by 3 similar plumose setae on distal margin of genital operculum.

Etymology. The specific name *acutirostris* is a combination of Latin words *acut* (= sharp point) and *rostr* (= snout). It alludes to the sharply pointed rostrum of the new species.

Remarks. At present, the genus *Asteropontoides* Stock, 1975 contains three known species: *A. attenuatus* (Thompson and Scott, 1903) and *A. nicobaricus* (Sewell, 1949) from the Indian Ocean and *A. elephantinus* Johnsson, 1998 from the Brazilian coast.

Asteropontoides acutirostris n. sp. can easily be distinguished from *A. elephantinus* and *A. nicobaricus*, because the caudal ramus of the latter two species is wider than long, 10 × 21 μm measured by Johnsson (1998) for *A. elephantinus* and 1.25 times as wide as long in *A. nicobaricus* (see Sewell, 1949). In *A. attenuatus* the antennule is 18-segmented in the female, the exopod of leg 5 is about 6 times as long as wide, the expanded anterior part of the genital double-somite of the female is roundly convex, seen from the illustration of Thompson and A. Scott (1903), and the outer lobe of the maxillule is armed distally with 3 setae. Therefore, *A. attenuatus* is not conspecific with *A. acutirostris* n. sp.

Stock (1975) established the genus *Asteropontoides* on the basis of two incompletely described species, *A. attenuatus* and *A. nicobaricus*. With the addition of *A. elephantinus* and the new species, this genus may be characterized anew as follows, based on the female: (1) the body is narrow, with 4-segmented urosome; (2) the antennule is 15-20-segmented; (3) antenna, maxilla, and maxilliped are slender; (4) the oral siphon is elongate, extending over insertions of legs; (5) the mandibular stylet is thin and 2-segmented and the palp is 1-segmented, with 2 distal setae; (6) the outer lobe of maxillule is more than half as long as the inner lobe; (7) the second exopodal segment of leg 1 with concave outer margin; (8) the armature formulae of the third exopodal and endopodal segments of leg 4 are III, I, 3 and 1, I, 2, respectively; (9) leg 4 with a well-developed inner seta on the coxa; and (10) the exopod of leg 5 is elongated, more than 4 times as long as wide.

Callomyzon n. gen.

Diagnosis. Body with thick exoskeleton, swollen cephalothorax and small urosome. Urosome 4-segmented in female and 5-segmented in male. Caudal ramus with 6

setae. Rostrum absent. Antennule of female 21-segmented; first segment with 1 seta; eighteenth segment with aesthetasc. Antennule of male 18-segmented, with geniculation between antepenultimate and penultimate segments. Antenna with small exopod bearing 3 setae; endopod 3-segmented, terminal segment with stout claw. Oral cone extending to insertions of maxilliped. Mandibular stylet with denticles distally. Mandibular palp 2-segmented, with 2 unequal distal setae; palp plus longer distal seta longer than stylet. Maxillule with 5 setae on inner lobe and 4 setae on outer lobe. Maxilla comprising syncoxa and claw-like basis. Maxilliped 6-segmented. Legs 1-4 with 3-segmented exopod and endopod; coxa of these legs without inner seta. Basis with 1 outer and 1 inner distal setae in leg 1, but only with outer setae in legs 2-4. First and second exopodal segments of legs 1-4 with 1 outer spine and 1 inner seta each. First and second endopodal segments of legs 1-4 with 1 and 2 inner setae, respectively. Armature formula for third exopodal segment in legs 1-4: III, 2, 2; III, I, 4; III, I, 4; and III, I, 3, respectively. Armature formula being 1, 2, 3 for third endopodal segment in legs 1-3, that of leg 4 being 0, 2, 1. No sexual dimorphism in legs 1-4. Leg 5 exopod small, with 3 setae.

Type species. *Callomyzon macrocephalus* n. sp.

Etymology. The generic name *Callomyzon* is a combination of Greek *Callo* (=thick-skinned) and *myzo* (to suck in), alluding to the thick exoskeleton of the new genus. Gender is neuter.

Remarks. In the genera of the Asterocheridae having 3-segmented rami in legs 1-4, the basic number of armature elements on the third endopodal segment is 6 in legs 1-3 and 5 in leg 4. The compositions of armature elements on these terminal endopodal segments are 6 setae (formula 1, 2, 3) in legs 1 and 2, 5 setae plus 1 spine (formula 1, 1+I, 3) in leg 3, and 4 setae plus 1 spine (formula 1, 1+I, 2) in leg 4. This armature condition is displayed by the type genus *Asterocheres* and many other genera in the family. In the case of leg 3 armature, very few genera deviate from this generality. Having six setae (formula 1, 2, 3) without a spine, as in *Callomyzon* n. gen., on the third endopodal segment is displayed only by two known genera: *Tychomyzon* Humes, 1991 and *Asterocheroides* Malt, 1991.

