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Article *in* Zootaxa · August 2021

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ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.5013.1.1
http://zoobank.org/urn:lsid:zoobank.org:pub:BBB1CB11-1AEA-4678-8F6C-B43B7F35E453

ZOOTAXA

5013

Copepods associated with Ascidian hosts (Tunicata): Intramolgidae and Lichomolgidae, with descriptions of four new genera and 13 new species

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Magnolia Press
Auckland, New Zealand

Accepted by E. Suárez-Morales: 28 Jun. 2021; published: 3 Aug. 2021

IL-HOI KIM & GEOFF A. BOXSHALL
Copepods associated with Ascidian hosts (Tunicata): Intramolgidae and Lichomolgidae, with descriptions of four new genera and 13 new species
(*Zootaxa* 5013)

75 pp.; 30 cm.

3 Aug. 2021

ISBN 978-1-77688-322-6 (paperback)

ISBN 978-1-77688-323-3 (Online edition)

FIRST PUBLISHED IN 2021 BY

Magnolia Press

P.O. Box 41-383

Auckland 1041

New Zealand

e-mail: magnolia@mapress.com

https://www.mapress.com/j/zt

ISSN 1175-5326 (Print edition)

ISSN 1175-5334 (Online edition)

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Abstract

Two new species of the hitherto monotypic family Intramolgidae are described, both are placed in the type genus *Intramolgus* Marchenkov & Boxshall, 1995. *Intramolgus heardensis* **sp. nov.** was found in association with *Polyzoa opuntia* Lesson, 1830, and the host of *I. atlantis* **sp. nov.** was *Styela chaini* Monniot C. & Monniot F., 1970. Eleven new species belonging to the family Lichomolgidae are reported. These include four new monotypic genera: *Antarctomolgus* **gen. nov.** accommodates *A. molgulae* **gen. et sp. nov.** from *Molgula pedunculata* (Herdman, 1881), *Didemnomolgus* **gen. nov.** accommodates *D. crenulatus* **gen. et sp. nov.** from *Didemnum molle* (Herdmann, 1886), *Spheromolgus* **gen. nov.** accommodates *S. rarus* **gen. et sp. nov.** from *Diplosoma simile* (Sluiter, 1909), and *Alupa* **gen. nov**. accommodates *A. geminata* **gen. et sp. nov.** from *Leptoclinides madara* Tokioka, 1953. The remaining new species are: *Debruma deplanata* **sp. nov.** from *Ascidia ornata* Monniot F. & Monniot C., 2001, *Lichomolgidium bipartitum* **sp. nov.** from *Pyura stolonifera* (Heller, 1878), *Lichomolgus papuensis* **sp. nov.** from *Rhopalaea circula* Monniot F. & Monniot C., 2001, *L. brevicaudatus* **sp. nov.** from an unidentified species of *Polycarpa* Heller, 1877, *L. alatus* **sp. nov.** from *Synoicum castellatum* Kott, 1992, *L. lepidotus* **sp. nov.** from *Aplidium altarium* (Sluiter, 1909), and *Lobomolgus foveolatus* **sp. nov.** from *Didemnum molle* (Herdmann, 1886). In addition, redescriptions are provided for *Henicoxiphium redactum* Illg & Humes, 1971, *Lichomolgidium sardum* Kossmann, 1877, *Lichomolgus canui* Sars, 1917, *L. forficula* Thorell, 1860, and *Zygomolgus dentatus* Kim I.H., 2006.

Key words: taxonomy, new species, ascidian hosts, symbiotic copepods

Introduction

Copepods are common associates of both solitary and colonial ascidians and several families within the order Cyclopoida either exclusively or predominantly use them as hosts (Boxshall & Halsey, 2004). The most species rich family, the Notodelphyidae, and the closely related family Archinotodelphyidae have been the subject of recent major studies (Kim & Boxshall 2020a, 2020b). Together, these two studies described 15 new species of archinotodelphyids plus 178 new species of notodelphyids, all from the Monniot collection of copepods housed at the Muséum National d'Histoire Naturelle in Paris. A third study focused on the cluster of cyclopoid families comprising the Ascidicolidae, Buproridae, Botryllophilidae, and Enteropsidae and established another 84 new species (Kim & Boxshall, 2021). The present account represents the fourth and final paper based on examination of the copepods in the Monniot collection. It covers two families, the Intramolgidae and the Lichomolgidae, the former is currently monotypic and the sole species is associated with an ascidian host, while the latter includes copepods associated with a wide variety of invertebrate hosts. These two families belong to the large lineage, the Ergasilida, representing the former poecilostome families within the order Cyclopoida (Khodami *et al.*, 2019).

Boxshall & Halsey (2004) listed 25 genera accommodating 135 valid species in the Lichomolgidae, but they omitted the monotypic genus *Zygomolgides* Stock, 1995 so the totals should have been 136 species in 26 genera. Since that synthesis went to press five new genera have been added, i.e. *Pterioidicola* Kim I.H., 2003, *Parastericola* Kim I.H., 2007, *Lobomolgus* Ho & Kim I.H., 2009, *Dontimolgus* Moon & Kim I.H., 2011, and *Protomolgus* Moon & Kim I.H., 2011, and the genus *Lichomolgides* Gotto, 1954 has been synonymised with *Zygomolgus* Humes & Stock, 1972 (Kim I.H., 2006). Prior to this study, therefore, 30 genera were recognised as valid and these accommodated a total of 152 valid species (Walter & Boxshall, 2020).

There are nine lichomolgid genera that exclusively utilise ascidians as hosts: *Ascidioxynus* Humes & Stock, 1972, *Debruma* Humes & Stock, 1972, *Dontimolgus*, *Henicoxiphium* Illg & Humes, 1971, *Heteranthessius* T.Scott, 1904, *Lichomolgidium* Kossmann, 1877, *Lobomolgus*, *Protomolgus*, and *Zygomolgus*. In addition the type genus *Lichomolgus* Thorell, 1860 includes several species that are found living in association with ascidians as well as species utilizing other host taxa, such as bivalve molluscs and echinoderms. Specimens belonging to six of these known genera are described here and four new genera are established within the family.

Material and methods

This paper is based on the Monniot collection of copepods associated with ascidian hosts. The specimens examined in this study were collected by Claude and Françoise Monniot (Muséum National d'Histoire Naturelle, Paris) during several decades of field collecting and distinguished systematic research on ascidians. The copepods were extracted from hosts collected during research campaigns undertaken all over the world and then stored in the MNHN collections. The host ascidians were initially fixed in seawater-formalin, and the copepods, once extracted, were preserved in 70-80% ethanol. Prior to light microscopy observation, the copepods were immersed in lactic acid for at least 10 minutes and then dissected. Dissected appendages were observed using the reverse slide method of Humes & Gooding (1964). Drawings were made with the aid of a microscope equipped with a drawing apparatus. Lengths of copepod specimens and measurements of appendages are mostly based on a single dissected specimen of each species. Body lengths were measured along the middle axis of body. The lengths of the appendage segments are given as the average of the longest and shortest margins. Type specimens have been deposited in the Museum National d'Histoire Naturelle, Paris; copepod registration numbers have the prefix MNHN-IU. Some individual ascidian hosts are stored in the MNHN and their registration numbers have the prefix MNHN-IT. Host names have been checked against those in the World Register of Marine Species (WoRMS Editorial Board, 2020). The morphological terminology for the copepods follows Huys & Boxshall (1991).

Systematics

Family Intramolgidae Marchenkov & Boxshall, 1995

Genus *Intramolgus* Marchenkov & Boxshall, 1995

Type species. *Intramolgus arcticus* Marchenkov & Boxshall, 1995 by original designation.

Remarks. The genus *Intramolgus*, the sole genus of the Intramolgidae, has been represented only by the type species *I. arcticus* which was found living in association with three ascidian species of the genus *Molgula* in the White Sea (Marchenkov & Boxshall, 1995). Here, we describe two additional species.

Intramolgus heardensis sp. nov.

(Figs. 1–3)

Type material. Holotype ♀ (MNHN-IU-2014-21592) and paratype ♀ (MNHN-IU-2014-21593), plus 1 ♀, 1 ♂ dissected paratypes (MNHN-IU-2014-21486) from *Polyzoa opuntia* Lesson, 1830: Heard Island, southern Indian Ocean.

Etymology. The type locality, Heard Island, provides the name of the new species.

Description of female. Body (Fig. 1A) consisting of extremely swollen prosome and slender urosome; body length 1.70 mm. Cephalothorax almost spherical, consisting of fused cephalosome and first and second pedigerous somites, 1.33 mm long, and 0.93 mm in dorsoventral depth. Cephalosome obscurely defined from first pedigerous somite by partial trace of dorsal articulation. Third and fourth pedigerous somites free and small. Urosome (Fig. 1B) 5-segmented; fifth pedigerous somite 75×159 μm; genital double-somite as long as wide (152×150 μm), with transverse row of fine spinules in middle of ventral surface (Fig. 1F); genital apertures located dorsolaterally, slightly anterior to midlength. Three free abdominal somites 45×118, 34×109, and 57×102 μm, respectively; anal somite ornamented with fine spinules along posteroventral margin (Fig. 1C). Caudal ramus (Fig. 1C) about twice as long as wide (77×38 μm) and ornamented with fine spinules along posteroventral margin: armed with 6 setae; seta I absent; outer lateral seta (seta II), outer distal seta (seta III) and inner distal seta (seta VI) spiniform, flagellate (tipped with setule); dorsal seta (seta VII) naked; setae II and III unilaterally pinnate along medial margin; setae IV-VI bipinnate; seta II positioned at 36% of ramus length.

Rostrum (Fig. 1D) narrowing distally towards truncate apex bearing pair of minute, transparent lobes. Antennule (Fig. 1E) 225 μm long, 7-segmented; first segment with stout, pointed process anterodistally; armature formula 3, 11, 3, 4, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked; third segment with 1 minute vestigial seta in addition to 3 setae. Antenna (Fig. 1F) 4-segmented, consisting of coxobasis and 3-segmented endopod; all endopodal segments ornamented with rows of fine spinules along outer side: coxobasis armed with 1 seta distally; first endopodal segment with 1 seta on inner margin and 1 small tubercle at inner distal corner; second endopodal segment with 2 small tubercles proximally, 3 setae (proximal seta small) plus 1 claw (claw not articulated at base); third endopodal segment about 2.3 times longer than wide (65×28 μm), armed with 3 short claws and 4 setae.

Labrum (Fig. 1G) much wider than long, with broad median incision and 2 pairs of small lobes near centre of medial incision. Mandible (Fig. 1H) armed with 5 elements consisting of lash-like, serrate terminal element incompletely articulated at base, 2 spinulose spines on convex outer margin of blade, and 2 unequal, spinulose spines (1 shorter and 1 longer setiform) on inner margin. Paragnath (Fig. 1I) as setulose lobe. Maxillule (Fig. 1J) distally bilobed; narrower inner lobe tipped with 3 setae; broader outer lobe with row of spinules and 5 setae, one positioned on outer margin, separated from other 4. Maxilla (Fig. 1K) 2-segmented; proximal segment (syncoxa) unarmed; distal segment (basis) terminating in spiniform process bearing 2 rows of spinules along its length, with 2 subequal, simple setae proximally and 1 inner spine ornamented with several spinules along both margins. Maxilliped (Fig. 2A) 4-segmented; first segment (syncoxa) broad, unarmed; second segment (basis) longest, armed with 2 setae on inner margin, distal seta slightly larger than proximal seta; small third segment unarmed; fourth segment terminating in strong claw, with 2 unequal, proximal setae.

Legs 1–4 (Fig. 2B–E) biramous with 3-segmented rami. Armature formula for legs 1–4 as in type species, as follows:

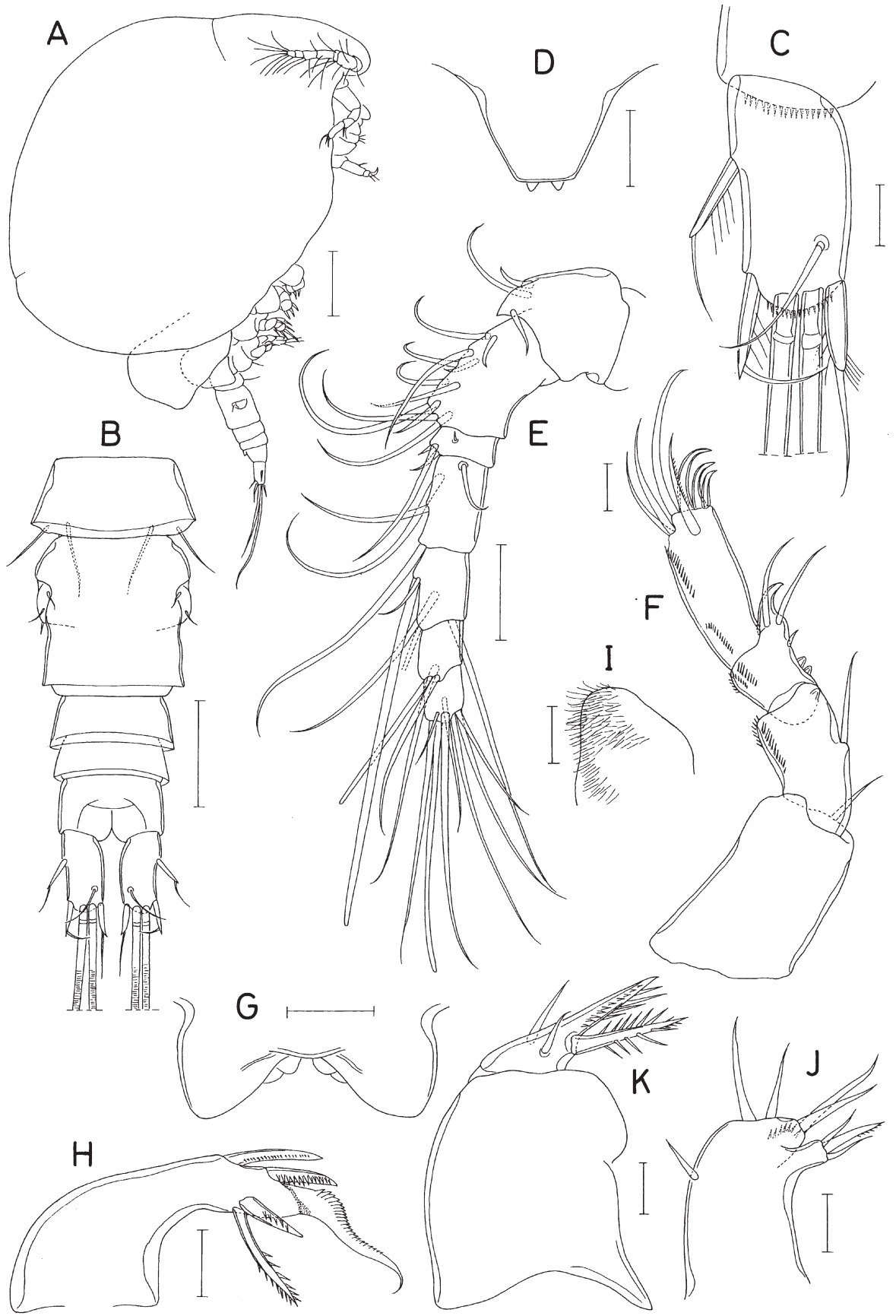

FIGURE 1. *Intramolgus heardensis* **sp. nov.**, female. A, habitus, right; B, urosome, dorsal; C, left caudal ramus, dorsal; D, rostrum; E, antennule; F, antenna; G, labrum; H, mandible; I, paragnath; J, maxillule; K, maxilla. Scale bars: A, 0.2 mm; B, 0.1 mm; C, F, H–K, 0.02 mm; D, E, G, 0.0l5 mm.

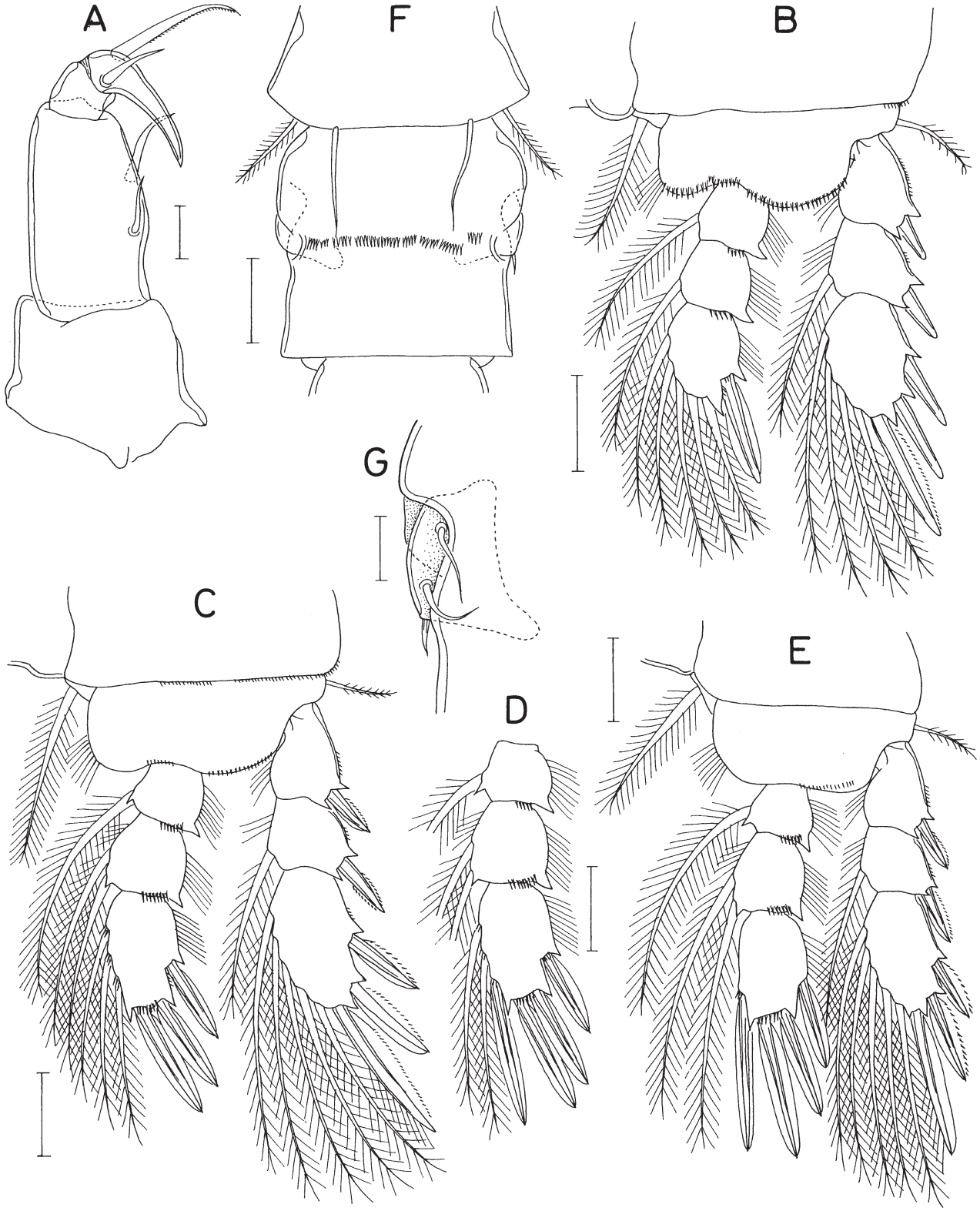

FIGURE 2. *Intramolgus heardensis* **sp. nov.**, female. A, maxilliped; B, leg 1; C, leg 2; D, endopod of leg 3; E, leg 4; F, first 2 urosomal somites, ventral; G, left genital aperture, dorsal. Scale bars: A, G, 0.02 mm; B–F, 0.05 mm.

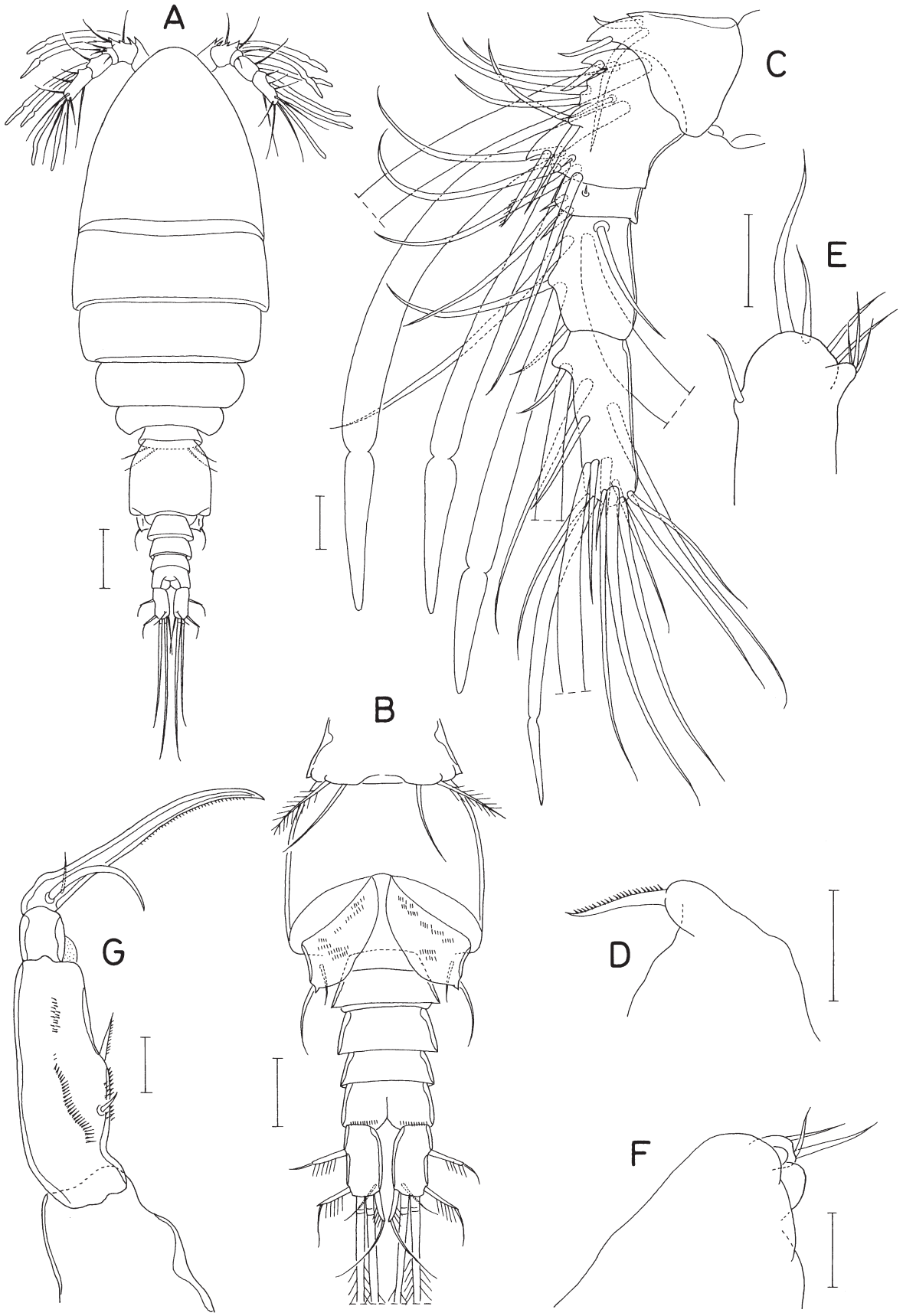

FIGURE 3. *Intramolgus heardensis* **sp. nov.**, male. A, habitus, dorsal; B, urosome, ventral; C, antennule; D, mandible; E, maxillule; F, maxilla; G, maxilliped. Scale bars: A, 0.1 mm; B, 0.05 mm; C–G, 0.02 mm.

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

Leg 5 (Fig. 2F) represented by 2 setae (pinnate outer and naked inner setae) on ventral margin of fifth pedigerous somite. Leg 6 (Fig. 2G) represented by 2 setae and 1 small spine on genital operculum.