Callomyzon n. gen. cannot be united with any of these two genera due to the significant differences from them, as follows. In *Tychomyzon* the antennule is 18-segmented in the female (vs. 21-segmented in *Callomyzon* n. gen), the mandible is *Asteropontius*-type with 1-segmented palp tipped by 1 seta (vs. 2-segmented palp tipped by 2 setae in *Callomyzon* n. gen.), the third exopodal segment of leg 4 is armed with 4 spines and 4 setae (formula III, I, 4; vs. III, I, 3 in *Callomyzon*), and the second endopodal segment of leg 1 is armed only with 1 inner seta (Humes, 1991; vs. armed with 2 setae in *Callomyzon*). In *Asterocheroides* the mandibular palp is 1-segmented, the third exopodal segment of leg 1 is armed with 2 spines and 4 setae (formula II, 4; not III, 4 as in *Callomyzon*), the third exopodal segments of legs 2-4 are armed with 3 spines and 4 setae (formula II, I, 4; not III, I, 4 or III, I, 3 as in *Callomyzon*), the first exopodal segment of leg 1 lacks an inner seta, and the first endopodal segment of leg 4 lacks an outer spine (Malt, 1991).

Callomyzon macrocephalus n. sp. (Figs. 27-29)

Material examined. Seven ♀♀ 6♂♂ from a sponge epibiotic on the scallop *Azumapecten farreri* (Jones and Preston, 1904), at Nogok (37°12′02″N, 129°20′38″E) in Samcheok, Gangwon-do, 01 July 2008. Holotype (♀, NIBRIV0000216720), allotype (♂, NIBRIV0000216721), and paratypes (4♀♀, 4♂♂, NIBRIV0000216722) have been deposited in NIBR, Incheon, Korea. Dissected paratypes (2♀♀, 1♂) are retained in the collection of the author.

Female. Body (Fig. 27A) with thick exoskeleton, relatively large prosome and small urosome. Body length 960 μm in dissected largest specimen. Prosome crouched and consisting of cephalothorax and 3 metasomites. Cephalothorax markedly swollen, 513×618 μm, much wider than metasomites, with rounded posterolateral corners. Second pedigerous somite (first metasomite) 109×425 μm, rectangular. Third and fourth pedigerous somites 342 and 228 μm wide, respectively, mostly concealed by preceding somites in dorsal view. Fourth pedigerous somite with angular posterolateral corners. Urosome (Fig. 27B) 4-segmented. Fifth pedigerous somite 127 μm wide. Genital double-somite 125×162 μm, with tapering posterolateral corners and with roundly convex anterior part of lateral margins and weakly convex posterior part of lateral margins (140 μm wide across posterior part); genital area located dorsally at anterior third. First abdominal somite 58×69, with convex lateral margins. Anal somite 54×48 μm, distinctly narrower than first abdominal somite. Caudal rami small, close to each other, and directed backwards straightly; each ramus 23×18 μm, 1.28 times as long as wide, ornamented with fine spinules along posteroventral margin, and armed with 6 setae; 2 dorsal setae slender but characteristically longer than other setae; inner distal seta (seta VI) naked and other setae plumose; 2 mid-terminal setae (setae IV and V) not lengthened.

Rostrum absent (Fig. 27J). Antennule (Fig. 27D) 397 μm long and 21-segmented; first segment with setules on anterior surface; armature formula 1, 2, 2, 2, 2 / 2, 2, 2, 7, 2 / 2, 2, 2, 2, 2 / 2, 2, 2+aesthetasc, 2, 4, and 7; all of setae naked, larger ones of them multiply annulated. Antenna (Fig. 27E) with short, unarmed syncoxa; basis

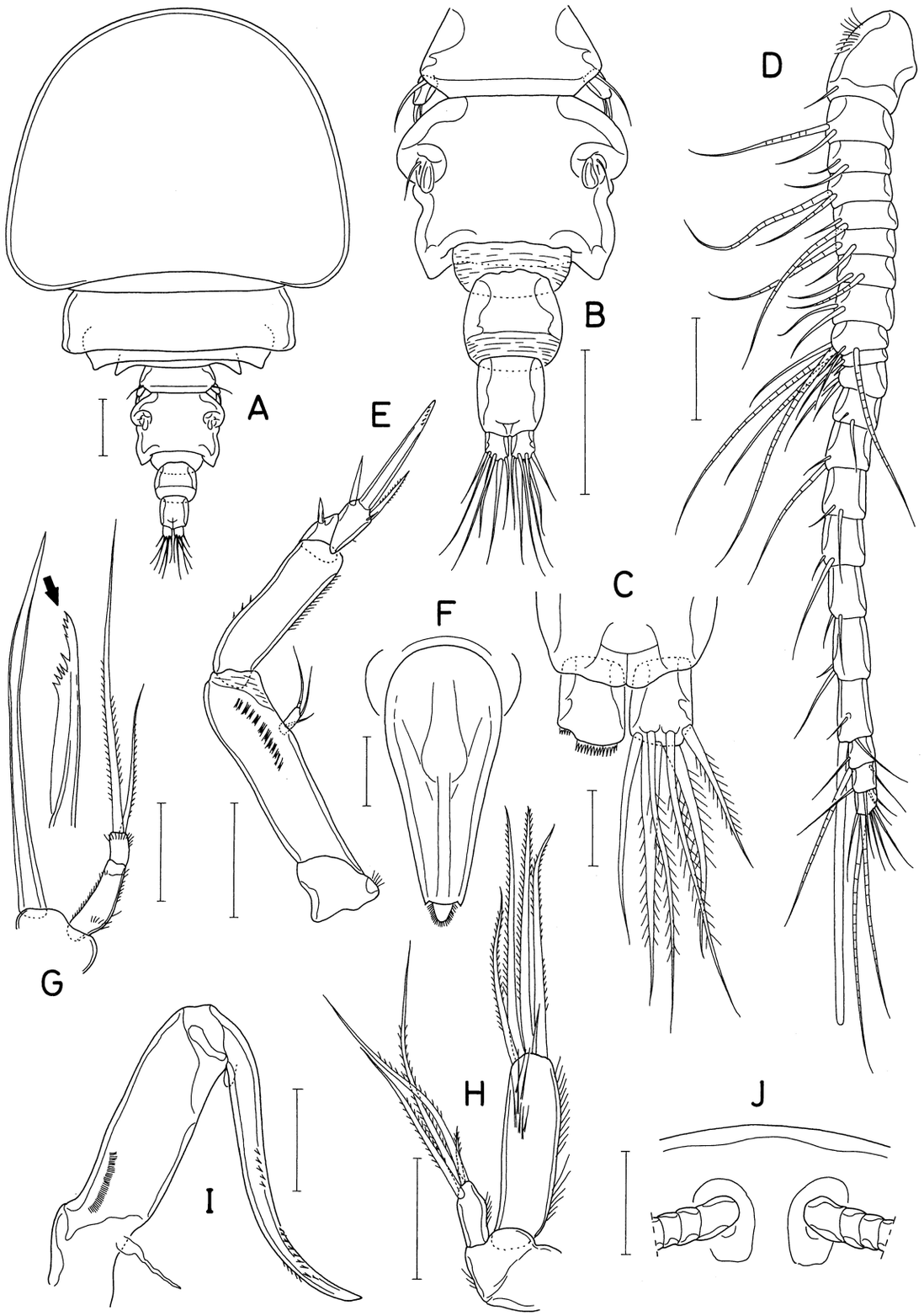

Fig. 27. *Callomyzon macrocephalus* n. gen. n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, caudal rami, dorsal; D, antennule; E, antenna; F, oral cone; G, mandible; H, maxillule; I, maxilla; J, rostral area, ventral. Scale bars: A, B, J, 0.1 mm; C, 0.02 mm; D-I, 0.05 mm.