Male. Body (Fig. 3A) narrow, not inflated; body length 985 μm; prosome 650×340 μm, consisting of cephalosome and 4 pedigerous somites. Urosome (Fig. 3B) 6-segmented; fifth pedigerous somite 113 μm wide; genital somite 136×145 μm, subquadrate; genital operculum ornamented with fine spinules on ventral surface. Four abdominal somites 40×98, 31×75, 22×69, and 33×69 μm, respectively. Caudal ramus about 2.07 times longer than wide (58×28 μm), armed as in female.

Rostrum as in female. Antennule 5-segmented (Fig. 3C); second segment with 2 pointed processes (proximal and subdistal) on anterior margin; armature formula 3, 12+3 aesthetascs, 3, 4+2 aesthetascs, and 13+3 aesthetascs; aesthetascs large, constricted at distal quarter and tapering distal to constriction. Antenna as in female.

Labrum as in female. Mandible (Fig. 3D) atrophied to form tapering lobe bearing 1 spinulose seta apically. Maxillule (Fig. 3E) similar to that of female. Maxilla (Fig. 3F) atrophied; proximal segment (syncoxa) bearing 2 small lobes near base of distal segment; distal segment (basis) as small lobe bearing 3 naked setae. Maxilliped (Fig. 3G) slender, 4-segmented; first segment (syncoxa) unarmed; second segment (basis) with 2 small setae on inner margin and several rows of minute spinules; small third segment unarmed; fourth segment produced into long claw armed with 2 unequal setae proximally and ornamented with fine spinules along distal half of concave margin.

Legs 1–5 as in female. Leg 6 (Fig. 3B) represented by 2 setae and 1 small cusp on genital operculum.

Remarks. *Intramolgus heardensis* **sp. nov**. is morphologically very similar to the type species, although they were found at opposite ends of the world. The shapes of the caudal setae, the structure and setation of the antennae and mandibles, and the armature of the swimming legs are the same in the two species. The main differences between the species are: (1) the second segment of the female antennule is armed with 11 setae in the new species but with 13 setae in *I. arcticus*; (2) the first and second endopodal segments of the antenna are ornamented with 1 and 2 tubercles, respectively, in the new species, but with 5 and 4 spinules, respectively, in *I. arcticus* (as illustrated by Marchenkov & Boxshall, 1995); (3) the maxillule is armed with 8 setae and is distally bilobed in the new species but is unilobate with 7 setae in *I. arcticus*; (4) the syncoxa of the female maxilla is smooth in the new species but ornamented with patch of spinules in *I. arcticus*; and (5) leg 5 consists of 1 naked and 1 pinnate seta in the new species but comprises 2 naked setae in *I. arcticus*. These differences are sufficient to justify the recognition of a new species to accommodate the material from Heard Island.

Intramolgus atlantis sp. nov.

(Figs. 4–6)

Type material. Holotype ♀ (MNHN-IU-2014-21594, dissected and mounted on a slide) from *Styela chaini* Monniot C. & Monniot F., 1970 (MNHN-IT-2008-8188); North America Basin (39°46.5′N, 70°43.3′W), R.V. "Atlantis" II, Stn 73, depth 1330-1470 m; WHOI coll., 25 August 1964.

Etymology. The name of new species alludes to its collection during the Atlantis II cruise.

Description of female. Body (Fig. 4A, B) cyclopiform; body length 910 μm; prosome slightly expanded, 618 μm long, 309 μm wide, and 350 μm in dorsoventral depth, with ring of mucus-like material covering lateral margins of first and second pedigerous somites and dorsal borders between cephalosome and first pedigerous somite and between second and third pedigerous somites. Urosome (Fig. 4C) much shorter than prosome, 5-segmented: fifth pedigerous somite 46×99 μm, with angular posterolateral corners. Genital double-somite 1.1 times longer than wide (121×109 μm); anterior half slightly broader, with convex lateral margins; genital apertures located dorsolaterally just anterior to middle of double-somite; ventral surface (Fig. 4D) ornamented with numerous transverse rows of minute spinules. Three free abdominal somites 39×76, 25×72, and 38×68 μm, respectively; first free abdominal somite ornamented with 1 transverse row of minute spinules along posteroventral border; anal somite also with

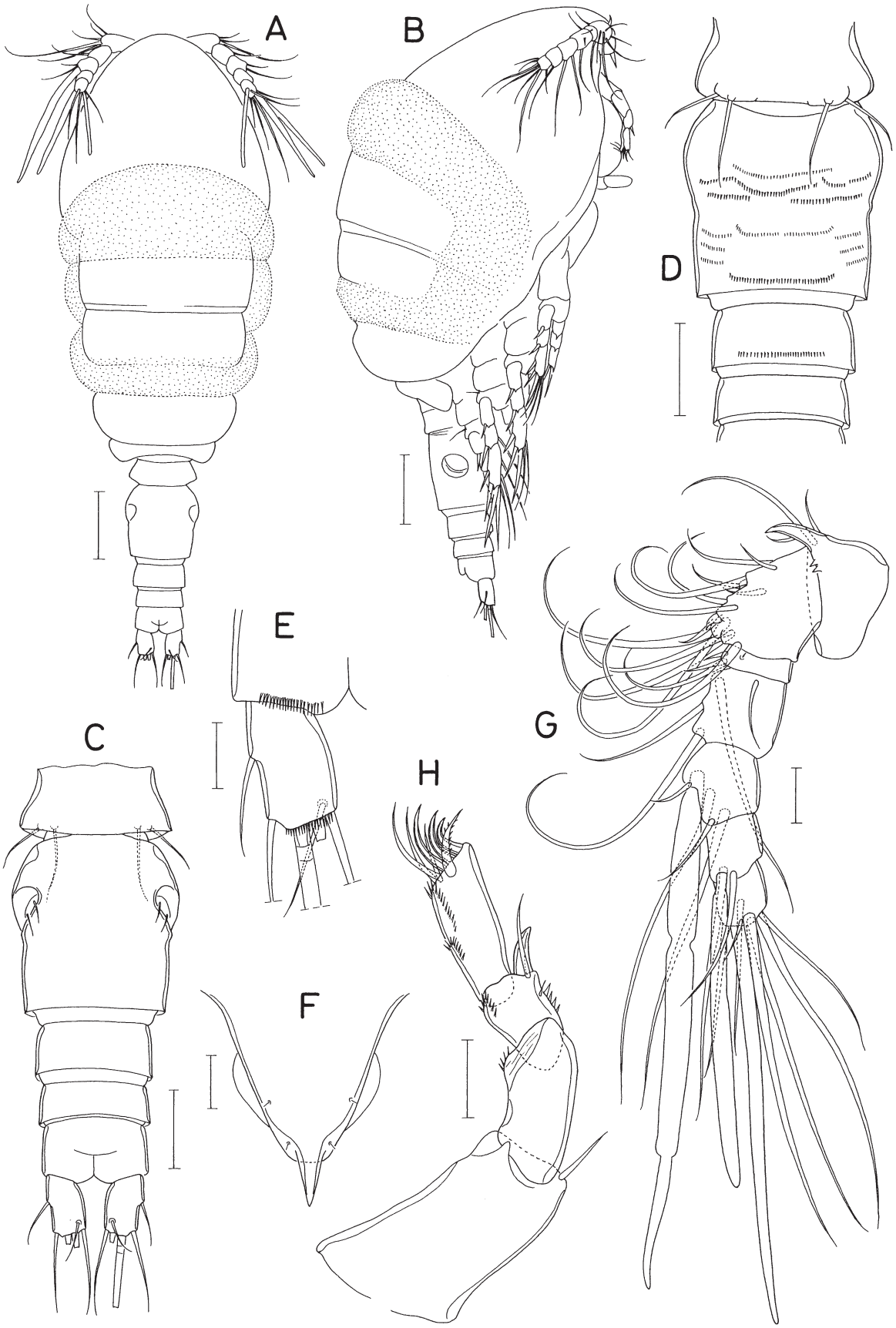

FIGURE 4. *Intramolgus atlantis* **sp. nov.**, female. A, habitus, dorsal; B, habitus, right; C, urosome, dorsal; D, anterior part of urosome, ventral; E, right caudal ramus, ventral; F, rostrum; G, antennule; H, antenna. Scale bars: A, B, 0.1 mm; C, D, 0.05 mm; E–H, 0.02 mm.

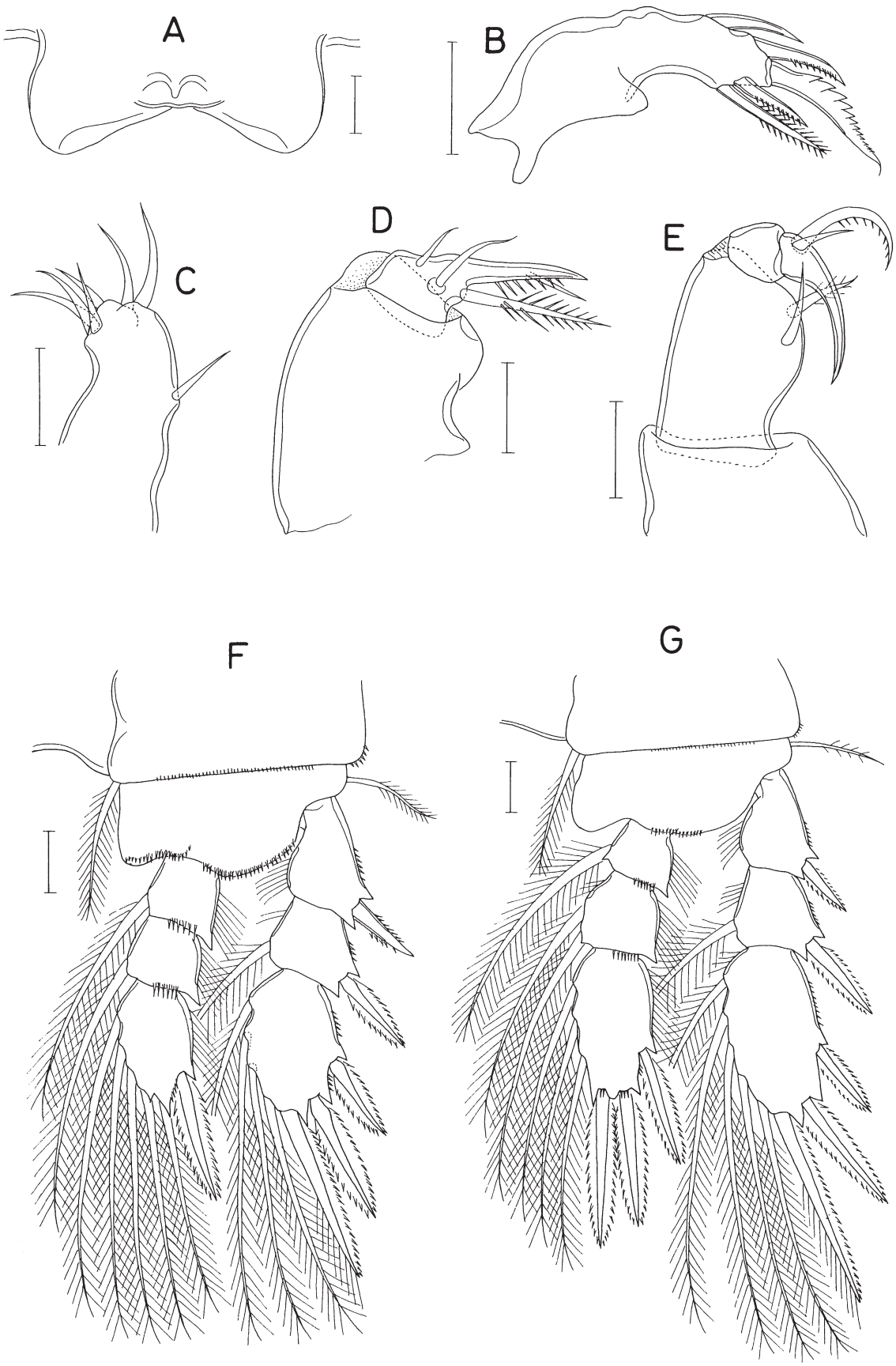

FIGURE 5. *Intramolgus atlantis* **sp. nov.**, female. A, labrum, B, mandible; C, maxillule; D, maxilla; E, maxilliped; F, leg 1; G, leg 2. All scale bars: 0.02 mm.

ventral rows of minute spinules basal to caudal rami (Fig. 4E). Caudal rami slightly convergent; each ramus (Fig. 4E) about 1.58 times longer than wide (38×24 μm), armed with 6 simple setae (setae II to VII) and row of spinules along posteroventral margin; seta I absent.

Rostrum (Fig. 4F) tapering towards beak-like process at apex, with membranous fringe on mid-lateral margins. Antennule (Fig. 4G) 7-segmented; first segment with elongate, claw-like process anterodistally and 2 denticles on margin near base of process; armature formula 3, 13, 3, 4, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked; aesthetasc on fifth segment constricted at proximal third and narrow in distal quarter. Antenna (Fig. 4H) 4-segmented, consisting of large coxobasis with 1 seta distally and 3-segmented endopod: first endopodal segment unarmed; second endopodal segment armed with 1 claw and 2 setae (including vestigial proximal seta), and ornamented with 4 spinules on inner margin; third endopodal segment about 2.4 times longer than wide (36×15 μm), armed distally with 3 small claws and 4 small setae.

Labrum (Fig. 5A) short, broad, medially incised. Mandible (Fig. 5B) armed with 5 elements (4 spines and 1 lash-like, serrate terminal element); all elements articulated at base. Maxillule (Fig. 5C) armed with 7 setae, weakly bilobed distally. Maxilla (Fig. 5D) with large, unarmed syncoxa; basis terminating in spiniform process bearing several spinules, one of spinules much longer than others; armed with 3 setae; largest inner seta spinulose. Maxilliped (Fig. 5E) 4-segmented, with fourth segment produced into terminal claw; first segment very broad and unarmed; second segment with 2 setae on expanded inner margin (distal seta weakly pinnate); small third segment unarmed; terminal segment armed proximally with 1 small seta and 1 large unilaterally spinulose seta.

Legs 1-4 (Figs. 5F, G, 6A, B) with 3-segmented rami. Armature formula as in preceding species, but all spines on both rami with serrate margins.

Leg 5 (Fig. 4D) represented by 2 naked setae. Leg 6 (Fig. 6C) represented by 2 setae on genital operculum.

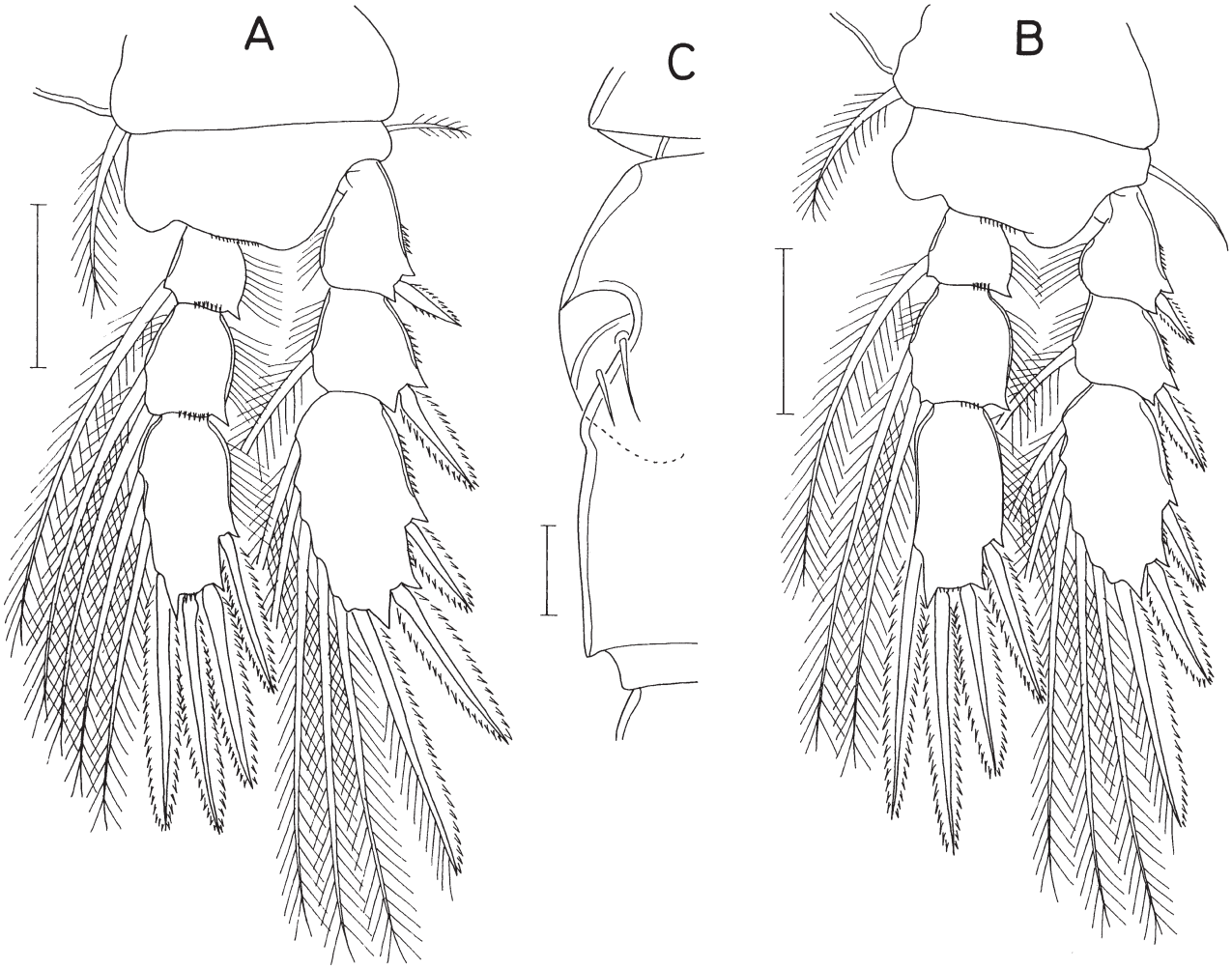

FIGURE 6. *Intramolgus atlantis* **sp. nov.**, female. A, leg 3; B, leg 4; C, left side of genital double-somite, dorsal. Scale bars: A, B, 0.05 mm; C, 0.02 mm.

Male. Unknown.

Remarks. The new species can be readily differentiated from its two congeners by the following features: (1) the prosome of the female bears a ring of unusual mucus-like material; (2) the caudal rami of the female are shorter than those of its congeners (1.58 times longer than wide, compared to more than twice as long as wide in both congeners); (3) all caudal setae are naked, compared to the pinnate ornamentation and flagellate tips of some caudal setae of the congeners; (4) the first segment of the antennule is produced anterodistally into an elongate claw-like process, compared to the short and stout process of congeners; (5) the first endopodal segment of the antenna is unarmed, in contrast to armed with 1 seta; and (6) the second endopodal segment of the antenna is armed with 1 claw and 2 setae, compared to 1 claw and 3 setae in both congeners. Collectively these differences support the establishment of a new species.

Family Lichomolgidae Kossmann, 1877

Remarks. The family Lichomolgidae is a large family comprising 152 species (Walter & Boxshall, 2020) found living in association with a wide range of marine invertebrate hosts, mainly molluscs, echinoderms and ascidians (Boxshall & Halsey, 2004). Nine genera are specific to ascidian hosts; *Ascidioxynus*, *Debruma*, *Dontimolgus*, *Henicoxiphium*, *Heteranthessius*, *Lichomolgidium*, *Lobomolgus*, *Protomolgus*, and *Zygomolgus* (Boxshall & Halsey, 2004; Moon & Kim, I.H., 2011). In addition, the type genus *Lichomolgus* also includes species living in association with ascidians, as well as with other host groups, such as bivalve molluscs.

Genus *Debruma* Humes & Stock, 1972

Remarks. Within the Lichomolgidae three genera (*Botulosoma* Carton, 1974, *Gelastomolgus* Humes, 1968, and *Debruma*) have only a single spine apically on the distal segment of the 2-segmented endopod of leg 4. An easy way to distinguish *Debruma* from these other two genera is to compare the armature of the third exopodal segments of legs 1 and 3. The third exopodal segment of leg 1 of *Debruma* is armed with 4 spines and 4 setae (formula III, I, 4), compared to 3 spines and 5 setae (formula II, I, 5) in *Botulosoma*, and 3 spines and 4 setae (formula II, I, 4) in *Gelastomolgus*. The third exopodal segment of leg 3 of *Debruma* is armed with 4 spines and 5 setae (formula III, I, 5), compared to 3 spines and 5 setae (formula II, I, 5) in *Botulosoma* and *Gelastomolgus*. *Botulosoma* is associated with echinoderms (Asteroidea) and *Gelastomolgus* with bivalve molluscs.

Debruma deplanata sp. nov.

(Figs. 7, 8)

Type material. Holotype ♀ (MNHN-IU-2014-21595, dissected and mounted on a slide) from *Ascidia ornata* Monniot F. & Monniot C., 2001 (MNHN-IT-2008-2621 = MNHN A3/CYS/135); Offshore sand cay, West side of White Island, Camiguin Island, the Philippines (09°15.38′N, 124°39.12′E), depth 18 m; CRCHO 148, Site Caminguin 4, CRRF coll., 19 April 1997.

Etymology. The specific name is derived from the Latin *deplanat* (meaning "flattened") referring to the flattened body of the new species.

Description of female. Body (Fig. 7A) stout, dorsoventrally flattened. Body length 1.24 mm; prosome 808×555 μm, oval in dorsal view. Urosome (Fig. 7B) stocky, 5-segmented. Fifth pedigerous somite 182 μm wide, with minute spinules at lateral apices. Genital double-somite 204×193 μm; genital apertures located dorsolaterally about at midlength of double-somite. Three free abdominal somites much shorter than wide, 48×132, 48×106, and 39×100 μm, respectively. Posteroventral margins of genital double-somite and 3 free abdominal somites fringed with crenate membrane (Fig. 7C). Caudal ramus very short, 36×45 μm, about 1.25 times wider than long, armed with 6 setae; setae II and VII naked; setae III and VI pinnate; setae IV and V missing. Egg sac (Fig. 8A) fusiform, 680×250 μm; each egg about 73 μm in diameter.

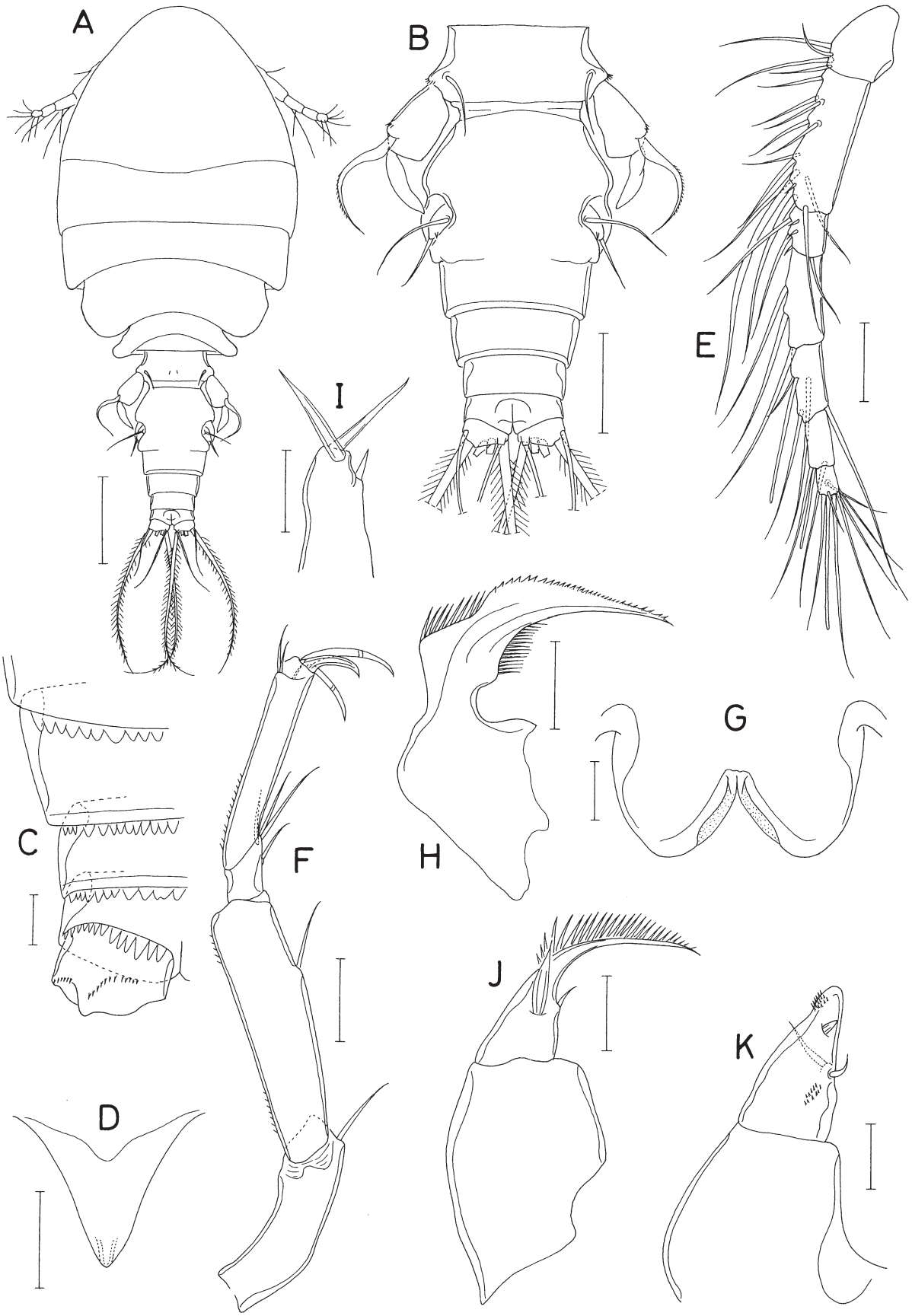

FIGURE 7. *Debruma deplanata* **sp. nov.**, female. A, habitus, dorsal; B, urosome, dorsal; C, right side of abdomen, ventral; D, rostrum; E, antennule; F, antenna; G, labrum; H, mandible; I, maxillule; J, maxilla; K, maxilliped. Scale bars: A, 0.2 mm; B, 0.1 mm; C, G–K, 0.02 mm; D–F, 0.05 mm.