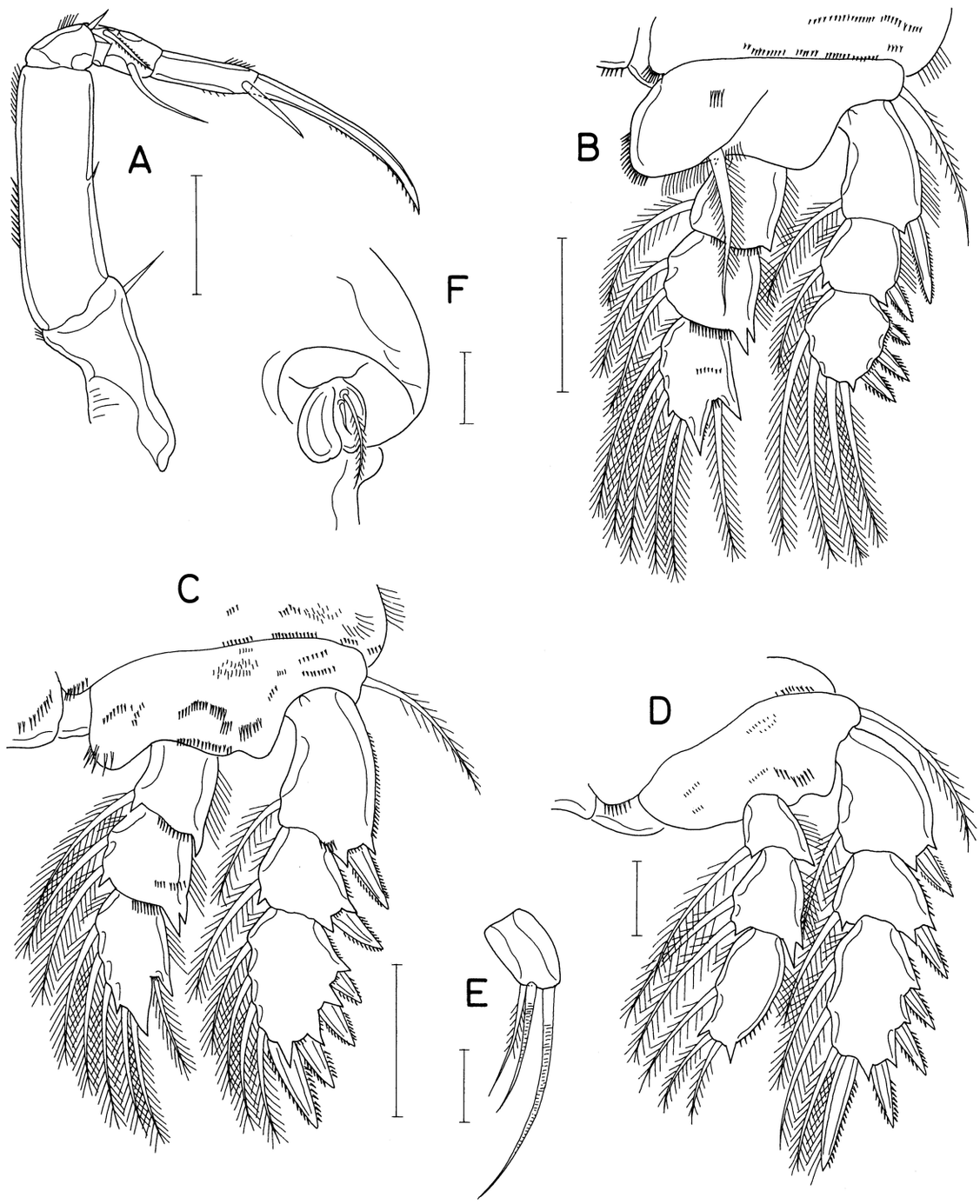

Fig. 28. *Callomyzon macrocephalus* n. gen. n. sp., female. A, maxilliped; B, leg 1; C, leg 2; D, leg 4; E, leg 5 exopod; F, right genital aperture. Scale bars: A-C, 0.05 mm; D-F, 0.02 mm.

87 μm long, ornamented with longitudinal row of minute pectens in distal half. Exopod small, 15 × 5 μm, with 2 distal and 1 lateral, small setae. Endopod 3-segmented; first segment 73 μm long, with setules or spinules on margins; small second segment with 1 spiniform seta; third segment with 2 setae and terminal, spiniform claw