Rostrum (Fig. 7D) tapering. Antennule (Fig. 7E) 315 μm long, 7-segmented; terminal segment shortest; armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked. Antenna (Fig. 7F) slender, consisting of coxobasis and 3-segmented endopod; coxobasis with 1 seta at inner distal corner; first endopodal segment longest, with 1 seta on inner margin and ornamented with fine spinules proximally and distally on outer margin; small second endopodal segment bearing 4 inner setae; third endopodal segment about 5.8 times longer than wide (121×21 μm), and ornamented with fine spinules on proximal outer margin; armed with 3 minute setae and 3 slender claws distally (2 claws longer and annulated, 1 short, non-annulated).

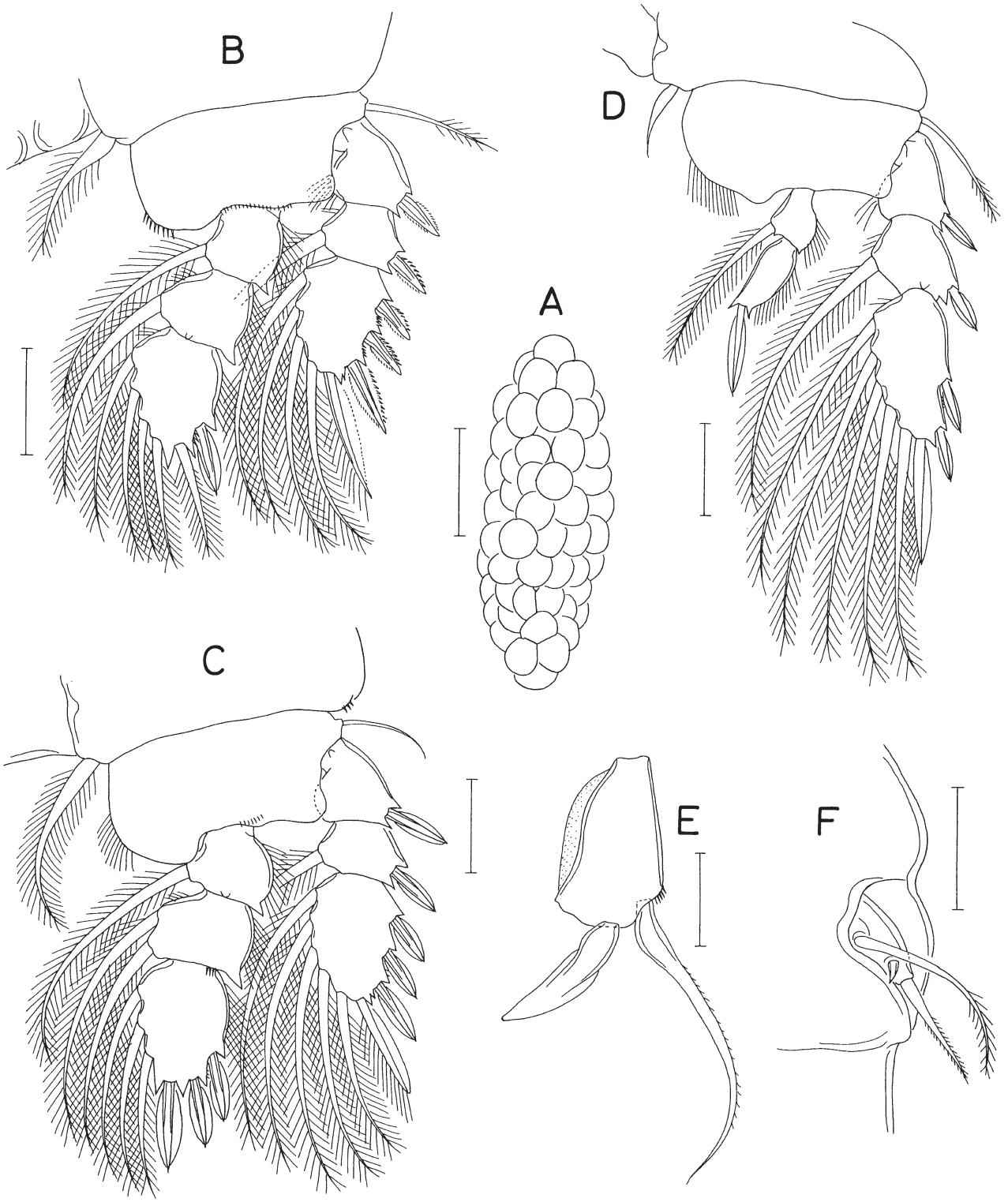

FIGURE 8. *Debruma deplanata* **sp. nov.**, female. A, egg sac; B, leg 1; C, leg 2; D, leg 4; E, exopod of leg 5; F, right genital aperture. Scale bars: A, 0.2 mm; B–F, 0.05 mm.

Labrum (Fig. 7G) deeply incised, with rounded posterior lobes. Mandible (Fig. 7H) constricted between basal part and blade; blade also constricted proximally, ornamented with spinules proximally along inner and outer margins; distal two-thirds of blade serrate along outer margin but smooth along inner margin. Maxillule (Fig 7I) lobate, with 1 small subdistal seta and 2 stiff distal setae directed crossways. Maxilla (Fig. 7J) consisting of unarmed syncoxa and basis terminating in gently curved, slender lash bearing row of spinules along convex outer margin, and armed with broad anterior seta and minute inner seta. Maxilliped (Fig. 7K) reduced, 2-segmented; proximal segment (syncoxa) unarmed; distal segment tapering, bluntly tipped, armed with 2 setae in middle, 1 small spine subdistally, and 2 patches (proximal and distal) of minute spinules.

Leg 1 (Fig. 8B), leg 2 (Fig. 8C) and leg 3 with 3-segmented rami. Leg 4 (Fig. 8D) with 3-segmented exopod and 2-segmented endopod. Inner distal margin of basis ornamented with spinules in leg 1 but with setules in legs 2–4. Leg 4 coxa with inner seta slightly expanded and naked; second endopodal segment 45×20 μm, with distal spine 48 μm long. Armature formula for legs 1–4 as follows:

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

Leg 5 consisting of outer dorsal seta inserted on fifth pedigerous somite and free exopod; exopodal segment (Fig. 8E) about 1.6 times longer than wide (81×51 μm), gradually broadening distally, with hyaline fringe along inner margin; armed with 1 seta (155 μm long) and 1 broad, knife-shaped spine (67 μm long). Leg 6 (Fig. 8F) represented by 1 pinnate seta, 1 spinulose seta and 1 small spine on genital operculum.

Male. Unknown.

Remarks. *Debruma* has been a monotypic genus represented only by the type species *D. clavelinae* Humes & Stock, 1973, found associated with the ascidian host *Clavelina picta* (Verrill, 1900) in Bermuda (Humes & Stock, 1973). *Debruma deplanata* **sp. nov.** differs from *D. clavelinae* as follows: (1) the body of the female is stocky (vs. slender in *D. clavelinae*); (2) the caudal ramus is wider than long (vs. 3.1 times longer than wide in *D. clavelinae*, according to Humes & Stock, 1973); (3) the third endopodal segment of the antenna is about 5.8 times longer than wide (vs. 2.8 times longer than wide in *D. clavelinae*); (4) the blade of the mandible is constricted proximally (vs. evenly attenuated in *D. clavelinae*); (5) the maxillule is armed with 3 setae (vs. armed with a single seta in *D. clavelinae*); and (5) the distal segment of the female maxilliped is tapering (vs. subdistally expanded in *D. clavelinae*). These differences are sufficient to justify the establishment of the new species.

Genus *Henicoxiphium* Illg & Humes, 1971

Remarks. The genus *Henicoxiphium* consists of only a single species, *H. redactum* Illg & Humes, 1971 described as an associate of the ascidian *Styela plicata* (Lesueur, 1823) in Florida and North Carolina, USA (Illg & Humes, 1971). The most significant diagnostic feature of *Henicoxiphium* is the endopod of leg 4 which is 3-segmented and the third segment is armed with a single distal spine (the armature formula for the endopod of leg 4 is 0-1; 0-1; 0, I, 0).

Henicoxiphium redactum Illg & Humes, 1971

(Figs. 9–11)

Material examined. 2 ♀♀ 1 ♂ (MNHN-IU-2017-2141) (1 ♀ and 1 ♂ dissected) from *Pyura lignosa* Michaelsen, 1908, Anse Noire, Martinique Island (14°32´N, 61°05.3´W), MADIBENTHOS Expedition, Stn AR 100, depth 2-8 m, 06 September 2016.

Supplementary description of female. Body (Fig. 9A) with weak exoskeleton. Body length 1.50 mm; maximum width 552 μm. Prosome moderately expanded, 825 μm long. Urosome (Fig. 9B) 5-segmented; fifth pedigerous somite 142 μm wide. Genital double-somite longer than wide (245×180 μm), rhomboidal, widest at proximal

third; genital apertures located at mid-length of double-somite. Three free abdominal somites 71×77, 67×72, and 80×67 μm, respectively. Caudal ramus (Fig. 9C) large, about 5.6 times longer than wide (268×48 μm) and more than 3 times longer than anal somite: armed with 6 naked setae; outer lateral seta (seta II) located at about 36% of ramus length; seta VII positioned dorsally near seta II at about 42% of ramus length. Egg sac (Fig. 9D) 608×196 μm, tapering distally; each egg about 72 μm in diameter.

Rostrum (Fig. 9E) semicircular. Antennule (Fig. 9F) slender, 7-segmented; armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked. Antenna (Fig. 9G) 3-segmented, consisting of coxobasis and 2-segmented endopod; coxobasis with 1 small seta distally on inner margin; proximal endopodal segment elongate with 1 minute seta on inner margin and row of spinules along outer margin; distal endopodal segment about 2.56 times longer than wide (64×25 μm), formed by fusion of original second and third endopodal segments, armed with 4 small setae proximally on inner margin, 5 small setae distally and subdistally, plus 2 large, unequal distal claws; longer claw 67 μm long, shorter 45 μm; one distal seta apparently inserted proximally on longer claw.

Labrum (Fig. 9H) deeply incised with broad posterior lobes. Mandible (Fig. 9I) with slender blade bearing several rows of spinules on convex outer surface and 1 row of setules along concave inner margin; forming elongate lash distally. Maxillule (Fig. 9J) as elongate lobe tipped with 2 unequal, naked setae. Maxilla (Fig. 9K) 2-segmented; proximal segment (syncoxa) unarmed; distal segment (basis) with extremely thin, elongate distal lash, and armed with 2 setae (minute inner seta and slightly expanded anterior seta); distal lash forming right angle with basis, ornamented with about 15 large spinules along proximal third of outer margin and minute spinules along distal two-thirds of outer margin; inner margin of lash smooth. Maxilliped (Fig. 9L) 3-segmented; all segments unarmed; third segment small, tapering.

Legs 1–4 with 3-segmented rami (Fig. 10A-E). Inner seta on coxa of leg 4 small. Outer seta on basis of legs 1-4 naked. Armature formula for legs 1–4 as follows:

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

Leg 5 consisting of dorsolateral seta on fifth pedigerous somite and free exopod; exopod (Fig. 10F) broadening distally, about 1.5 times longer than wide (35×23 μm), with roundly expanded inner distal corner: armed with 2 spiniform setae distally; small inner seta 13 μm long; longer outer seta 42 μm long, slightly broadened in middle. Leg 6 (Fig. 10G) represented by 2 unequal setae and 1 spiniform process on genital operculum.

Description of male. Body (Fig. 11A) similar to that of female, 1.05 μm long; prosome 556×360 μm. Urosome (Fig. 11B) 6-segmented: fifth pedigerous somite 93 μm wide; genital somite 170×148 μm, with rounded corners; 4 abdominal somites 48×59, 45×55, 36×48, and 45×49 μm, respectively. Caudal ramus about 5.56 times longer than wide (150×27 μm), with same form as female.

Rostrum as in female. Antennule with 3 additional aesthetascs: 2 on second and 1 on fourth segments, at sites indicated by dots in Fig. 9F. Antenna as in female.

Labrum, mandible, maxillule, and maxilla as in female. Maxilliped (Fig. 11C) 4-segmented; first and third segments unarmed; second segment with convex inner margin bearing 1 stiff seta; fourth segment forming strongly curved, elongate claw bearing 1 large and 1 minute seta proximally.

Legs 1-4 as in female. Leg 5 exopod (Fig. 11D) about 1.5 times longer than wide (23×15 μm), armed distally with 2 very unequal setae, 8 and 36 μm long. Leg 6 represented by 2 equal, naked setae at posterolateral corners of genital somite (Fig. 11B).

Remarks. *Henicoxiphium redactum* has not been reported since its original description by Illg & Humes (1971). In contrast to the original description, our dissected female is 1.50 mm long, distinctly larger than type specimens which were 1.05 to 1.29 mm long; the maxillule is armed with 2 setae compared with 3 setae in the type specimens; the distal endopodal segment of the antenna has 4 proximal inner setae, compared to 3 setae in the type specimens; and the exopod of male leg 5 is 23×15 μm, distinctly broader than that of type specimens (recorded as 23×9 μm). We consider that these differences can be attributed to infraspecific variability, because numerous taxonomically important features of our material, such as the characteristic forms of the caudal ramus, maxillule, and exopod of female leg 5, and the characteristic positions of caudal setae, are shared with the type specimens.

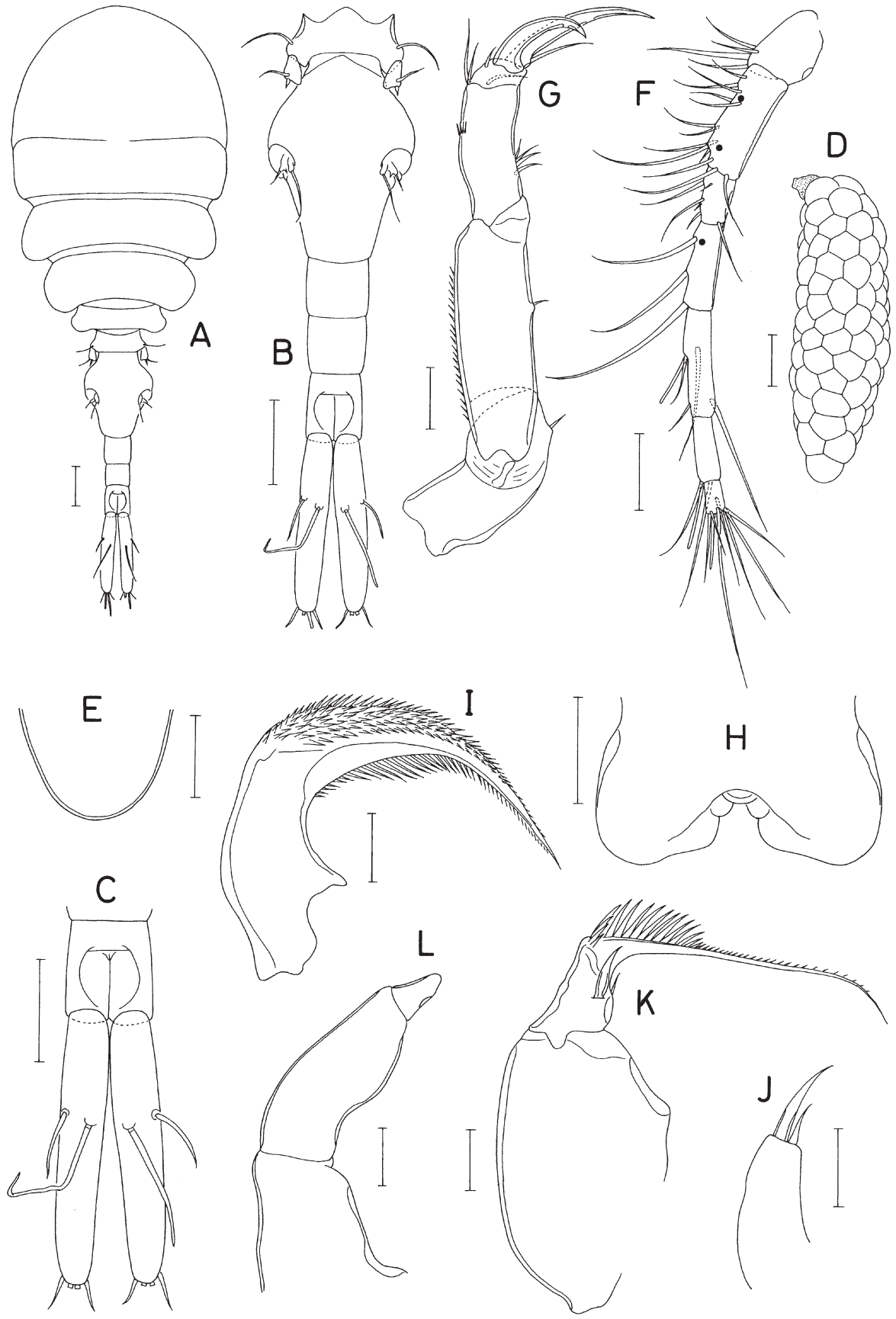

FIGURE 9. *Henicoxiphium redactum* Illg and Humes, 1971, female. A, habitus, dorsal; B, urosome, dorsal; C, anal somite and caudal rami, dorsal; D, egg sac; E, rostrum; F, antennule; G, antenna; H, labrum; I, mandible; J, maxillule; K, maxilla; L, maxilliped. Scale bars: A–D, 0.1 mm; E, F, H, 0.05 mm; G, I–L, 0.02 mm.

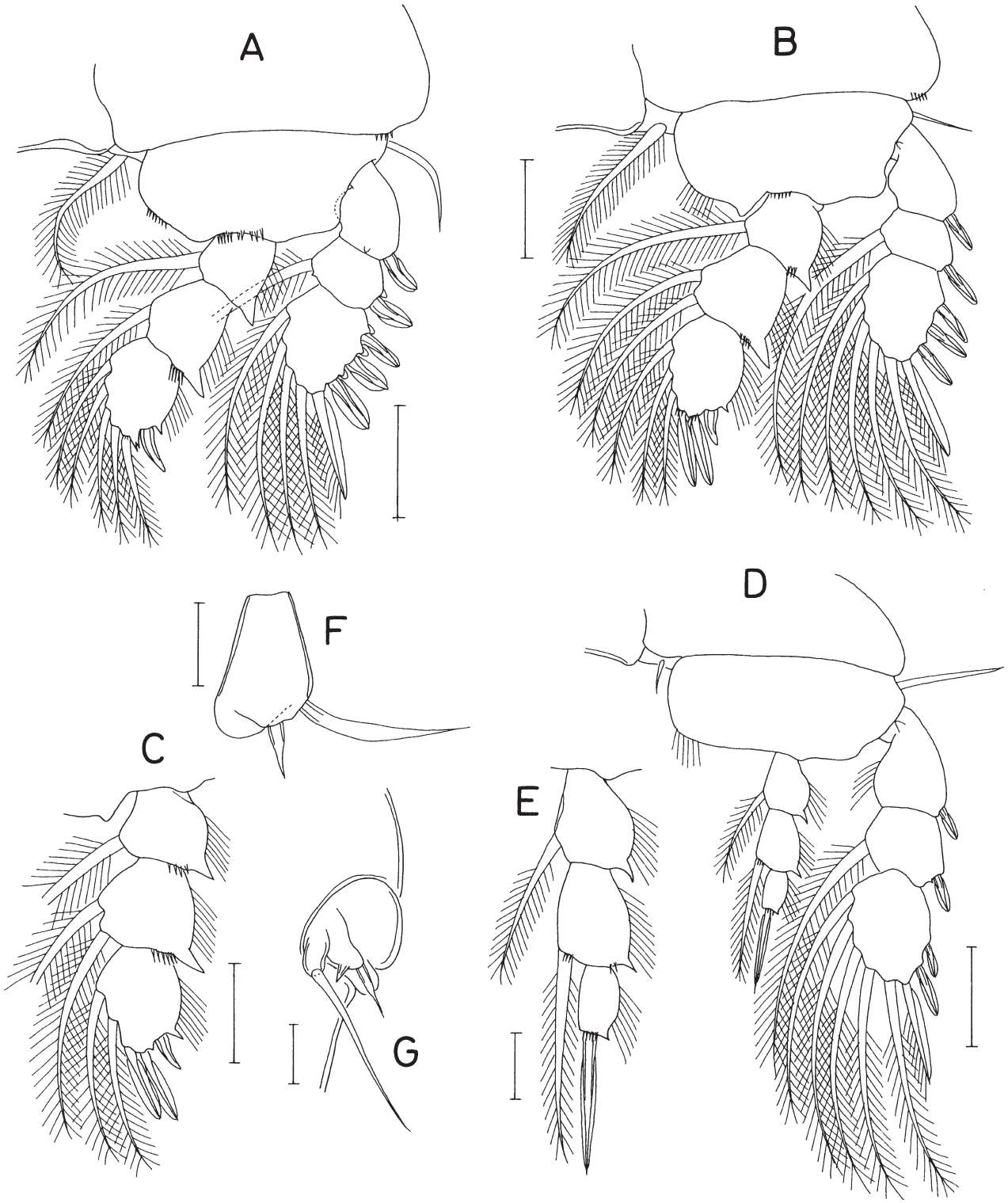

FIGURE 10. *Henicoxiphium redactum* Illg and Humes, 1971, female. A, leg 1; B, leg 2; C, endopod of leg 3; D, leg 4; E, endopod of leg 4; F, exopod of leg 5; G, right genital aperture, dorsal. Scale bars: A–D, 0.05 mm; E–G, 0.02 mm.

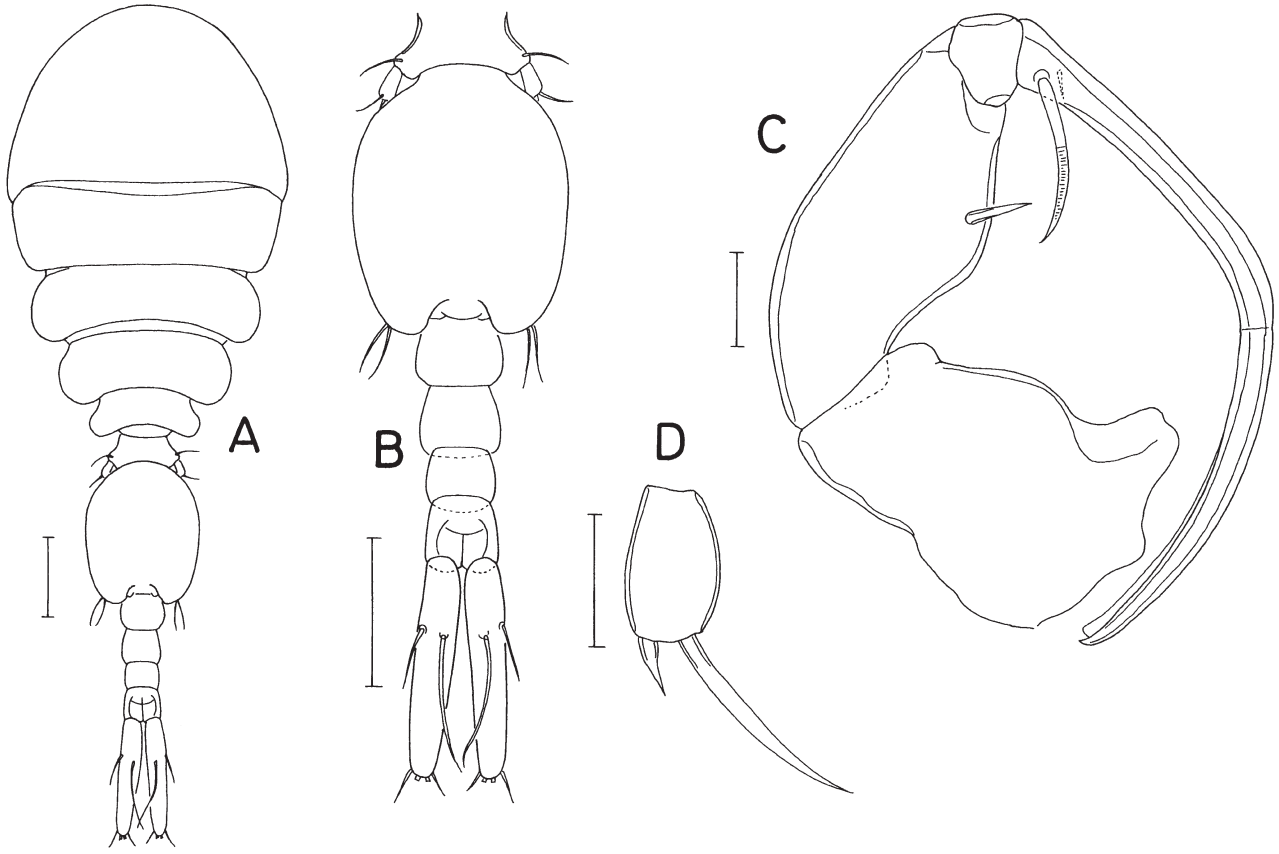

FIGURE 11. *Henicoxiphium redactum* Illg and Humes, 1971, male. A, habitus, dorsal; B, urosome, dorsal; C, maxilliped; D, exopod of leg 5. Scale bars: A, B, 0.1 mm; C, D, 0.02 mm.

Genus *Lichomolgidium* Kossmann, 1877

Remarks. The genus *Lichomolgidium* currently consists of three known species. The type species *L. sardum* Kossmann, 1877 is redescribed here and a new species is described below. The major key characters of this genus include; the maxilliped is 2-segmented, the mandible lacks a distal lash, and the inner seta (seta I) on the basis of the maxilla is absent or rudimentary.

Lichomolgidium sardum Kossmann, 1877
(Figs. 12–14)

Syn. *Lichomolgidium cynthiae* (Brian, 1924), **new synonym.**

Material examined. 4 ♀♀, 6 ♂♂ (MNHN-IU-2014-21596) (1 ♀ and 1 ♂ dissected) from *Molgula amesophleba* (Codreanu & Mack-Fira, 1956), Etang de Leucate, Mediterranean coast of France (09°15.38′N, 124°39.12′E), coll. 1985.

Description of female. Body (Fig. 12A) narrow; body length of dissected specimen 1.54 mm (other 3 specimens 1.09, 1.44, and 1.58 mm). Prosome 842 µm long; cephalothorax 491×539µm. Urosome (Fig. 12B) 5-segmented; fifth pedigerous somite 186 µm wide; genital double-somite 1.18 times longer than wide (212×179 µm), expanded in middle; genital apertures located dorsolaterally at midlength of double-somite. Three free abdominal somites 75×115, 64×96, and 85×82µm, respectively. Caudal ramus (Fig. 12C) about 4.9 times longer than wide (178×36 µm): armed with 6 setae; innermost distal seta (seta VI) pinnate proximally, other 5 setae naked; 2 median terminal setae tape-like, with membranous fringe along lateral margins; outer lateral seta inserted at about 65% of ramus length. Spermatophore (Fig. 12D) taken from female, bulbous, 84×45 µm.

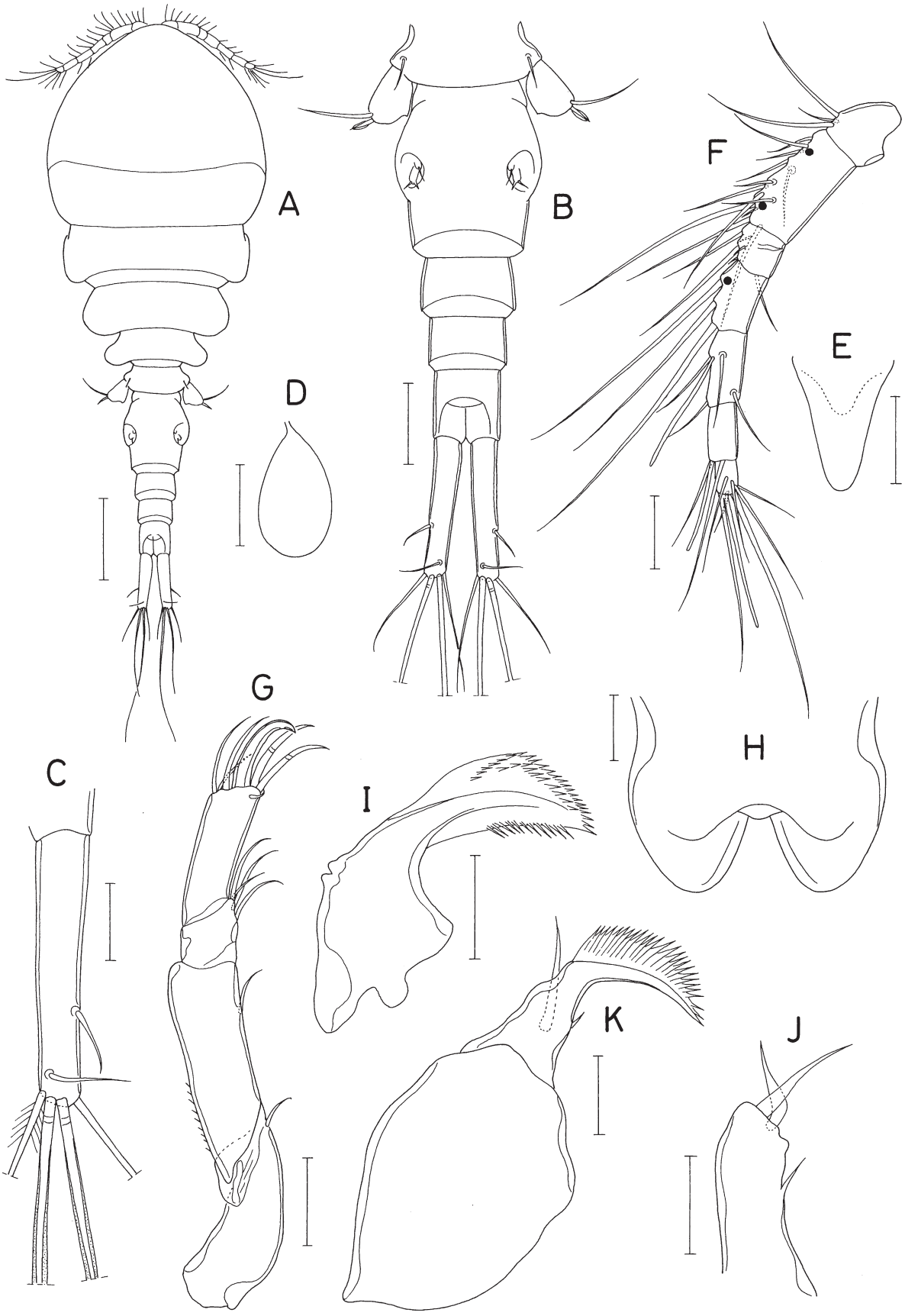

FIGURE 12. *Lichomolgidium sardum* Kossmann, 1877, female. A, habitus, dorsal; B, urosome, dorsal; C, right caudal ramus, dorsal; D, spermatophore; E, rostrum; F, antennule; G, antenna; H, labrum; I, mandible; J, maxillule; K, maxilla. Scale bars: A, 0.2 mm; B, 0.1 mm; C–G, 0.05 mm; H–K, 0.02 mm.

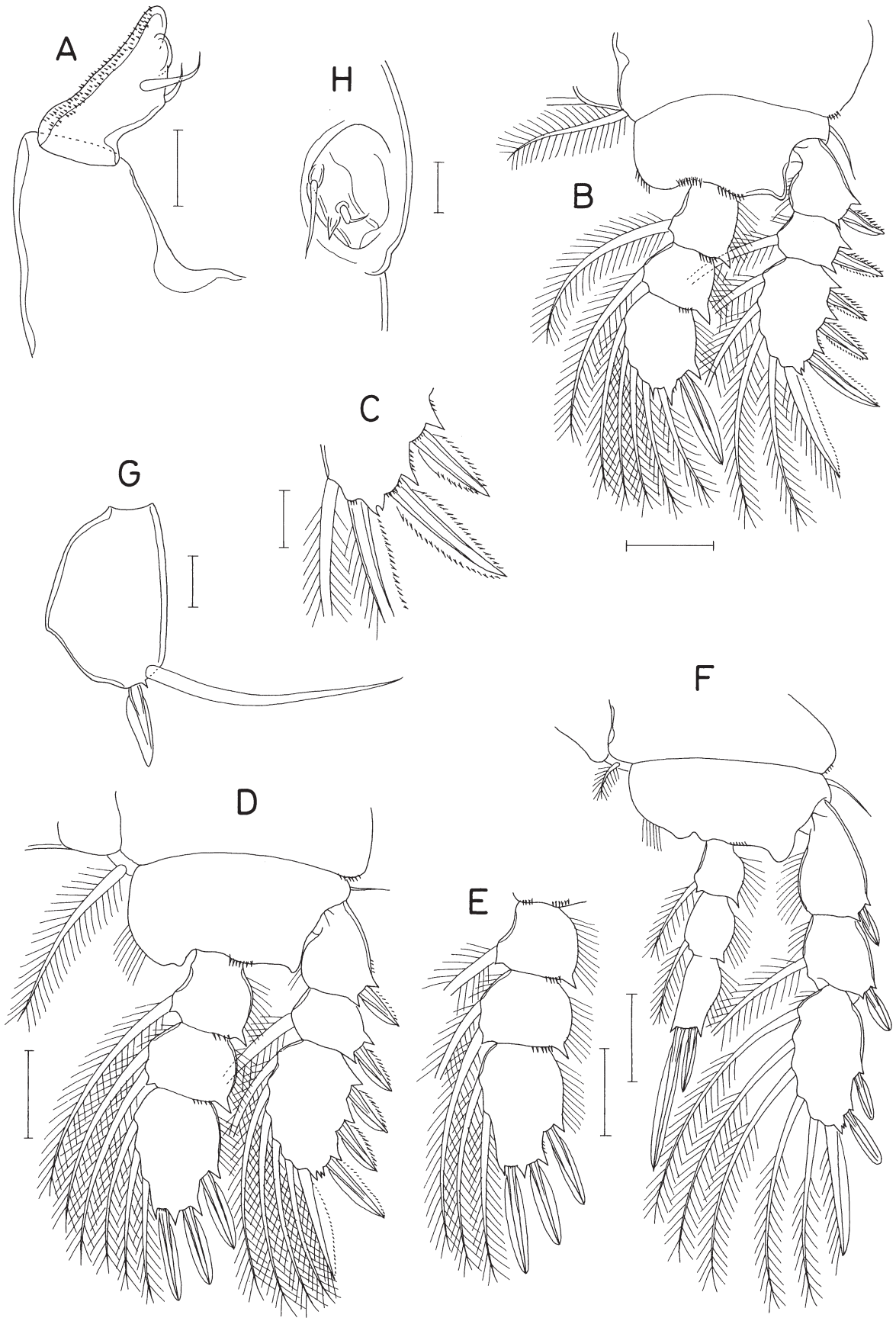

FIGURE 13. *Lichomolgidium sardum* Kossmann, 1877, female. A, maxilliped; B, leg 1; C, distal part of third exopodal segment of leg 1; D, leg 2; E, endopod of leg 3; F, leg 4; G, exopod of leg 5; H, right genital aperture, dorsal. Scale bars: A, C, G, H, 0.02 mm; B, D–F, 0.05 mm.

Rostrum (Fig. 12E) narrow, longer than wide, tapering towards rounded apex. Antennule (Fig. 12F) 298 μm long, 7-segmented; armature formula 3, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked. Antenna (Fig. 12G) 4-segmented; armature formula 1, 1, 4, and 4+3 claws; terminal segment about 2.7 times longer than wide (75×28 μm); distal setae on terminal segment not longer than claws; one distal claw strong, other 2 claws slender, setiform, annulated in middle.

Labrum (Fig. 12H) deeply incised with broad, rounded posterior lobes. Mandible (Fig. 12I) with pair of small lobes on convex margin near base of blade; blade short and broad, lacking distal lash, with 2 rows of spinules along convex outer margin and 1 row of spinules along inner margin. Maxillule (Fig. 12J) armed with 1 setiform process on inner margin and 2 crossing setae on oblique distal margin. Maxilla (Fig. 12K) consisting of syncoxa and basis; syncoxa large but unarmed; basis with short terminal lash with broadly pectinate convex margin and bearing 2 setae (minute inner seta and longer anterior seta). Maxilliped (Fig. 13A) 2-segmented; proximal segment unarmed; distal segment blunt, weakly bilobed at apex, armed with 2 unequal setae on inner side, and ornamented with numerous minute spinules along outer surface.

Legs 1–4 consisting of coxa, basis, and 3-segmented rami (Fig. 13B-F); inner seta on coxa pinnate; outer seta on basis small, naked. Terminal process of third exopodal segment bifid in leg 1 (Fig. 13B, C), but trifid in legs 2–4 (Fig. 13D, F). Leg 3 similar to leg 2, except third endopodal segment bearing 3 spines and 2 setae (Fig. 13E). Articulation incomplete between second and third endopodal segments of leg 4. Third endopodal segment of leg 4 about twice as long as wide (45×23 μm), terminal 2 spines unequal, 38 μm (outer) and 88 μm (inner). Armature formula for legs 1–4 as follows:

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

Leg 5 consisting of dorsolateral seta on fifth pedigerous somite and free exopod; exopodal segment (Fig. 13G) 1.52 times longer than wide (73×48 μm), inflated medially, and widest at 60% of segment length; armed distally with 1 spine (33 μm long), 1 naked seta (105 μm long) and 1 minute denticle. Leg 6 (Fig. 13H) represented by 2 setae and 1 dentiform process, one seta stout and tipped with setule.

Description of male. Body (Fig. 14A) narrower than female. Body length 1.14 mm in dissected specimen; mean body length 1.12 mm (1.05-1.24 mm) based on 6 specimens; prosome 640×378 μm. Urosome (Fig. 14B) 6-segmented: fifth pedigerous somite 105 μm wide; genital somite subcircular, 147×141 μm; 4 abdominal somites 38×71, 42×64, 33×57, and 45×51 μm, respectively. First to third abdominal somites each fringed with spinules along posteroventral margin. Caudal ramus about 4.07 times longer than wide (110×27 μm), armed with 6 naked setae.

Rostrum as in female. Antennule with 3 additional aesthetascs, 2 on second and 1 on fourth segments, as indicated by dots in Fig. 12F. Antenna as in female.

Labrum, mandible, maxillule, maxilla as in female. Maxilliped (Fig. 14C) 4-segmented; first segment unarmed with inflated inner distal half; second segment with 2 setae and spinules on inner side; small third segment unarmed; fourth segment forming strongly curved, long terminal claw bearing 2 unequal setae proximally.

Legs 1-4 as in female. Exopod of leg 5 (Fig. 14D) about 1.8 times longer than wide (45×25 μm); outer margin distinctly convex; terminal spine 24 μm long and terminal seta 64 μm long. Leg 6 (Fig. 14E) represented by 2 naked setae and 1 denticle on genital operculum.

Remarks. There are three nominal species in the genus *Lichomolgidium*: *L. sardum* from the Mediterranean, *L. cynthiae* (Brian, 1924) from the Atlantic, and *L. tupuhiae* Jones, 1975 from New Zealand. Our specimens taken from the ascidian *Molgula amesophleba* in the Mediterranean are very similar to both *L. sardum* and *L. cynthiae*. The latter two species are very similar to each other and their known host ranges overlap, with the former recorded from *Pyura microcosmus* (Savigny, 1816) only, and the latter from *P. microcosmus*, *Styela clava* Herdman, 1881 and *Halocynthia papillosa* (Linnaeus, 1767) (Gotto, 1961; Humes & Stock, 1973). Although Humes and Stock (1973) examined both Mediterranean and Atlantic material and distinguished between them, as *L. sardum* and *L. cynthiae*, respectively, the differences they observed between the two species are very slight or unclear. We care-

fully compared our specimens with the report by Humes & Stock (1973) for *L. sardum* and *L. cynthiae* and found no meaningful difference between them, which leads us to conclude that they are all conspecific. We propose to treat *L. cynthiae* (Brian, 1924) as a junior subjective synonym of *Lichomolgidium sardum* Kossmann, 1877, and our record of this species from *Molgula amesophleba* constitutes a new host record.

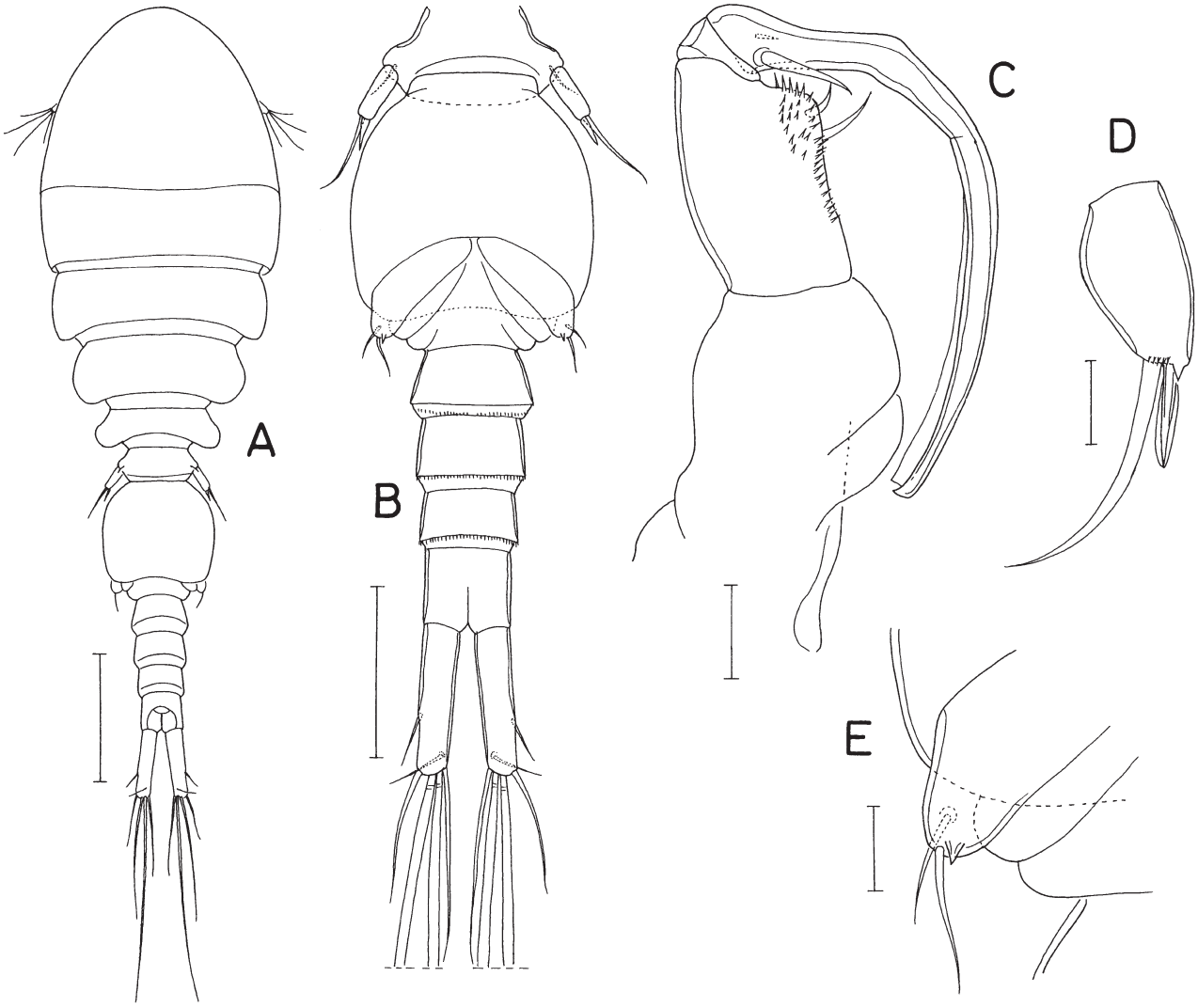

FIGURE 14. *Lichomolgidium sardum* Kossmann, 1877, male. A, habitus, dorsal; B, urosome, ventral; C, maxilliped; D, exopod of leg 5; E, right genital operculum, ventral. Scale bars: A, 0.2 mm; B, 0.1 mm; C–E, 0.02 mm.

***Lichomolgidium bipartitum* sp. nov.**
(Figs. 15, 16)

Type material. Holotype ♀ (MNHN-IU-2014-21597, dissected and mounted on a slide) from *Pyura stolonifera* (Heller, 1878) (MNHN-IT-2008-7777); MRAC-ULB expedition (Musée Royal de l'Afrique Centrale et Université Libre de Bruxelles), Inhaca Is., Mozambique (26°03´S, 32°54´E), depth 10-20 m, 07 August 1969.

Etymology. The name of the new species refers to the 2-segmented endopod of leg 4.