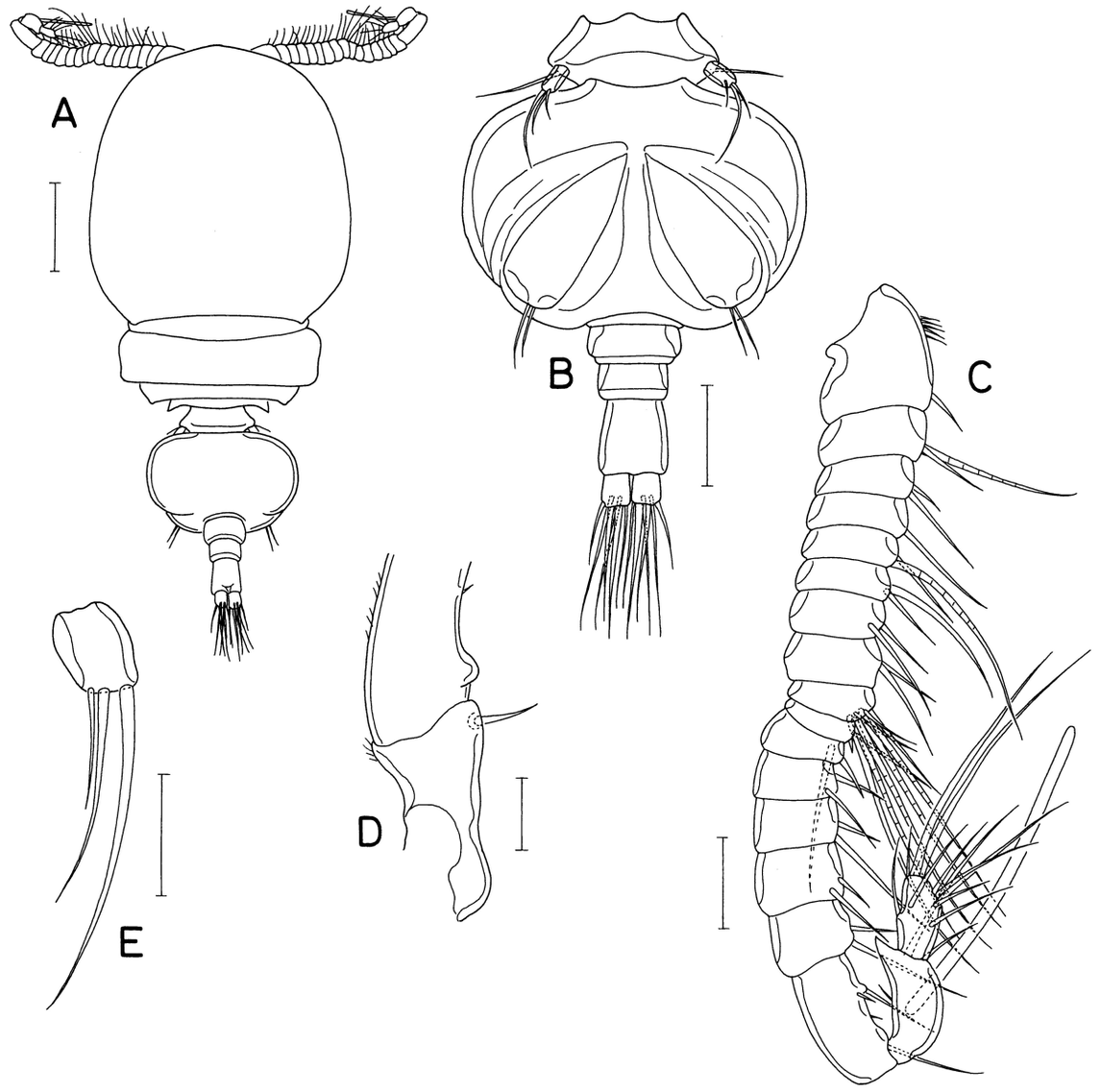

Fig. 29. *Callomyzon macrocephalus* n. gen. n. sp., male. A, habitus, dorsal; B, urosome, ventral; C, antennule; D, proximal part of maxilliped; E, leg 5 exopod. Scale bars: A, 0.1 mm; B, 0.05 mm; C-E, 0.02 mm.

of 56 μm long.

Oral cone (Fig. 27F) evenly tapering, 225 μm long, 87 μm in greatest width near base, terminated by linguiform, setulose lamella, and extending to base of maxilliped. Mandible (Fig. 27G) consisting of stylet and palp. Stylet 192 μm long, its distal part needle-like, but denticulated in different viewing angle (Fig. 27G). Palp 2-segmented; first segment 44 μm long; second segment 15 μm long, with 2 distal setae of 156 and 77 μm long, respectively. Maxillule (Fig. 26H) bilobed; inner lobe 81 μm long, with 5 setae distally; lengths of these 5 setae 104, 103, 99, 75, and 21 μm, respectively; outer lobe 26 μm long, with 4 setae distally; lengths of 4 setae on outer lobe 106, 100, 78, and 23 μm long, respectively. Maxilla (Fig. 27I) 2-segmented; syncoxa with flexible gland tube proximally and ornamented with longitudinal row of minute spinules proximally; basis forming weakly curved claw bearing rows of spinules. Maxilliped (Fig. 28A) 6-segmented; syncoxa with 1 stiff, needle-like seta at inner distal corner; basis 123 × 34 μm, with 1 minute seta at halfway of inner margin and row of spinules on outer margin; armature formula for 4-segmented endo-

pod 2, 1, 1, and 1 + claw; terminal segment 42 μm long; terminal claw 92 μm long, more than twice as long as terminal segment, with fine spinules on concave margin.

Legs 1-4 with 3-segmented rami; armature formula 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
Legs 2 & 3:	0-0	1-0	I-1; I-1; III, I, 4	0-1; 0-2; 1, 2, 3
Leg 4:	0-0	1-0	I-1; I-1; III, I, 3	0-1; 0-2; 0, 2, 1

Coxa of legs 1-4 without inner seta. Inner distal corner of basis of legs 1-3 spinulose, but that of leg 4 naked. Second endopodal segment of legs 1-4 with bicuspid outer distal corner (Fig. 28B-D). Outer spine on first exopodal segment of leg 1 28 μm long. Ventral surface of basis of legs 2-4 with several rows of minute spinules.

Leg 5 represented by dorsolateral seta on fifth pedigerous somite and free exopod; exopod (Fig. 28E) small, 23 × 14 μm, armed with 3 distal setae (62, 36, and 31 μm long from outer to inner ones), shortest innermost one of them being plumose. Leg 6 represented by 2 small setae in genital aperture, longer one of them being plumose (Fig. 28F).

Male. Body (Fig. 29A) smaller and narrower than that of female. Body length 647 μm. Cephalothorax 323 × 302 μm, slightly longer than wide. Three metasomites 235, 185, and 118 μm wide, respectively. Urosome (Fig. 29B) 5-segmented. Fifth pedigerous somite 85 μm wide. Genital somite sub-circular, 120 × 172 μm, distinctly wider than long. Three abdominal somites 20 × 48, 18 × 36, and 38 × 35 μm, respectively. Anal somite as long as combined 2 preceding somites. Caudal ramus 18 × 14 μm, 1.29 times as long as wide.

Rostrum absent as in female. Antennule (Fig. 29C) 270 μm long, 18-segmented, and geniculate between antepenultimate and penultimate segments; armature formula 1, 2, 2, 1, 2 / 2, 2, 2, 8, 2 / 2, 2, 2, 2, 2 / 4, 3 + aesthetasc, and 10; penultimate segment with pointed process at anterodistal corner. Antenna as in female.

Oral cone, mandible, maxillule, and maxilla as in female. Maxilliped with 1 blunt process proximally on inner margin (Fig. 29D).

Legs 1-4 as in female. Leg 5 exopod (Fig. 29E) 15 × 12 μm, distally armed with 3 naked, unequal setae, longest one of which being 56 μm long. Leg 6 represented by 2 subequal setae tipped on genital operculum (Fig. 29B).

Etymology. The specific name *macrocephalus* is a combination of Greek *macro* (= large) and *cephal* (= the head). It alludes to the large cephalothorax of the new species.

Remarks. In one of four observed samples of leg 4, the third exopodal segment of leg 4 is armed with 4 spines and 2 inner setae (formula III, I, 2) and the third endopodal segment of the same leg is armed with 4 setae (formula 1, 2, 1). These setations are considered to be variations.

Family Cancerillidae Giesbrecht, 1897
Genus *Parartotrogus* T. and A. Scott, 1893

***Parartotrogus arcticus* T. and A. Scott, 1901 (Figs. 30, 31)**

Parartotrogus richardi var. *arcticus* T. & A. Scott, 1901, p. 352, pl. 6.
Parartotrogus arcticus: G.O. Sars, 1915, p. 136, pl. 79.

Material examined. One ♀ from washings of more than 200 individuals of the ophiuroid *Ophiopholis aculeata* (Linnaeus) caught as a fisheries bycatch, in the depth of about 100 m, off Sacheon Port (37°50′14″N, 128°52′32″E) in Gangneung, 20 August 2010.

Female. Body (Fig. 30A) orange in color when alive and 935 μm long, with broad prosome and small urosome. Prosome consisting of cephalothorax and 3 metasomites (second to fourth pedigerous somites). Cepahothorax 473 × 435 μm, much expanded laterally in anterior 2/3 and gradually narrowed posteriorly in posterior 1/3, with large, broad, apically truncated rostral prominence. Second and third pedigerous somites 77 × 257 and 46 × 200 μm, respectively. Fourth pedigerous somite much smaller than preceding somites, 20 × 96 μm. Urosome (Fig. 30B) 5-segmented. Fifth pedigerous somite short and narrower than genital double-somite. Genital double-somite 112 × 113 μm, angularly expanded laterally in anterior part, widest across anterior 1/3, and gradually narrowed in posterior 2/3; genital aperture located dorsolaterally. Three abdominal somites 40 × 62, 32 × 62, and 46 × 63 μm, respectively. Caudal ramus (Fig. 30C) 52 × 22 μm (length/width ratio 2.27 : 1) and covered by hairy setules, with 6 setae; dorsodistal seta naked, other setae plumose.

Rostrum as large anterior prominence of cephalothorax. Antennule (Fig. 30D) 263 μm long and 9-segmented; armature formula 1, 12, 4, 2, 2, 3, 2, 2, 12 + 2 aesthetascs; first 2 segments broader than other segments; first segment with setules on anterior margin; one of 2 aesthetascs on terminal segment large, but remaining one small, originated from proximal part of a distal seta; all setae naked. Antenna (Fig. 30E) 4-segmented; coxa (first segment) short and unarmed; basis (second segment) also unarmed. Exopod (Fig. 30F) 1-segmented, slender, about 42 × 8 μm, with 1 apical and 1 subapical setae and about 10 large setules. Endopod 2-segmented; proximal segment more than twice as long as wide and unarmed; distal segment slightly longer than wide, distally with