Description of female. Body (Fig. 15A) moderately broad; body length 1.89 µm; prosome 1.06×0.67 mm. Urosome (Fig. 15B) 5-segmented; fifth pedigerous somite 276 µm wide, ornamented with minute spinules at tip of lateral margin. Genital double-somite 255×269 µm, slightly wider than long; genital apertures located dorsally at midlength of double-somite. Three free abdominal somites 109×185, 95×149, and 127×129 µm, respectively. Anal somite ornamented with fine spinules posteroventrally near base of caudal rami. Caudal ramus (Fig. 15C) about 3.4 times longer than wide (182×53 µm) and about 1.4 times longer than anal somite, gradually narrowing distally:

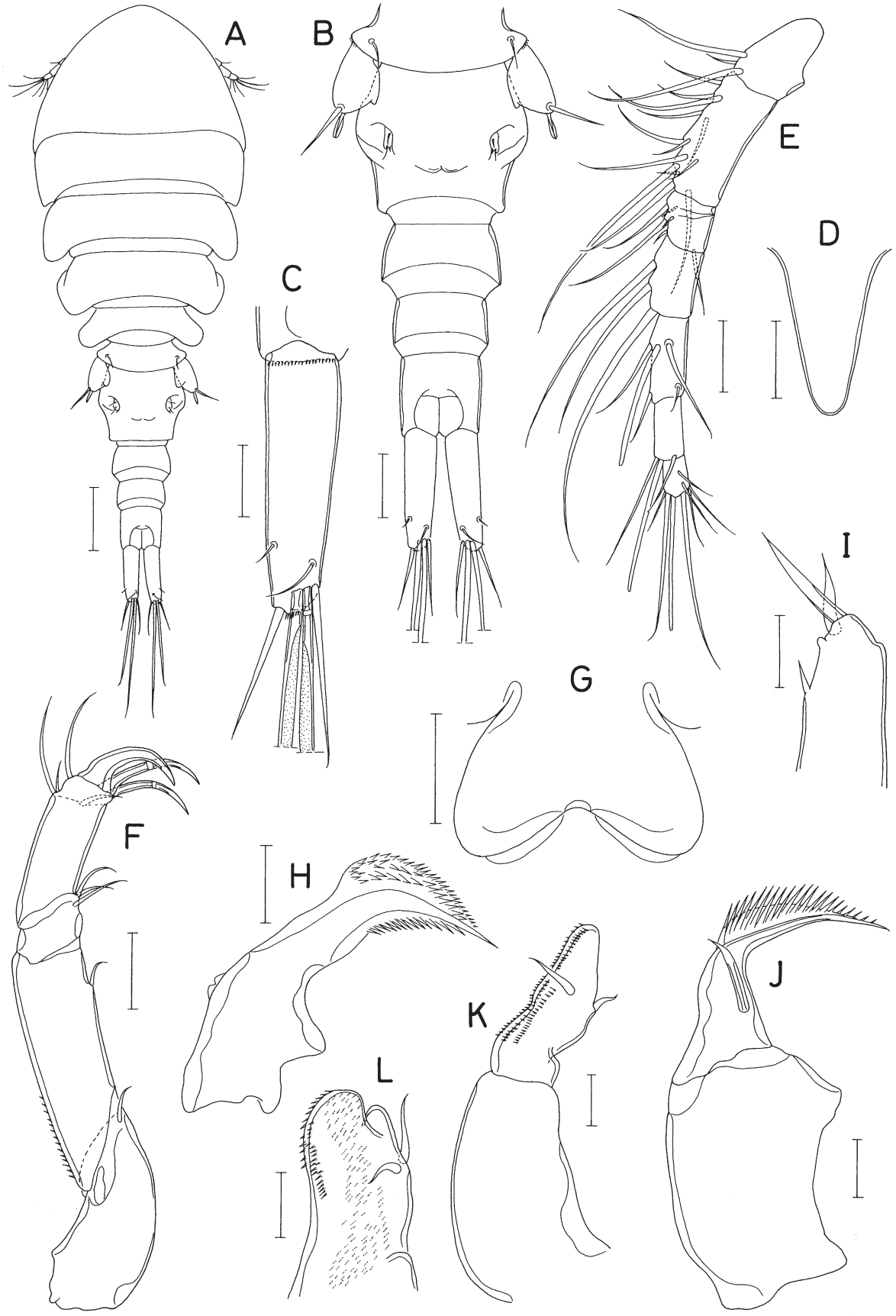

FIGURE 15. *Lichomolgidium bipartitum* **sp. nov.**, female. A, habitus, dorsal; B, urosome, dorsal; C, left caudal ramus, dorsal; D, rostrum; E, antennule; F, antenna; G, labrum; H, mandible; I, maxillule; J, maxilla; K, maxilliped; L, distal segment of maxilliped. Scale bars: A, 0.2 mm; B, 0.1 mm; C–G, 0.05 mm; H–L, 0.02 mm.

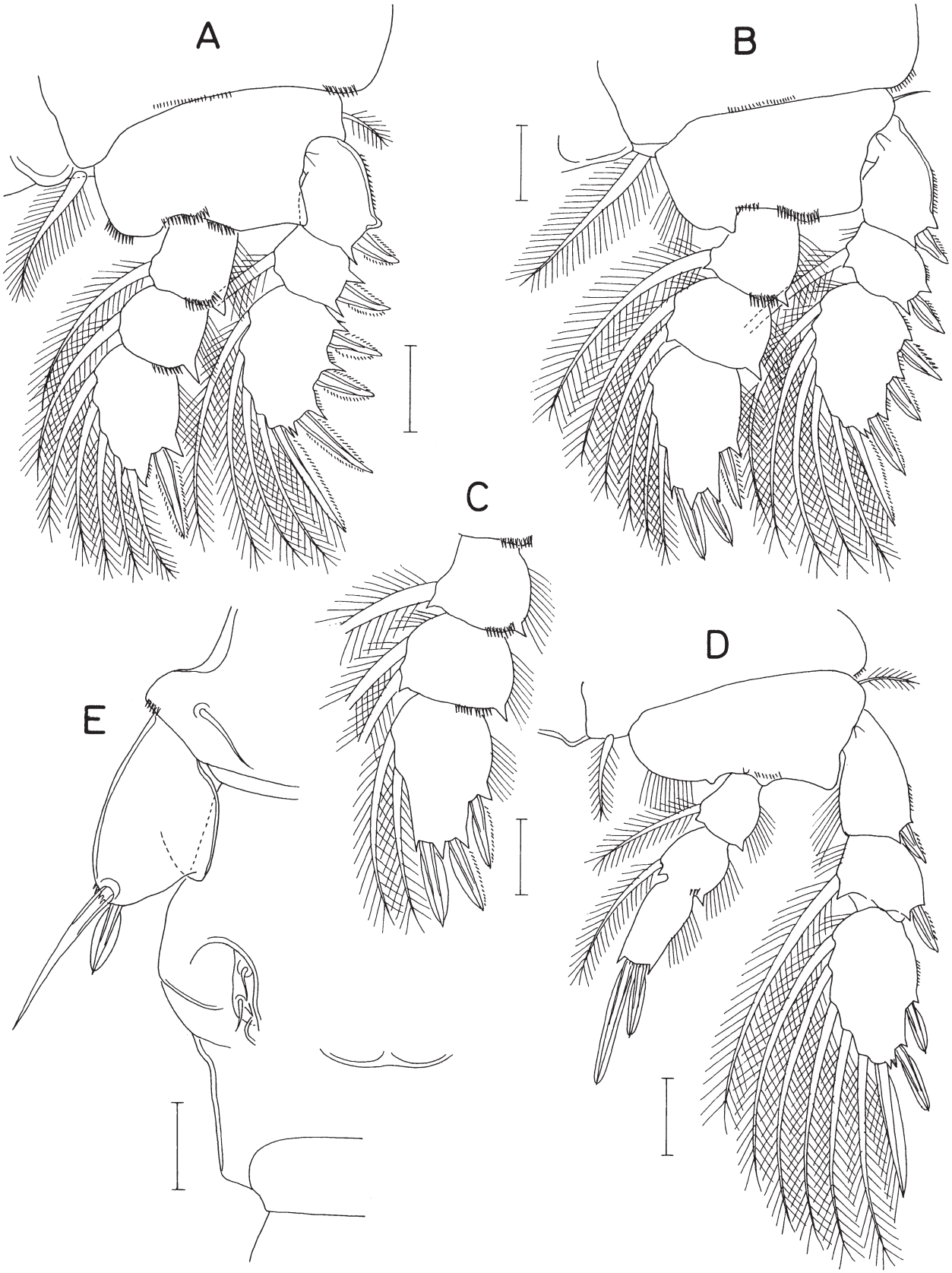

FIGURE 16. *Lichomolgidium bipartitum* **sp. nov.**, female. A, leg 1; B, leg 2; C, endopod of leg 3; D, leg 4; E, left leg 5 and genital aperture, dorsal. All scale bars: 0.05 mm.

armed with 6 naked setae; lateral seta (seta II) reduced (length less than half width of ramus), positioned at 75% of ramus length; 2 mid-terminal setae (setae IV and V) flattened, tape-like, unilaterally fringed with membrane.

Rostrum (Fig. 15D) narrow, longer than wide (about 110×75 μm), tapering to rounded apex. Antennule (Fig. 15E) 356 μm long, 7-segmented; armature formula 3, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked; posterodistal seta on fifth segment reduced, setule-like. Antenna (Fig. 15F) 4-segmented; armature formula 1, 1, 3, and 4+3 claws; terminal segment about 2.4 times longer than wide (85×35 μm); terminal claws consisting of 1 thicker claw plus 2 slender, annulated claws.

Labrum (Fig. 15G) medially incised, distinctly broadened distally, with rounded posterior lobes and membranous fringe along inner margin of lobes. Mandible (Fig. 15H) with 2 small lobes outer margin; distal blade short, broad, with about 3 rows of spinules on convex side, and 1 row of spinules along concave inner margin. Maxillule (Fig. 15I) armed with 1 lateral and 2 apical crossing setae, plus small papilliform process subapically. Maxilla (Fig. 15J) with unarmed syncoxa; basis armed only with spiniform anterior seta; inner and proximal setae (seta I and III) absent; distal lash rather short, pectinate along convex outer margin. Maxilliped (Fig. 15K, L) 2-segmented; proximal segment unarmed; distal segment unequally bifurcate and blunt distally, armed with 2 setae on inner side, and ornamented with numerous minute spinules on outer surface.

Legs 1–4 biramous with 2-segmented protopods (Fig. 16A–D). Legs 1-3 with 3-segmented rami; leg 4 with 3-segmented exopod and 2-segmented endopod. Outer seta on basis pinnate in legs 1 and 4, but naked in legs 2 and 3. Third exopodal segments of legs 1-4 with bifid terminal process (Fig. 16A, B, D). Distal segment of leg 4 endopod with lateral constriction marking original plane of articulation between second and third segments. Terminal spines of leg 4 endopod 47 μm (outer) and 55 μm long (inner). Armature formula for legs 1–4 as follows:

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

Leg 5 (Fig. 16E) consisting of dorsolateral seta on fifth pedigerous somite and free exopod; exopodal segment about 1.6 times longer than wide (106×65 μm), inner margin protruding with angular apex; terminal spine 47 μm and terminal seta 98 μm. Leg 6 (Fig. 16E) represented by 2 small setae and 1 denticle on genital operculum.

Male. Unknown.

Remarks. *Lichomolgidium bipartitum* **sp. nov.** differs from *L. sardum* in the following features: (1) the genital double-somite is wider than long (vs. longer than wide in *L. sardum*); (2) the second endopodal segment of the antenna is armed with 3 setae (vs. 4 setae in *L. sardum*); (3) the caudal ramus is about 1.4 times longer than the anal somite (vs. more than twice as long as the anal somite in *L. sardum*); and (4) the endopod of leg 4 is 2-segmented (vs. 3-segmented in *L. sardum*).

Lichomolgidium tupuhiae is easily separated from other species of *Lichomolgidium* in having 4 setae on the first antennular segment (cf. 3 in other species), and 2 similar setae, rather than 1 spine and 1 seta, on the exopod of leg 5 (Jones, 1975).

The endopod of leg 4 of *L. bipartitum* **sp. nov.** is 2-segmented although the plane of fusion of the second and third segments is readily visible, and its armature formula is 0-1; 0, II, 1. These features are shared by several genera in the family Lichomolgidae, including: *Ascidioxynus*, *Astericola* Rosoll, 1888, *Paclabius* Kossmann, 1877, *Stellicola* Kossmann 1877, and *Synstellicola* Humes & Stock, 1972. Nevertheless, the new species is accommodated in *Lichomolgidium* because it shares other typical character states of this genus, such as the possession of 3 (1 thick and 2 slender) terminal claws on the antenna, a short blade on the mandible, the 2-segmented maxilliped with a blunt distal tip on the second segment, the lack of an inner seta (seta I) on the distal segment (basis) of the maxilla, and the inflated exopod of female leg 4.

Genus *Lichomolgus* Thorell, 1859

Remarks. The genus *Lichomolgus* currently contains 30 known species associated mainly with ascidian and bivalve hosts. The segmentation of the antenna is an important character in the taxonomy of lichomolgoid copepods. According to Humes & Stock (1973), the antenna of *Lichomolgus* is 4-segmented, although in *L. chamarum* Humes, 1968 the articulation between the third and fourth segments is obscure. During our comparisons between *Lichomolgus* species, we concluded that six species of this genus have been inappropriately placed in this genus, namely: *L. arcanus* Humes and Cressey, 1958, *L. asaphidis* Humes, 1959, *L. chamarum*, *L. hippopi* Humes, 1976, *L. spondyli* Yamaguti, 1936, and *L. uncus* Jones, 1976. The original descriptions of these six species all refer to the antenna as 4-segmented but the published illustrations in these descriptions all show the antenna as 3-segmented. The terminal segment of the antenna often has a suture-like transverse line subdistally, and we consider this was probably interpreted as a true segmental boundary in these descriptions.

Lichomolgus inflatus Tanaka, 1961 was also reported as having a 4-segmented antenna in the original description (Tanaka, 1961). The figure of the female antenna of this species is difficult to interpret, but the male antenna was figured as clearly 3-segmented. Considering that no sexual dimorphism has been reported for the segmentation of the antenna in the Lichomolgidae, we consider that the female antenna should also be regarded as 3-segmented in this species. All seven of the above species are associates of bivalves and it seems likely that a new genus should be established to accommodate these species.

Lichomolgus canui Sars, 1917

(Figs. 17, 18)

Material examined. 1 ♀ (MNHN-IU-2014-21487) in *Molgula helleri* Drasche, 1884 (MNHN-IT-2008-5542 = MNHN S3/MOL.A/163), Mar Grande, Tarento, Italy, 1978.

Redescription of female. Body (Fig. 17A) with slightly inflated prosome and slender urosome; body length 1.35 mm; prosome 782×505 μm. Cephalothorax sub-globular, with faint dorsal suture line between cephalosome and first pedigerous somite. Urosome (Fig. 17B) 5-segmented; fifth pedigerous somite 127 μm wide, distinctly narrower than genital double-somite. Genital double-somite longer than wide (193×155 μm); with expanded anterior half; genital apertures positioned dorsolaterally at mid-length of double-somite. Three free abdominal somites unornamented, 60×82, 47×70, and 68×73 μm, respectively. Caudal rami slightly divergent; each ramus (Fig. 17C) about 3.0 times longer than wide (120×40 μm): armed with 6 setae; all caudal setae naked and shorter than ramus; 4 distal setae bluntly tipped; lateral seta (seta II) positioned at 57% of ramus length.

Rostrum (Fig. 17D) well-developed, nearly spatulate. Antennule (Fig. 17E) slender, 280 μm long, 7-segmented; armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked. Antenna (Fig. 17F) 4-segmented; armature formula 1, 1, 3, and 5+2 claws; first endopodal segment (second segment) ornamented with numerous fine spinules on outer surface; third endopodal segment about 1.6 times longer than wide (42×26 μm); 2 terminal claws unequal (inner broader and shorter than outer).

Labrum (Fig. 17G) with subquadrate posterior lobes; each lobe with broad membranous fringe along inner margin and angularly projecting lateral margin. Mandible (Fig. 17H) slender, with elongate, proximally curved distal lash, ornamented with 4 rows of short spinules along convex margin and 1 row of longer spinules along concave margin. Maxillule (Fig. 17I) with 1 small setiform process subdistally and 2 broad, annulated setae distally. Maxilla (Fig. 17J) consisting of syncoxa and basis; syncoxa unarmed; basis produced into extremely elongate terminal lash and bearing 3 setae; distal lash ornamented with row of spinules proximally along outer margin (proximalmost spinule thick, claw-like); inner seta (seta I) slightly longer than half length of distal lash, spinulose along outer margin. Maxilliped (Fig. 17K) 3-segmented; first segment unarmed; second segment broadened near middle and armed with 2 equal setae; small third segment terminating in spiniform, abruptly bent process, with 1 small seta subdistally.

Legs 1–3 with 3-segmented rami (Fig. 18A-C). Leg 4 (Fig. 18D) with 3-segmented exopod and 2-segmented endopod. Outer spines on second and third exopodal segments of leg 1 (Fig. 18A) with serrate proximal margin and fringed with membrane along distal margin. Leg 3 same as leg 2, except third endopodal segment armed with 3 spines and 2 setae (Fig. 18C). Second endopodal segment of fourth leg about 2.8 times longer than wide (65×23 μm); lengths of terminal spines, 35 μm (outer) and 64 μm (inner). Armature formula for legs 1–4 as follows:

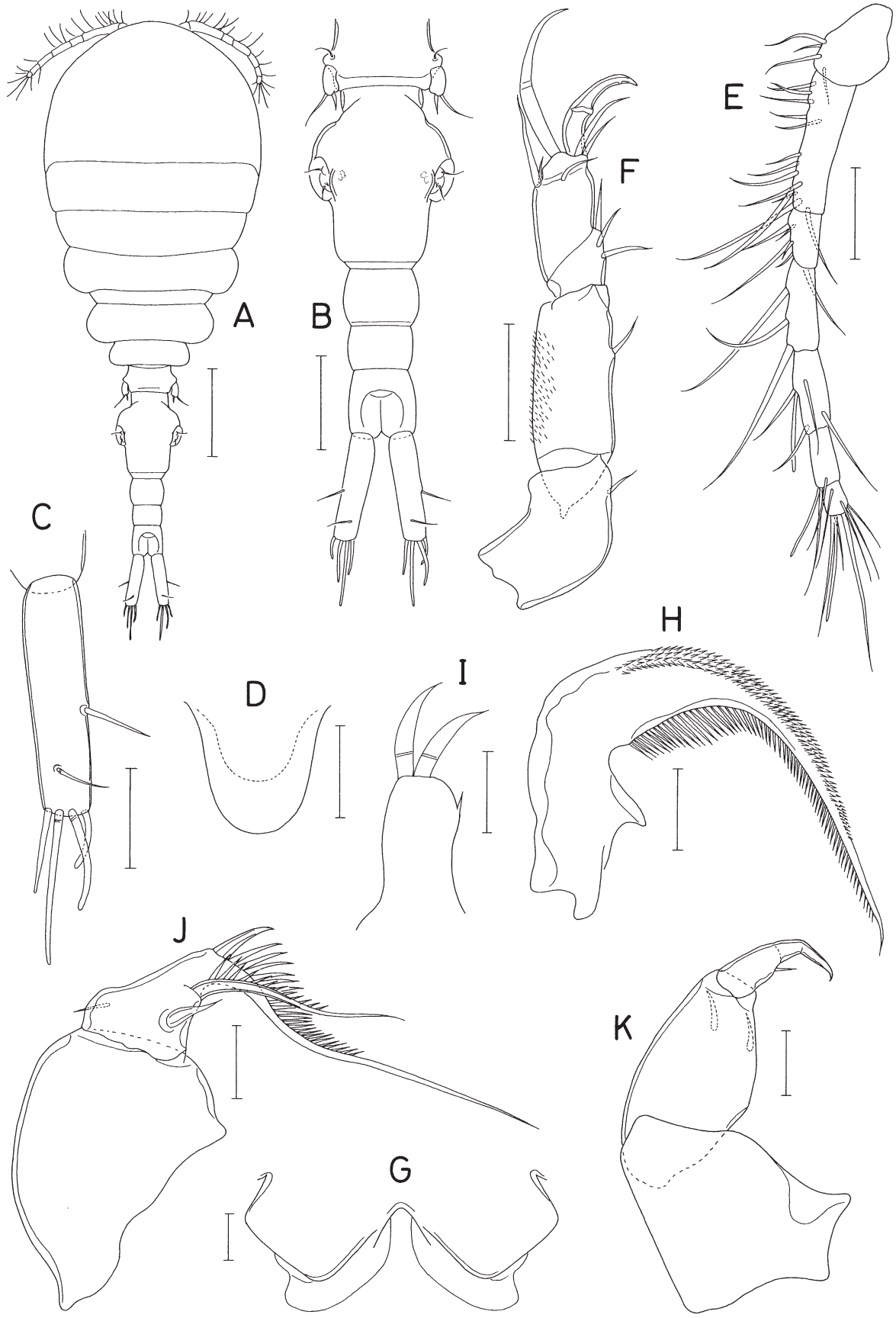

FIGURE 17. *Lichomolgus canui* Sars, 1917, female. A, habitus, dorsal; B, urosome, dorsal; C, right caudal ramus, dorsal; D, rostrum; E, antennule; F, antenna; G, labrum; H, mandible; I, maxillule; J, maxilla; K, maxilliped. Scale bars: A, 0.2 mm; B, 0.1 mm; C–F, 0.02 mm; G–K, 0.02 mm.

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

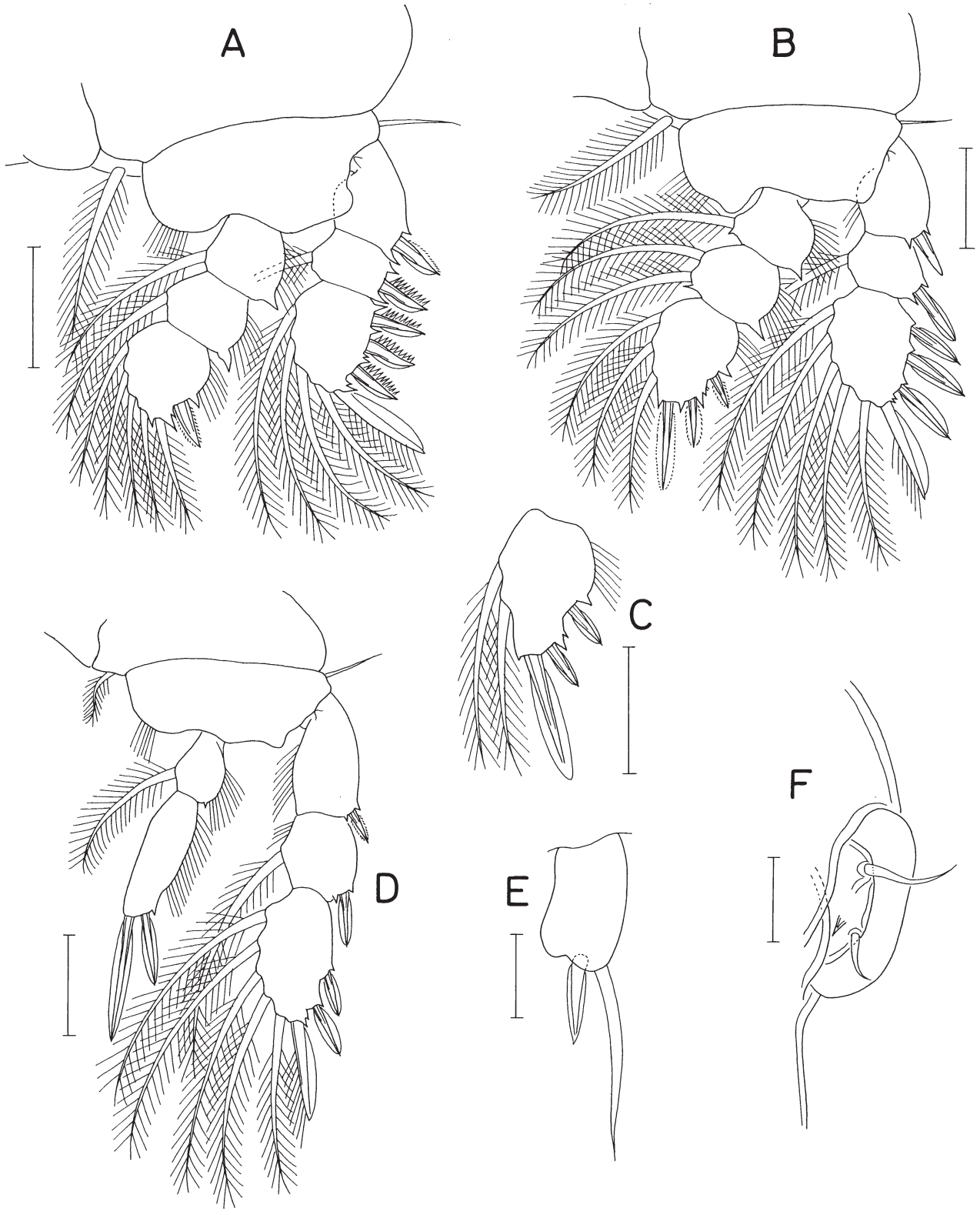

FIGURE 18. *Lichomolgus canui* Sars, 1917, female. A, leg 1; B, leg 2; C, distal segment of endopod of leg 3; D, leg 4; E, exopod of leg 5; F, right genital aperture, dorsal. Scale bars: A–D, 0.05 mm; E, F, 0.02 mm.

Leg 5 consisting of dorsolateral seta on fifth pedigerous somite and free exopod: exopodal segment (Fig. 18E) about 1.8 times longer than wide (32×18 μm), with slightly inflated inner distal margin; terminal spine 21 μm and terminal seta 46 μm. Leg 6 (Fig. 18F) represented by 2 naked setae and 1 denticle on genital operculum.

Male. Not found.

Remarks. In the original description of *L. canui*, Sars (1917) correctly illustrated the shape of the female maxilliped showing the terminal segment as abruptly bent. This form of female maxilliped seems to be a specific feature of *L. canui*, which is also exhibited by our specimen. Other features of this species, such as the slightly divergent caudal rami which are about twice as long as the anal somite, and the terminal segment of the antenna which is about 1.6 times longer than wide and armed with 1 strong inner claw and 1 elongate outer claw, are also shared by Sars' type specimens and our Mediterranean female. The ascidian *Molgula helleri* from which our copepod was extracted is a new host record for *L. canui*.

Lichomolgus forficula Thorell, 1860

(Figs. 19, 20)

Material examined. 2 ♀♀ (MNHN-IU-2014-21598) (1 ♀ dissected) in *Ascidia mentula* Müller, 1776, Corsica (42°10.70′N, 09°36.22′E), MEDITS 2016 cruise, RV "L'Europe", Stn M16-1, October 2016.

Supplementary description of female. Body (Fig. 19A) with moderately broad prosome and slender urosome. Body length 1.20 mm; prosome 564×389 μm. Dorsal suture line indistinct between cephalosome and first pedigerous somite. Urosome (Fig. 19B) 5-segmented; fifth pedigerous somite 91 μm wide, narrower than genital double somite. Genital double-somite about 1.5 times longer than wide (158×105 μm), with roundly expanded anterior half and tapering distal half; genital apertures positioned dorsolaterally in middle of double-somite. Three free abdominal somites 48×57, 30×48, and 102×45 μm, respectively; anal somite characteristically elongate (about 2.3 times longer than wide). Caudal ramus (Fig. 19B) elongate, about 12.8 times longer than wide (205×16 μm), armed with 6 small, thin setae; lateral seta (seta II) and dorsal seta (seta VII) both positioned at about 37% of ramus length.

Rostrum (Fig. 19C) longer than wide, clearly defined from cephalosome, gently tapering towards rounded apex. Antennule (Fig. 19D) 214 μm long, 7-segmented; terminal segment shortest; armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; 1 of distal setae on second segment distinctly longer than other setae. Antenna (Fig. 19E) 4-segmented; armature formula 1, 1, 3, and 4+3 claws; third segment (second endopodal segment) bearing 1 distinct and 2 minute, setule-like setae; terminal segment about 3.1 times longer than wide (55×18 μm); 3 terminal claws extremely unequal in size, 70, 28, and 15 μm long, respectively, smallest hardly visible.

Labrum (Fig. 19F) broad and deeply incised; posterior lobes defined from proximal part by surface suture, fringed with narrow membrane along free posterior margin. Mandible (Fig. 19G) moderately narrow, with elongate distal lash; ornamented with several rows of spinules on convex outer surface and 1 row of thin spinules along concave inner margin. Maxillule (Fig. 19H) lobate, armed with 2 unequal setae on distal margin and 1 small, thin seta on inner margin. Maxilla (Fig. 19I) consisting of syncoxa and basis; syncoxa unarmed; basis with 3 unequal setae, inner seta (seta I) large, with 2 rows of spinules along distal margin; distal lash set at right angle to proximal part of basis, ornamented with row of elongate spinules along outer margin. Maxilliped (Fig. 19J) 3-segmented; first segment unarmed; second segment tapering and armed with 2 small setae subdistally; third segment small, claw-like, bearing 1 minute seta proximally.

Legs 1-3 (Fig. 20A-C) biramous, consisting of coxa, basis, and 3-segmented rami. Inner coxal seta of legs 1-3 pinnate, but that of leg 4 minute and naked. Outer seta on basis of legs 1-4 naked. Third exopodal segment of leg 3 armed with 3 spines and 5 setae, as in leg 4. Leg 4 (Fig. 20D) with 3-segmented exopod and 2-segmented endopod; inner seta on proximal endopodal segment about half as long as distal endopodal segment; distal endopodal segment slightly curved, armed with 2 very unequal spines on distal margin, larger inner spine more than 3 times longer than outer, both shorter than segment. Armature formula for legs 1-4 as follows

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

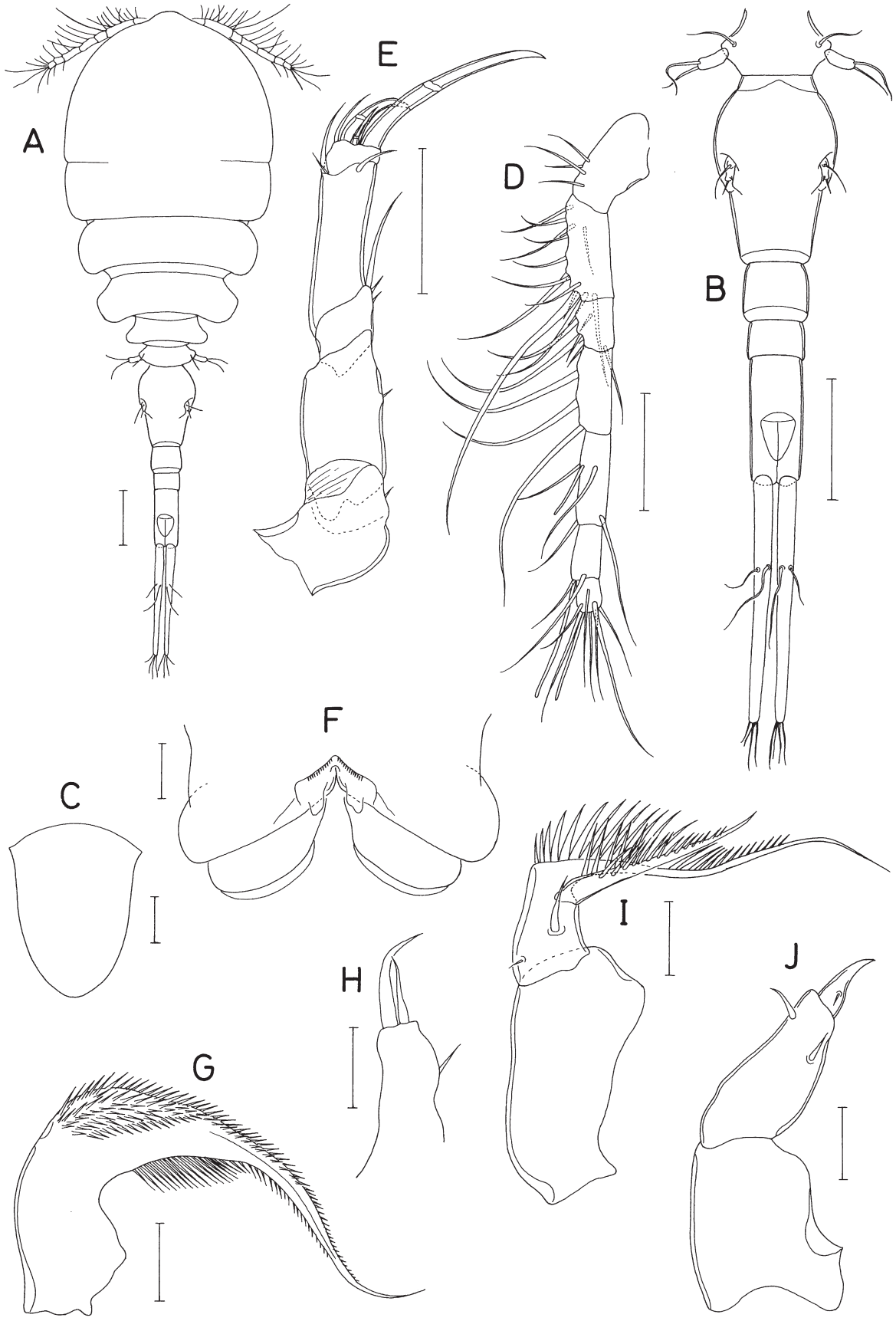

FIGURE 19. *Lichomolgus forficula* Thorell, 1860, female. A, habitus, dorsal; B, urosome, dorsal; C, rostrum; D, antennule; E, antenna; F, labrum; G, mandible; H, maxillule; I, maxilla; J, maxilliped. Scale bars: A, B, 0.1 mm; C, F–J, 0.02 mm; D, E, 0.05 mm.

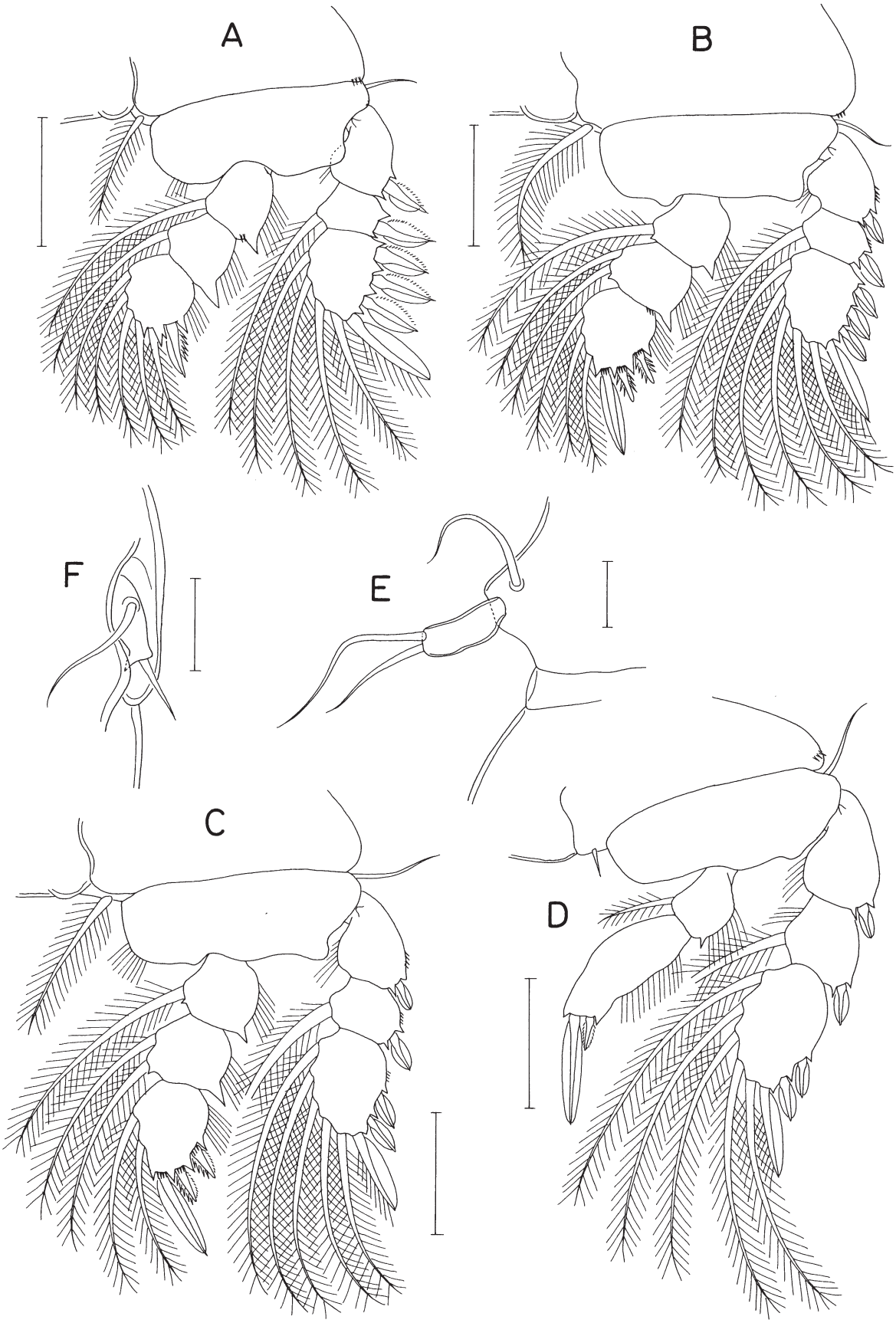

FIGURE 20. *Lichomolgus forficula* Thorell, 1860, female. A, leg 1; B, leg 2; C, leg 3; D, leg 4; E, leg 5; F, right genital aperture, dorsal. Scale bars: A–D, 0.05 mm; E, F, 0.02 mm.

Leg 5 (Fig. 20E) consisting of dorsolateral seta on fifth pedigerous somite and free exopod; exopodal segment about 2.6 times longer than wide (28×11 μm), armed distally with 2 unequal, naked setae. Leg 6 (Fig. 20F) represented by 2 naked setae and 1 small cusp on genital operculum.

Male. Not found.

Remarks. *Lichomolgus forficula* can readily be identified by its characteristic features, including the elongate anal somite and caudal rami, and the presence of the two very unequal terminal claws on the antenna. The third exopodal segment of leg 3 of *L. forficula* is armed with 3 spines and 5 setae (armature formula II, I, 5). This feature is shared with *L. marginatus* Thorell, 1859 and *L. furcillatus* Thorell, 1859. All three of these species are associated with ascidians and probably represent a distinct genus, but the entire genus is in need of revision.

Lichomolgus papuensis sp. nov.

(Figs. 21, 22)

Type material. Holotype ♀ (MNHN-IU-2009-5188) and paratype ♀ (MNHN-IU-2014-21599). Dissected paratype ♀ (MNHN-IU-2014-21489) from *Rhopalaea circula* Monniot F. & Monniot C., 2001: Madang Resort, Madang, Papua New Guinea, PAPUA NIUGINI Expedition, Stn PR72 (05°12.5'S, 145°48.5'E), MNHN coll., 21 November 2012.

Etymology. The name of the new species is taken from its type locality, Papua New Guinea.

Description of female. Body (Fig. 21A) consisting of broad prosome and moderately narrow urosome; body length 1.08 mm in dissected paratype; prosome 704×500 μm. Cephalothorax expanded, sub-globular, with faint suture line dorsally between cephalosome and first pedigerous somite. Urosome (Fig. 21B) 5-segmented; fifth pedigerous somite 112 μm wide. Genital double-somite 163×135 μm, widest at about 45% of double-somite length; genital apertures located dorsolaterally just posterior to widest region of double-somite; posterior region gradually narrowing posteriorly. Three free abdominal somites 48×67, 35×63, and 56×67 μm, respectively; anal somite with minute spinules along posteroventral border. Caudal ramus (Fig. 21C) broad, about 2.6 times longer than wide (87×34 μm), with 6 caudal setae (or insertion scars of setae); lateral seta located at about 63% of ramus length.

Rostrum (Fig. 21D) broadly rounded, with sclerotized lateral margins and faint posterior margin. Antennule (Fig. 21E) 270 μm long, 7-segmented; terminal segment shortest; armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked. Antenna (Fig. 21F) 4-segmented; armature formula 1, 1, 3, and 5+2 claws; setae small, setule-like; terminal segment about 2.3 times longer than wide (35×15 μm): 2 terminal claws very unequal in length, inner claw as long as terminal segment and twice as long as outer claw, with membranous tip.

Labrum (Fig. 21G) with swollen posterior lobes and deep median incision; each lobe strongly tapering, with 2 convex swellings on outer margin. Mandible (Fig. 21H) slender, with elongate lash and 1 row of spinules along both margins of blade and lash. Maxillule (Fig. 21J) as lobe, slightly broadening distally, armed with 3 setae (2 apical and 1 inner distal); inner distal seta transparent. Maxilla (Fig. 21I) 2-segmented; proximal segment (syncoxa) unarmed; distal segment with elongate distal lash, armed with spiniform inner and slender anterior setae; inner spiniform seta ornamented with spinules along outer margin; distal lash whip-like, directed at right angle from basis, ornamented with row of spinules proximally on outer margin. Maxilliped (Fig. 21K) 3-segmented; first segment unarmed; second segment with single small seta subdistally; small terminal segment tapering and claw-like, with 1 small seta proximally.

Legs 1-3 with 3-segmented rami (Fig. 22A-C). Basis of legs 1-4 with naked outer seta. Basis of legs 2 and 3 with semicircular lobe on inner distal margin. Third endopodal segment of leg 3 armed with 3 spines and 2 setae (Fig. 22C), otherwise leg 3 same as leg 2. Leg 4 (Fig. 22D) with 3-segmented exopod and 2-segmented endopod; distal endopodal segment 2.05 times longer than wide (45×22 μm); 2 terminal spines 23 μm (outer) and 40 μm (inner). Outer spines on rami of legs 1-4 small, naked or weakly serrate. Armature formula for legs 1–4 as usual for the genus.

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

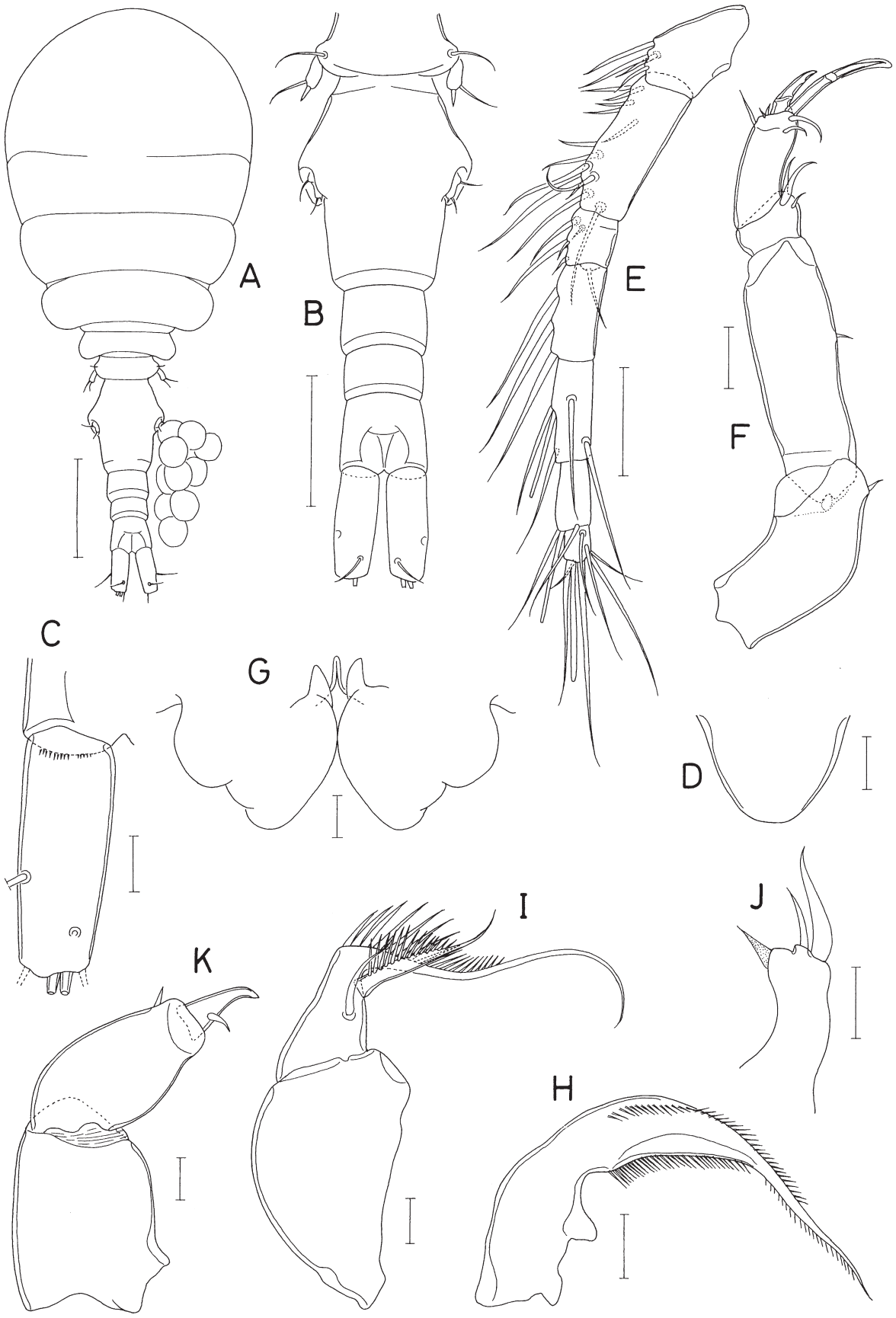

FIGURE 21. *Lichomolgus papuensis* **sp. nov.**, female. A, habitus, dorsal; B, urosome, dorsal; C, left caudal ramus, dorsal; D, rostrum; E, antennule; F, antenna; G, labrum; H, mandible; I, maxilla; J, maxillule; K, maxilliped. Scale bars: A, 0.2 mm; B, 0.1 mm; C, D, F, 0.02 mm; E, 0.05 mm; G–K, 0.01 mm.

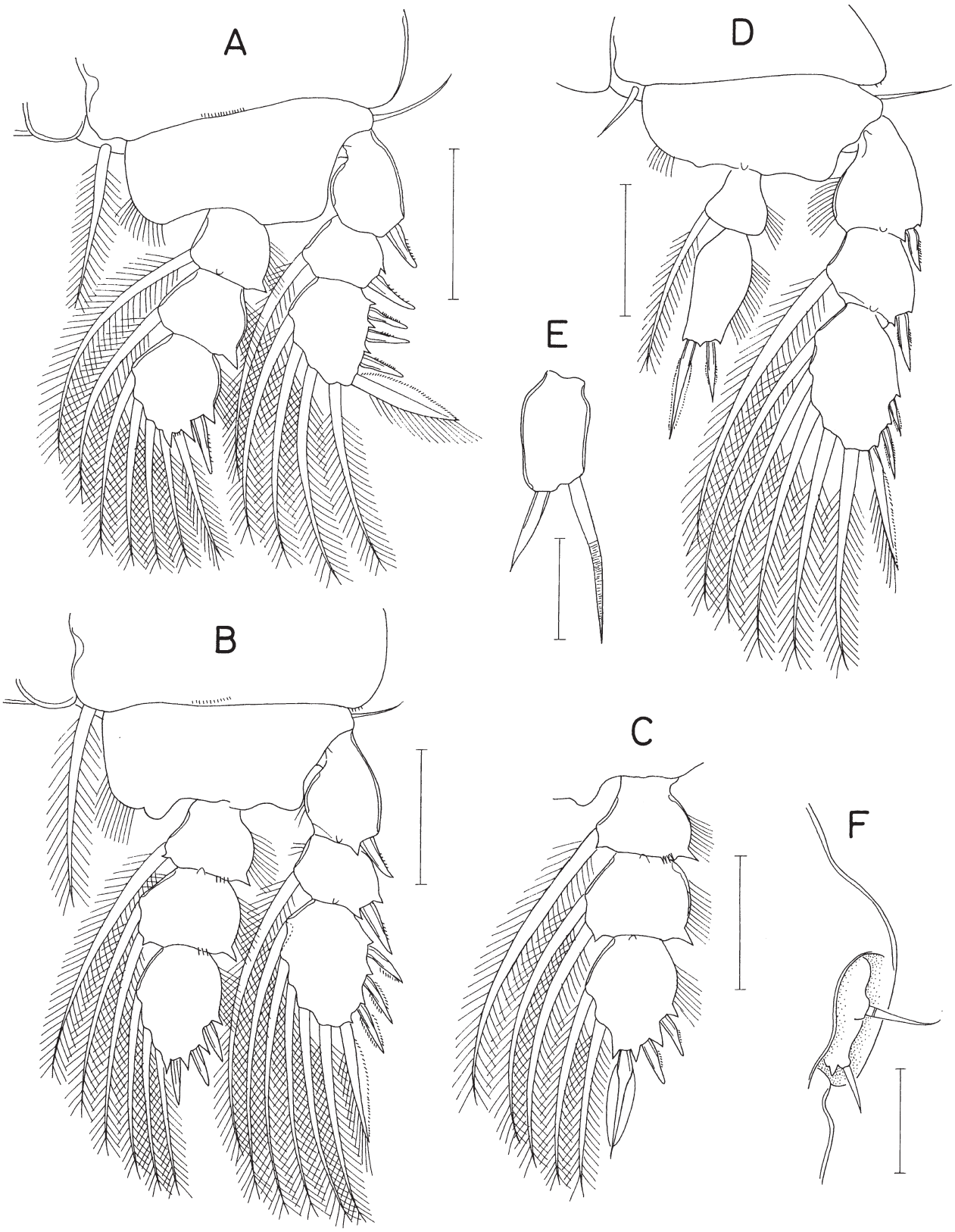

FIGURE 22. *Lichomolgus papuensis* **sp. nov.**, female. A, leg 1; B, leg 2; C, endopod of leg 3; D, leg 4; E, exopod of leg 5; F, right genital aperture, dorsal. Scale bars: A–D, 0.05 mm; E, F, 0.02 mm.