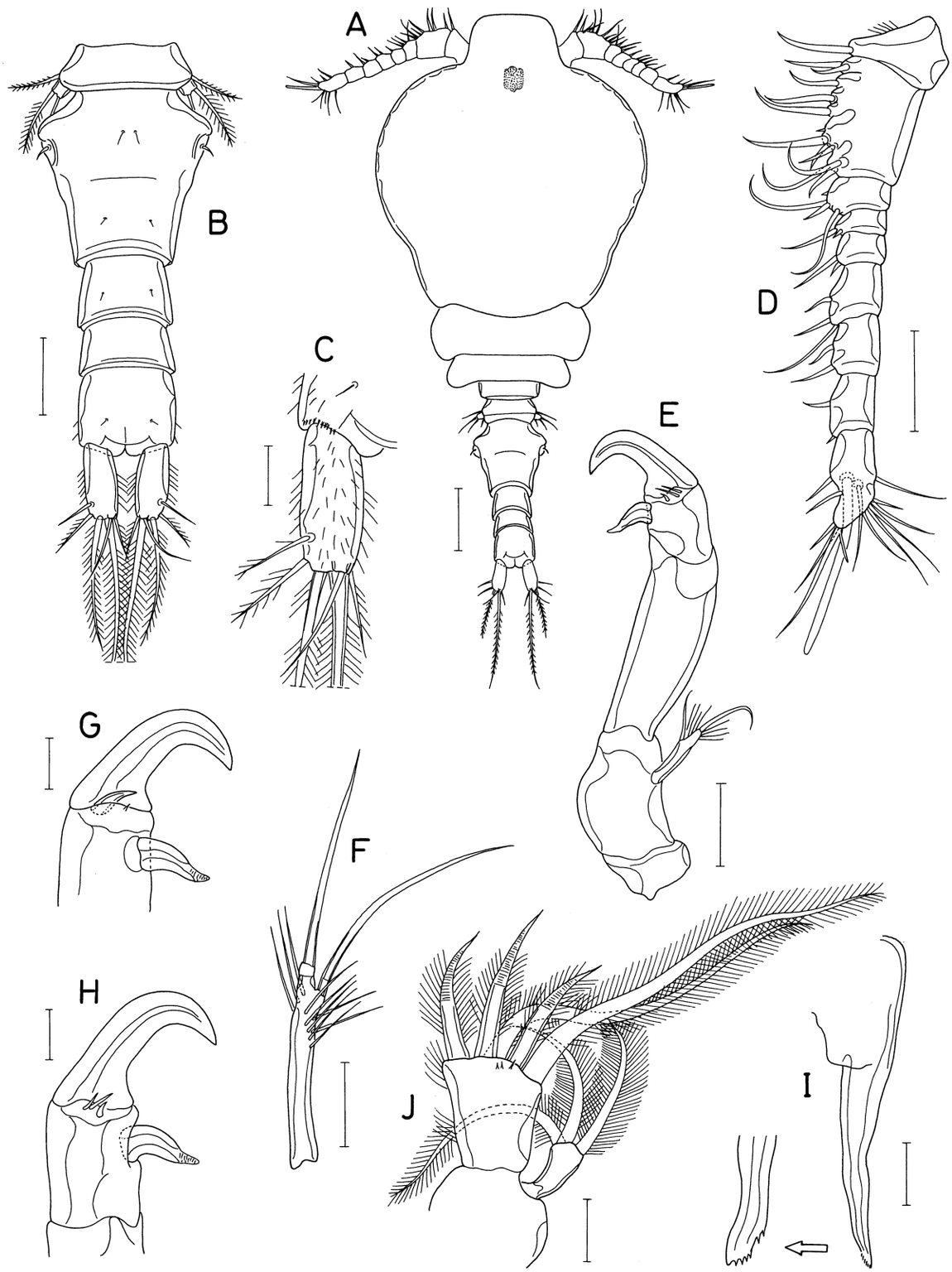

Fig. 30. *Parartotrogus arcticus* T. and A. Scott, female. A, habitus, dorsal; B, urosome, dorsal; C, left caudal ramus, dorsal; D, antennule; E, antenna; F, exopod of antenna; G, distal part of antennary endopod; H, same, opposite side; I, mandible; J, maxillule. Scale bars: A, 0.1 mm; B, D, E, 0.05 mm; C, F-J, 0.02 mm.