Leg 5 consisting of dorsolateral seta on fifth pedigerous somite and free exopod; exopodal segment (Fig. 22E) roughly rectangular, 1.9 times longer than wide (19×10 μm), armed distally with 1 spine (12 μm long) and 1 seta (25 μm long). Leg 6 (Fig. 22F) represented by 2 setae and 1 denticle on genital operculum.

Male. Unknown.

Remarks. The terminal segment of the antenna of species of *Lichomolgus* is armed with 1 to 4 claws distally, in addition to setae, and various combinations of claw shapes are expressed, according to species, as follows: a single strong claw, or 2 setiform claws, or 2 strong claws, or 1 strong + 2 setiform claws, or 2 strong + 1 setiform claws, or 1 strong + 3 setiform claws, or 2 strong and 2 setiform claws. Two strong terminal claws on the antenna, as found in the new species, are present in four congeners, *L. diazonae* Gotto, 1961, *L. forficula*, *L. ieversi* Thompson & Scott, 1903, and *L. indicus* Ummerkutty, 1962. The length/width ratios of the caudal rami vary in these species, and this is therefore useful to distinguish between them. The ratio is less than 1:1 (wider than long) in *L. indicus* but more than 5:1 in other three species. Therefore, these four species are easily distinguished from *L. papuensis* **sp. nov.** in which the ratio is 2.64:1.

Lichomolgus papuensis **sp. nov.** can also be compared with congeners that share a similar length/width ratio of the caudal ramus. The ratio in *L. papuensis* **sp. nov.** is 2.64:1. Similar ratios, (i.e. in the range of 2:1 to 3:1), are found in three species: *L. furcillatus* in which the ratio is about 3:1 measured from the illustration of Sars (1917), *L. hippopi* in which the ratio is 2.44:1 (Humes, 1976), and *L. hoi* Stock, 1995, in which the ratio is about 2.1:1 (60×29 μm, according to Stock, 1995). These three congeners can readily be distinguished from the new species. In *L. furcillatus*, which is associated with ascidians in the North East Atlantic and the Mediterranean Sea (Humes & Stock, 1973), the third exopodal segment of leg 3 is armed with 3 spines and 5 setae (rather than 4 spines and 5 setae, as in the new species) and the distal endopodal segment of leg 4 is elongate (Sars, 1917). In *L. hippopi*, which is associated with bivalve molluscs in the Moluccas, the antenna is 3-segmented and armed with a single large terminal claw, the maxillule is armed with 2 setae, the third exopodal segment of leg 4 is armed with 4 spines and 5 setae (rather than 3 spines and 5 setae, as in the new species), and the distal endopodal segment of leg 4 has a cusp on the outer margin (Humes, 1976). Finally, in *L. hoi*, which is associated with bivalve molluscs in New Guinea, the genital apertures of the female are positioned posterior to the middle of the genital double-somite, the distal endopodal segment of leg 4 has a cusp on the outer margin, and the exopodal segment of leg 5 is inflated with a convex inner margin (Stock, 1995).

Lichomolgus brevicaudatus **sp. nov.**

(Figs. 23–25)

Type material. Holotype ♀ (MNHN-IU-2014-21600) and paratype ♂ (MNHN-IU-2014-21601), plus 1 ♀, 1 ♂ dissected paratypes (MNHN-IU-2014-21488) from *Polycarpa* sp. MNHN-IT-2008-6805 (=MNHN S1/Pol.B/326); About 1 mile West of Murex resort, West of Manado, Sulawesi, Indonesia, OCDN A5, Site MANADO 12, CRRF coll., 14 May 1993.

Etymology. The specific name is derived from the Latin *brev* (=short) and *caud* (=the tail), alluding to the short caudal rami of the new species.

Description of female. Body (Fig. 23A) consisting of ovoid prosome and small urosome; body length 1.02 mm; prosome 670×473 μm. Cephalothorax with faint, indistinct dorsal suture line between cephalosome and first pedigerous somite. Urosome (Fig. 23B) 5-segmented; fifth pedigerous somite 109 μm wide; genital double-somite subcircular, expanded, slightly longer than wide (175×153 μm); genital apertures positioned dorsolaterally, slightly posterior to middle of double-somite. Three free abdominal somites not ornamented, 48×64, 36×57, and 34×59 μm, respectively. Caudal ramus (Fig. 23C) 1.15 times longer than wide (31×27 μm); armed with 6 setae, all setae located subdistally or distally; setae IV-VI pinnate, other 3 setae naked. Egg sac cylindrical, 538×182 μm; each egg about 65 μm in diameter.

Rostrum (Fig. 23E) with broadly rounded posterior margin. Antennule (Fig. 23F) slender, 298 μm long, 7-segmented; armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked. Antenna (Fig. 23G) 4-segmented, with armature formula 1, 1, 4, and 4+3 claws; one of 4 setae on third segment (second endopodal segment) minute, setule-like; terminal segment about 2.0 times longer than wide (44×22 μm); 3 terminal claws consisting of 1 strong, shorter outer claw and 2 longer, annulated setiform inner claws; largest distal seta longer than terminal segment.

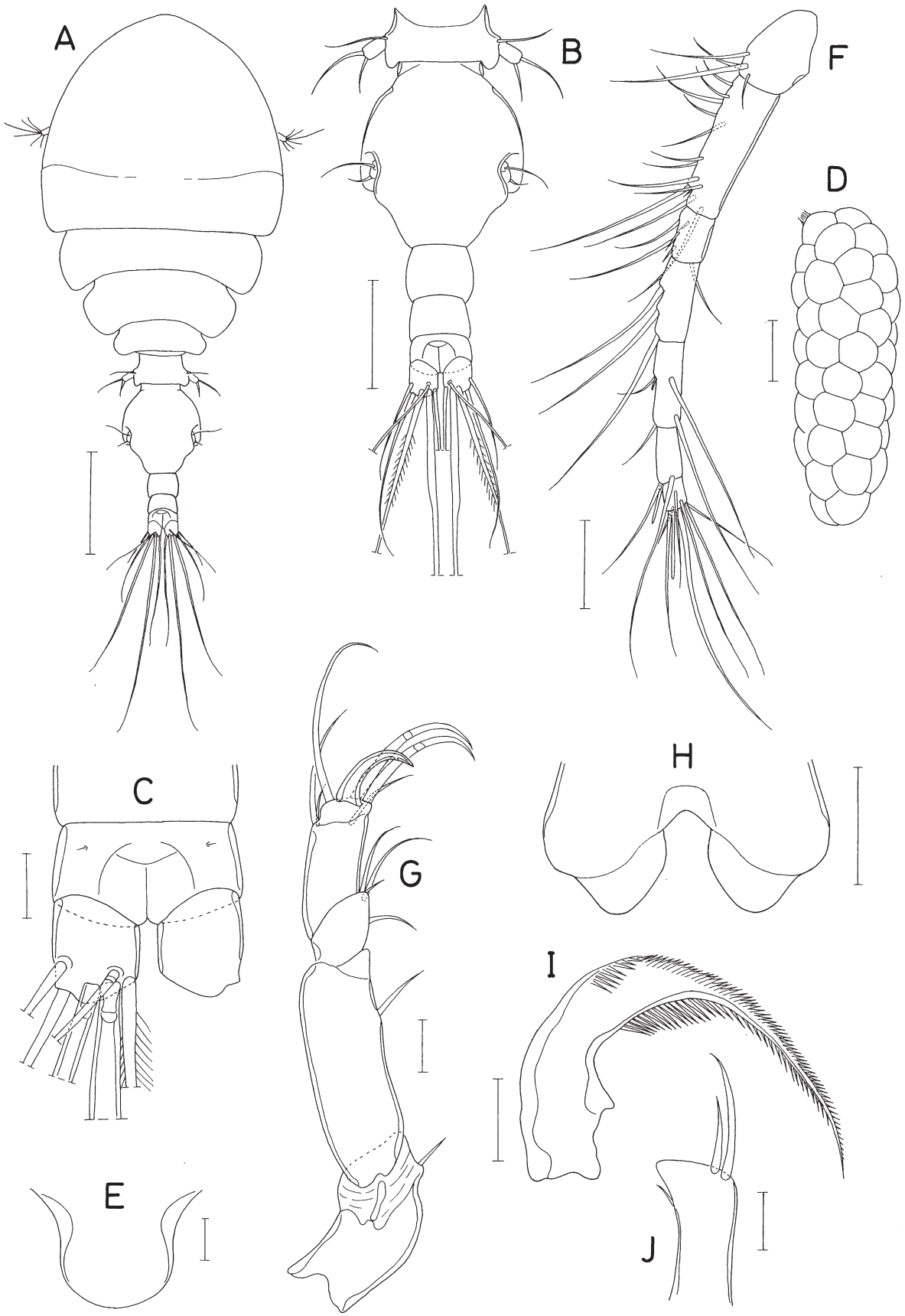

FIGURE 23. *Lichomolgus brevicaudatus* **sp. nov.**, female. A, habitus, dorsal; B, urosome, dorsal; C, anal somite and caudal rami, dorsal; D, egg sac; E, rostrum; F, antennule; G, antenna; H, labrum; I, mandible; J, maxillule. Scale bars: A, 0.2 mm; B, D, 0.1 mm; C, E, G, I, J, 0.02 mm; F, H, 0.05 mm.

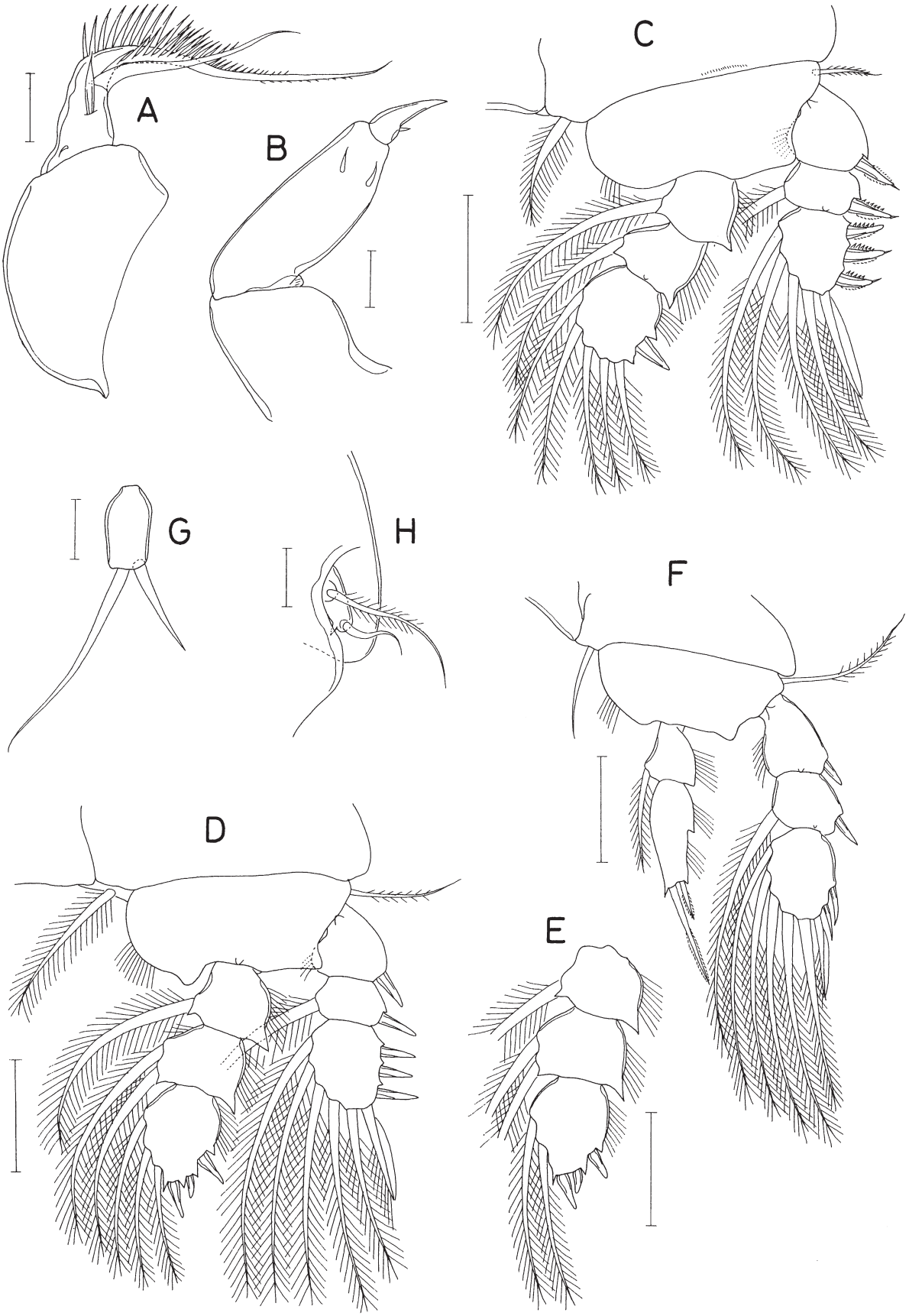

FIGURE 24. *Lichomolgus brevicaudatus* **sp. nov.**, female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, endopod of leg 3; F, leg 4; G, exopod of leg 5; H, right genital aperture, dorsal. Scale bars: A, B, G, H, 0.02 mm; C–F, 0.05 mm.

Labrum (Fig. 23H) with broad median incision and broad hyaline fringe along inner margin of posterior lobes. Mandible (Fig. 23I) slender, with elongate distal lash and spinule row along both margins of blade and lash. Maxillule (Fig. 23J) truncate distally, with produced inner distal corner, armed with 2 apical setae and 1 minute, subapical inner seta. Maxilla (Fig. 24A) consisting of unarmed syncoxa and basis with elongate distal lash and 3 setae; distal lash bearing row of long spinules along proximal half of outer margin; inner seta (seta I) bearing row of spinules along outer margin; anterior seta (seta II) stiff, knife-shaped; proximal seta (seta III) minute. Maxilliped (Fig. 24B) 3-segmented; first segment unarmed; second segment with 2 small, equal setae subdistally; third segment attenuated, claw-like, with 1 small seta proximally.

Legs 1-3 with 3-segmented rami. Outer spines on exopod of leg 1 (Fig. 24C) serrate along proximal margin. Leg 3 same as leg 2 (Fig. 24D) except third endopodal segment bearing 3 spines and 2 setae (Fig. 24E). Leg 4 (Fig. 24F) with 3-segmented exopod and 2-segmented endopod; distal endopodal segment 50×22 μm, with 1 dentiform process on outer margin; 2 terminal spines 18 μm (outer) and 49 μm (inner). Armature formula as in *L. papuensis* **sp. nov.**

Leg 5 exopodal segment (Fig. 24G) subquadrate, 28×16 μm, about 1.75 times as long as wide, with 2 setae distally; outer seta 75 μm, inner seta 35 μm. Leg 6 (Fig. 24H) represented by 1 pinnate and 1 naked seta and 1 denticle on genital operculum.

Description of male. Body (Fig. 25A) similar in form to that of female. Body length 785 μm long; prosome 509×345 μm. Dorsal suture line distinct between cephalosome and first pedigerous somite. Urosome (Fig. 25B) 6-segmented; fifth pedigerous somite 79 μm wide, with small tubercle on ventral surface; genital somite subcircular, 130×144 μm. Four abdominal somites 32×55, 29×52, 26×53, and 21×52 μm, respectively. Caudal ramus as long as wide (25×25 μm), armed as in female.

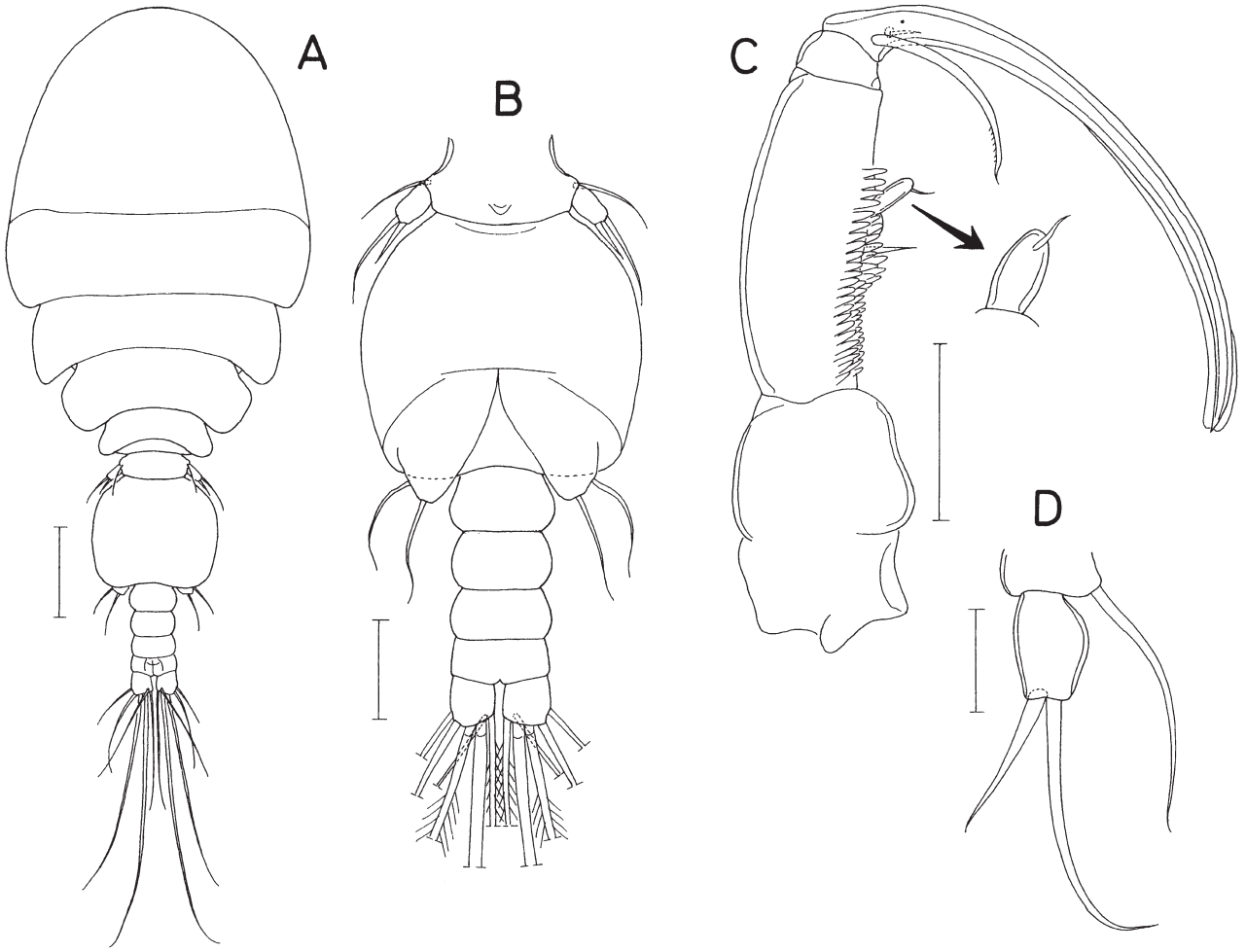

FIGURE 25. *Lichomolgus brevicaudatus* **sp. nov.**, male. A, habitus, dorsal; B, urosome, ventral; C, maxilliped; D, leg 5. Scale bars: A, 0.1 mm; B, C, 0.05 mm; D, 0.02 mm.

Rostrum as in female. Antennule also as in female, without additional aesthetascs. Antenna as in female, but all 4 setae on second endopodal segment distinct, subequal in length.

Labrum, mandible, maxillule and maxilla as in female. Maxilliped (Fig. 25C) 4-segmented; second segment with 3 longitudinal rows of spinules and 2 setae on inner surface, distal seta modified to digitiform element tipped with setule; terminal segment as long claw bearing 1 small and 1 large seta proximally.

Legs 1–4 as in female. Leg 5 (Fig. 25D) exopod 21×15 μm, with convex outer margin; armed with 2 setae distally; outer seta 56 μm , inner seta 32 μm. Leg 6 (Fig. 25B) represented by 2 equal, naked setae on genital operculum.

Remarks. *Lichomolgus brevicaudatus* **sp. nov.** has short caudal rami, with a length/width ratio of 1.15:1 in the female. Similarly short caudal rami with a ratio of less than 1.5:1 are found in five congeners: *L. eganae* Gotto, 1975, *L. fusiformis* Kim I.H., 2009, *L. indicus*, *L. nakaii* Matsuzaki & Ogawa, 1989, and *L. pectinatus* Moon & Kim I.H., 2011.

Lichomolgus fusiformis, *L. nakaii* and *L. pectinatus* each have 1 spine and 1 seta (rather than 2 setae as in the new species) on the exopod of leg 5, and *L. indicus* lacks a dentiform process (present in the new species) on the outer margin of the distal endopodal segment of leg 4. Therefore *L. brevicaudatus* **sp. nov.** is easily distinguishable from these four species

The new species is similar to *L. eganae* which is associated with the ascidian *Cnemidocarpa radicosa* (Herdman, 1882) (as *Cnemidocarpa etheridgii* Hartmeyer) in Australia (Gotto, 1975). The form of the genital double-somite is particularly similar in these two species, but marked differences can be seen in the exopods of leg 5 of both sexes, and in the male maxilliped. The inner margin of the exopodal segment of female leg 5 is smooth in the new species but has a pointed process in *L. eganae*, and the exopodal segment of male leg 5 is inflated in the middle in the new species but gradually broadening in *L. eganae* (as described and illustrated by Gotto, 1975). In the male maxilliped, the second segment has one simple seta and 1 specialized seta in the new species but only a simple seta in *L. eganae*.

Lichomolgus alatus sp. nov.

(Figs. 26, 27)

Type material. Holotype ♀ (MNHN-IU-2014-21602, dissected and mounted on a slide) from *Synoicum castellatum* Kott, 1992 (MNHN-IT-2008-8565, =MNHN A1/SYN/68): Reef in Channel East of Brooker I., Calvados Is. group, Louisades, Papua New Guinea, OCDN 5742-2, site Brooker Channel, depth 7 m, CRRF coll., 01 June 1998.

Etymology. The specific name is derived from the Latin *alat* (=winged), referring to the wing-like posterolateral extensions of the epimera of the second pedigerous somite.

Description of female. Body (Fig. 26A) narrow; body length 1.34 mm long; prosome 777 μm long; maximum width 482 μm (across second pedigerous somite). Cephalothorax longer than wide (477×464 μm), with faint dorsal suture line dividing cephalosome and first pedigerous somite. Epimera of second pedigerous somite, wing-like, characteristically expanded posterolaterally. Urosome (Fig. 26B) 5-segmented; fifth pedigerous somite 142 μm wide; genital double-somite as long as wide (188×188 μm), widest at about 40% of double-somite length, with tapering posterior half; genital apertures positioned dorsolaterally at widest region. Three free abdominal somites longer than wide, 91×85, 88×76, and 94×89 μm, respectively; anal somite (Fig. 26C) ornamented with transverse rows of spinules anteriorly on ventral surface, and with minute spinules along posteroventral margin. Caudal rami (Fig. 26C) slightly divergent; each ramus about 3.5 times longer than wide (120×34 μm) and ornamented with minute spinules on posteroventral margin: armed with 6 setae; lateral seta naked, positioned slightly posterior to midlength of ramus; four distal setae (setae III-VI) pinnate but lateral and dorsal setae (setae II and VII) naked. Egg sac (Fig. 27A) cylindrical, 560×175 μm; each egg about 63 μm in diameter.

Rostrum (Fig. 26D) well-sclerotized, slightly longer than wide, with parallel lateral margins and rounded posterior margin. Antennule (Fig. 26E) 280 μm long, 7-segmented; armature formula 4, 13, 6, 3, 4+aesthetasc. 2+aesthetasc, and 7+aesthetasc; all setae naked. Antenna (Fig. 26F) 4-segmented; armature formula 1, 1, 2+claw, and 3+4 claws; claw on third segment (second endopodal segment) short but strong; terminal segment about 2.1 times longer than wide (51×24 μm); four terminal claws annulated, consisting of 2 strong, shorter median claws and 2 longer, setiform claws (outer and inner).