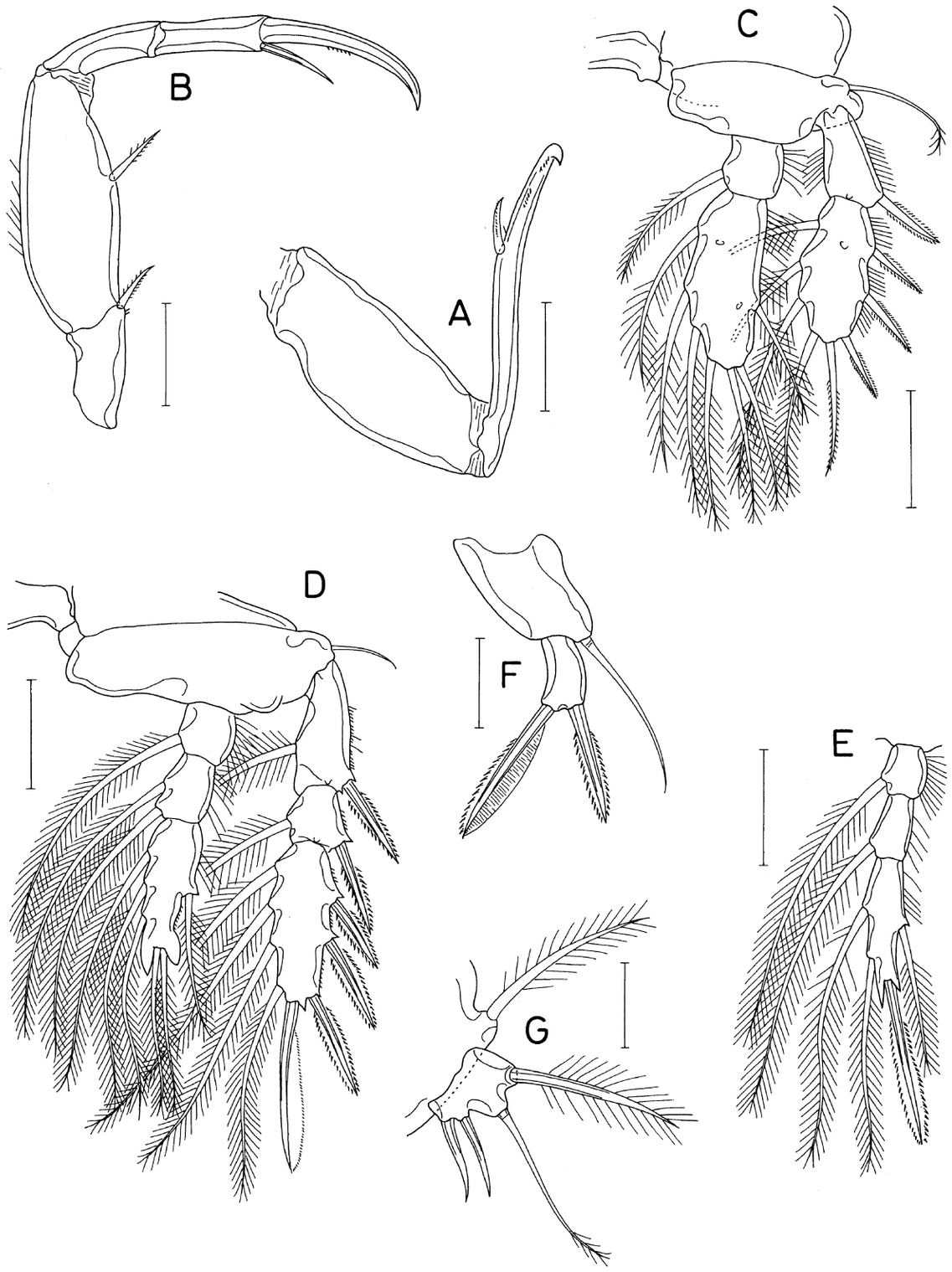

Fig. 31. *Parartotrogus arcticus* T. and A. Scott, female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, leg 3 endopod; F, leg 4; G, leg 5. Scale bars: A-E, 0.05 mm; F, G, 0.02 mm.

massive hook and small claw, and with inner subdistal, claw-like spine and 4 minute distal setae (Fig. 30G, H).

Oral cone short and directed ventrally. Mandible (Fig. 30I) tapering, with several denticles distally. Maxillule (Fig. 30J) bilobed; inner lobe 35 × 32 μm, gradually broadened distally, with 5 pinnate seta, 2 of which distinctly longer than other 3; outer lobe much smaller than inner lobe, 22 × 11 μm, gradually broadened distally, with 3 distal, plumose setae. Maxilla (Fig. 31A) 2-segmented; syncoxa unarmed and widest at proximal third; basis much narrower but longer than syncoxa, distally recurved, with 1 spiniform seta at place slightly distal to midlength and minute spinules subdistally. Maxilliped (Fig. 31B) 4-segmented; syncoxa narrow, with 1 inner distal seta; basis 128 × 49 μm, widest in middle, with 1 seta near middle of inner margin. Endopod 2-segmented; first segment unarmed; second segment 51 μm long, with 1 seta distally; terminal claw 88 μm long, weakly curved, with several minute spinules on concave margin.

Leg 1 (Fig. 31C) with 2-segmented rami. Leg 2 (Fig. 31D) and leg 3 with 3-segmented rami. Third endopodal segment of leg 2 with expanded distal processes (Fig. 31D), but that of leg 3 with slender, pointed distal processes (Fig. 31E). Leg 4 (Fig. 31F) uniramous, consisting of protopod and 1-segmented exopod; protopod with 1 naked, outer distal seta; exopod 17 × 9 μm, with 2 distal spines of 34 (inner) and 27 μm (outer), respectively. Armature formula of legs 1-3 as follows:

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

Leg 5 (Fig. 31G) consisting of 1 dorsolateral pinnate seta on fifth pedigerous somite and free exopod; exopod wider than long, 15 × 20 μm, with 2 distal pinnate setae and 2 inner spiniform setae. Leg 6 represented by 1 small seta in genital aperture (Fig. 30B).

Male. Unknown.

Remarks. In the body form *Parartotrogus arcticus* is very similar to the sole conger *P. richardi* T. and A. Scott, 1893. Nevertheless, they can easily be distinguished from each other by the following differences: (1) the body length in the female of *P. arcticus* is 0.8 mm (G.O. Sars, 1915) or 0.94 mm (this study), whereas that of *P. richardi* is 0.5 mm (T. and A. Scott, 1893) or 0.47-0.52 mm (Giesbrecht, 1899); (2) the second endopodal segment of leg 1 carries 7 setae in *P. arcticus*, but 5 setae in *P. richardi*; (3) the third exopodal segment of leg 3 carries 3 outer spines (formula III, I, 4) in *P. arcticus*, but 2 outer spines (formula II, I, 4) in *P. richardi*; (4) the endopod of leg 3 is 3-segmented, with armature formula 0-1; 0-1; 1, I, 2 in *P. arcticus*, whereas it is 2-segmented, with armature formula 0-1; 0, 1, 3 in *P. richardi*.

The hosts of the genus *Parartotrogus* have not been known until now. The present finding of *P. arcticus* as an associate of an ophiuroid in the Sea of Japan suggests that copepods of *Parartotrogus* are associates of ophiuroid echinoderms, as other genera in the Cancerillidae. Because *P. arcticus* and its host *Ophiopholis aculeata* (Linnaeus) are the circum-arctic species, it is presumable that *P. arcticus* had migrated along with the ophiuroid host from the North Pacific to the Atlantic across the Arctic Ocean during the geological time, as in most of circum-arctic species of marine invertebrates (Briggs, 1995; Vermeij and Roopnarine, 2008). Similar examples of trans-Arctic migrations of copepods associated with echinoderms are *Asterocheres lilljeborgi* Boeck, 1859 which is redescribed in the present paper and *Scottomyzon gibberum* (T. and A. Scott, 1894) (see Kim, 1992).

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