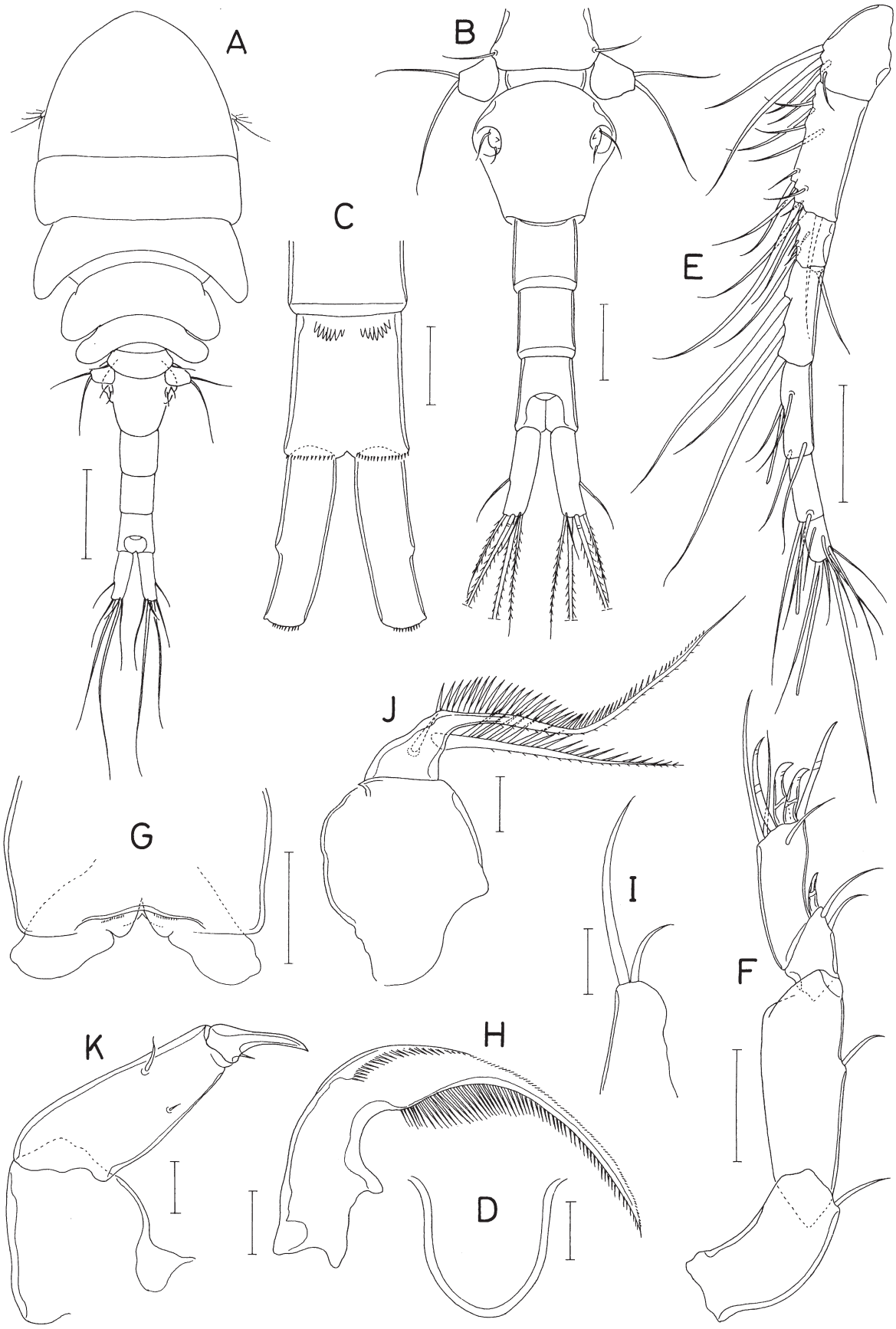

FIGURE 26. *Lichomolgus alatus* **sp. nov.**, female. A, habitus, dorsal; B, urosome, dorsal; C, anal somite and caudal rami, ventral; D, rostrum; E, antennule; F, antenna; G, labrum; H, mandible; I, maxillule; J, maxilla; K, maxilliped. Scale bars: A, 0.2 mm; B, 0.1 mm; C, E–G, 0.05 mm; D, H–K, 0.02 mm.

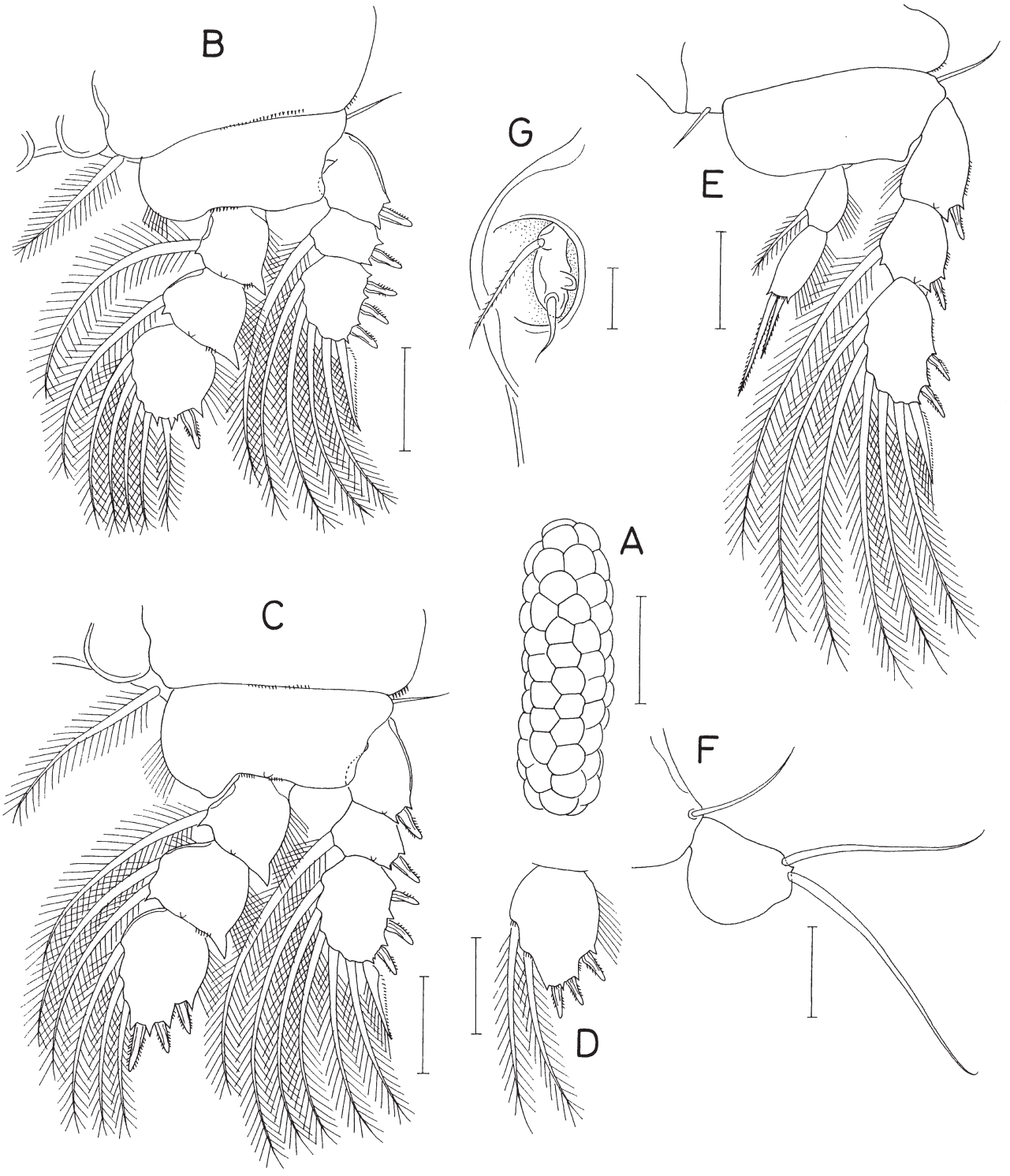

FIGURE 27. *Lichomolgus alatus* **sp. nov.**, female. A, egg sac; B, leg 1; C, leg 2; D, third endopodal segment of leg 3; E, leg 4; F, leg 5; G, left genital aperture, dorsal. Scale bars: A, 0.2 mm; B–F, 0.05 mm; G, 0.02 mm.

Labrum (Fig. 26G) consisting of sclerotized proximal part and divergent, transparent, lamellate posterior lobes. Mandible (Fig. 26H) narrow, with elongate distal lash, and ornamented with row of minute spinules along convex margin and row of longer, setule-like spinules along concave margin blade and lash. Maxillule (Fig. 26I) with 2 unequal, naked setae apically. Maxilla (Fig. 26J) consisting of syncoxa and basis; syncoxa characteristically with 1 claw-like cusp at outer distal corner; basis with extremely elongate, spinulose distal lash and 2 setae; inner seta (seta I) elongate 91 μm long, with large spinules along outer margin and minute spinules along inner margin; anterior

seta (seta II) small and simple; seta III absent. Maxilliped (Fig. 26K) 3-segmented; first segment unarmed; second segment with 2 small, unequal setae (1 vestigial); third segment claw-like, with 1 small seta proximally.

Legs 1, 2 (Fig. 27B, C) and 3 with 3-segmented rami. Outer seta on basis of legs 1-4 and inner coxal seta of leg 4 naked, other setae on these legs pinnate. Leg 3 same as leg 2, except third endopodal segment (Fig. 27D) bearing 3 spines and 2 setae. Leg 4 (Fig. 27E) with 3-segmented exopod and 2-segmented endopod; endopod narrow; distal endopodal segment 41×18 μm; 2 distal spines setiform 30 μm (outer) and 59 μm (inner), respectively. Armature formula for legs 1–4 as follows:

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

Leg 5 (Fig. 27F) consisting of dorsolateral seta on fifth pedigerous somite and free exopod; exopodal segment 1.27 times longer than wide (61×48 μm), with inflated, strongly convex inner margin and 2 long, naked setae; outer seta 117 μm and inner seta 156 μm. Leg 6 (Fig. 27G) represented by 2 setae and 1 blunt tubercle on genital operculum.

Male. Unknown.

Remarks. About half of the known species of *Lichomolgus* have a smooth outer margin on the compound distal endopodal segment of leg 4, lacking any dentiform process. Of these, only six species plus *L. alatus* **sp. nov**., have a caudal ramus that is 3 to 4 times longer than wide. These species are *L. arcanus*, *L. asaphidis*, *L. canui*, *L. furcillatus*, *L. spondyli*, and *L. tridacnae* Humes, 1972. These six species can be distinguished from *L. alatus* **sp. nov**. by the following diagnostic features: *L. canui* and *L. furcillatus* have 1 spine and 1 seta (rather than 2 setae, as in the new species) on the exopod of female leg 5, and *L. arcanus*, *L. asaphidis*, *L. spondyli* and *L. tridacnae* all have a single, large terminal claw on the antenna (rather than 4 claws, as in the new species).

Two key diagnostic features of *L. alatus* **sp. nov**. are the presence of wing-like, posterolaterally extended epimera on the second pedigerous somite, and the possession of a claw on the second endopodal segment of the antenna. The latter feature is unusual for *Lichomolgus*, but can be observed in *Zygomolgus*. However, the new species is placed in *Lichomolgus* because it has the typical slender mandible lacking digitiform scales on the outer side of the blade, and the proximal spinules on the distal lash of the maxilla are not specialized, compared to 3 to 5 broad, digitiform proximal spinules on the lash of *Zygomolgus*.

Lichomolgus lepidotus sp. nov.

(Figs. 28, 29)

Type material. Holotype ♀ (MNHN-IU-2014-21603, dissected and mounted on a slide) from *Aplidium altarium* (Sluiter, 1909): Mouth of Ngerduais channel, Arai, Palau (07°20.82′N, 134°34.35′E), OCDN 5002-V, Site NGERDWAIS3, depth 0-5 m, CRRF coll., 09 April 1997.

Etymology. The specific name is from the Greek *lepi* (= a scale), alluding to the presence of scales on the ventral surface of the anal somite.

Description of female. Body (Fig. 28A) rather narrow; body length 0.96 mm; prosome 582×382 μm. Cephalothorax with faint dorsal suture line between cephalosome and first pedigerous somite. Urosome (Fig. 28B) 5-segmented; fifth pedigerous somite 118 μm wide; genital double-somite longer than wide (148×128 μm), expanded at level of genital apertures; genital apertures large, located dorsolaterally about at midlength of double-somite. Three free abdominal somites 53×68, 41×61, and 59×68 μm, respectively; anal somite (Fig. 28C) with 2 pairs of large, triangular membranous scales anteriorly on ventral surface and with minute spinules along posteroventral margin. Caudal ramus (Fig. 28C) broad, about 1.6 times longer than wide (52×32 μm) and ornamented with 3 spinules (or scales) on posteroventral margin; armed with 6 setae; outer lateral seta positioned at about 70% of ramus length; dorsal seta (seta VII) naked, other 5 setae pinnate.

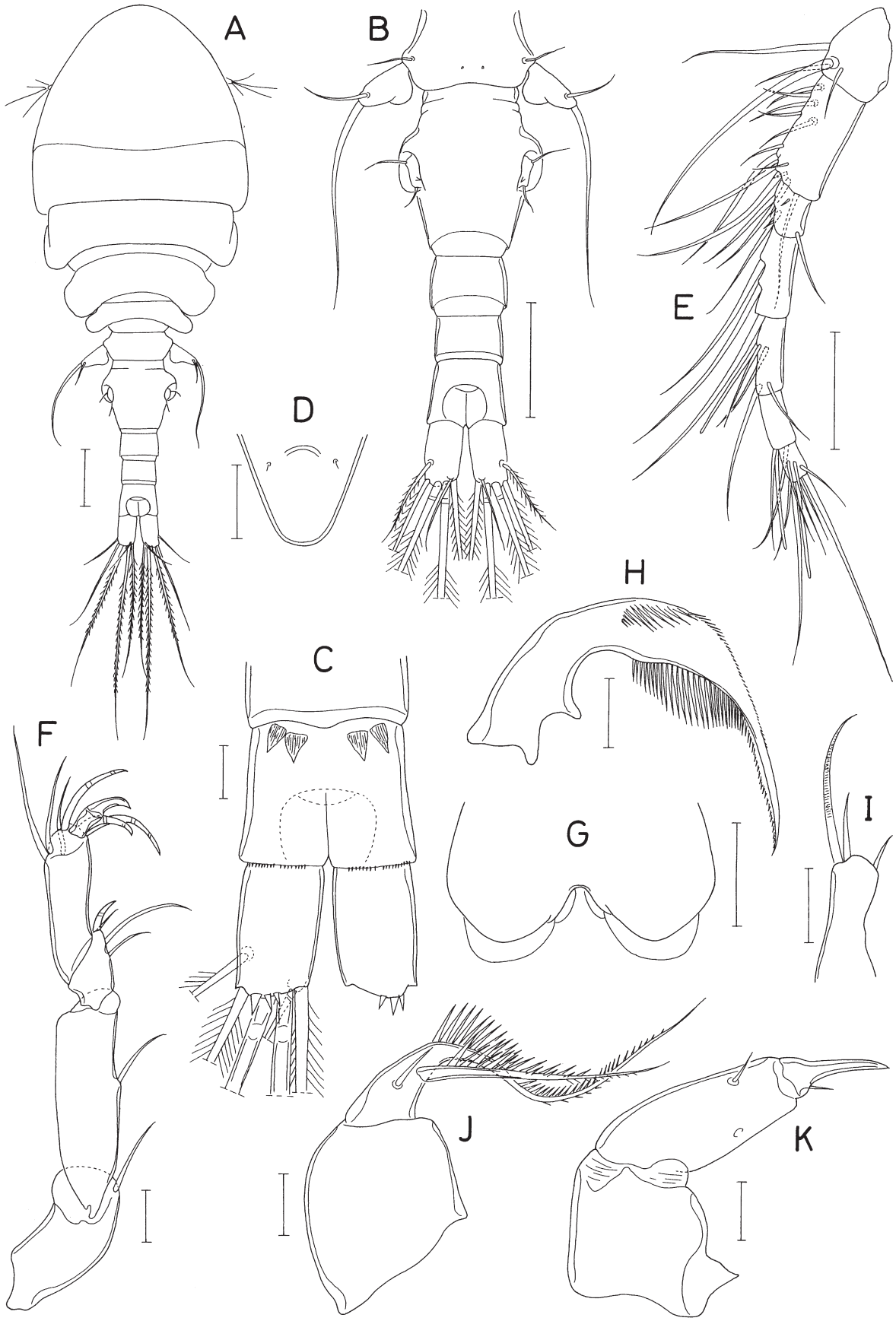

FIGURE 28. *Lichomolgus lepidotus* **sp. nov.**, female. A, habitus, dorsal; B, urosome, dorsal; C, anal somite and caudal rami, ventral; D, rostrum; E, antennule; F, antenna; G, labrum; H, mandible; I, maxillule; J, maxilla; K, maxilliped. Scale bars: A, B, 0.1 mm; C, D, F, H–K, 0.02 mm; E, G, 0.05 mm.

Rostrum (Fig. 28D) evenly tapering towards rounded apex. Antennule (Fig. 28E) 210 μm long, 7-segmented; armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked; 1 seta on first segment much larger than other 3 setae. Antenna (Fig. 28F) 4-segmented; armature formula 1, 1, 3+claw, and 3+4 claws; claw on third segment small, annulated; terminal segment about 2.8 times longer than wide (50×18 μm); terminal claws consisting of 1 strong, shorter claw and 3 slender, setiform claws.

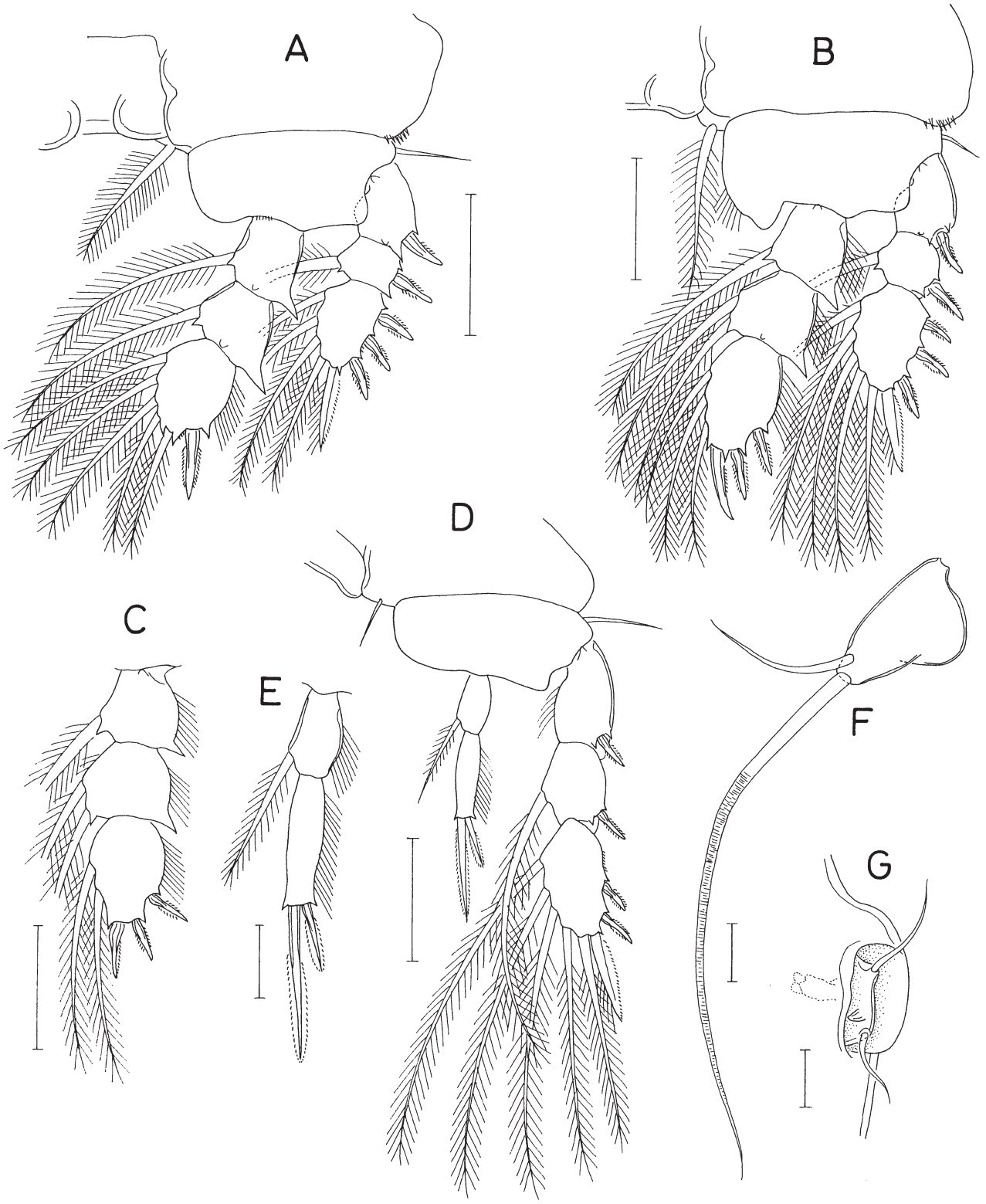

FIGURE 29. *Lichomolgus lepidotus* **sp. nov.**, female. A, leg 1; B, leg 2; C, endopod of leg 3; D, leg 4; E, endopod of leg 4; F, exopod of leg 5; G, right genital aperture, dorsal. Scale bars: A–D, 0.05 mm; E–G, 0.02 mm.

Labrum (Fig. 28G) with shallow median incision and broad posterior lobes bearing membranous fringe along posterior margin. Mandible (Fig. 28H) slender, with elongate distal lash and row of spinules along both margins of blade and lash. Maxillule (Fig. 28I) with 3 unequal setae apically. Maxilla (Fig. 28J) consisting of syncoxa and basis; syncoxa unarmed; basis with extremely elongate distal lash and 2 setae on basis; larger inner seta 84 μm long, spinulose along outer margin; anterior seta naked and slender; proximal seta (seta III) absent. Maxilliped (Fig. 28K) 3-segmented; first segment unarmed; second segment with 1 seta and 1 insertion scar of seta; third segment attenuated, claw-like, with 1 small seta proximally.

Legs 1-3 (Fig. 29A-C) with 3-segmented rami. First and second endopodal segments of legs 1-3 produced into well-developed outer distal process. Inner coxal seta of leg 4 small and naked. Outer seta on basis of legs 1-4 naked. Leg 4 (Fig. 29D) with 3-segmented exopod and 2-segmented endopod; endopod (Fig. 29E) slender, second segment 36×10 μm, with 2 terminal spines 19 μm (outer) and 43 μm long (inner). Armature formula for legs 1-4 as in *L. alatus* **sp. nov.**

Leg 5 (Fig. 28B) consisting of dorsolateral seta on fifth pedigerous somite and free exopod; exopodal segment (Fig. 29F) about 1.6 times longer than wide (55×34 μm), tapering, with inner proximal swelling: armed distally with 2 extremely unequal setae; inner seta 196 μm long, extending beyond posterior margin of genital double-somite, about 3.5 times longer than outer seta. Leg 6 (Fig. 29G) represented by 2 setae and 1 denticle on genital operculum.

Male. Unknown.

Remarks. Most species of *Lichomolgus* have elongate caudal rami. However in four species the caudal ramus is relatively short as in *L. lepidotus* **sp. nov**., with a length/width ratio more than 1:1 but less than 2:1. These four species are *L. fusiformis*, *L. nakaii*, *L. pectinatus*, and *L. brevicaudatus* **sp. nov.** described above. All four of these species have a dentiform process on the outer margin of the compound distal endopodal segment of leg 4, and therefore can easily be differentiated from the new species. As additional differences, *L. fusiformis*, *L. nakaii*, and *L. pectinatus* all have 1 spine and 1 seta on the exopod of leg 5 (in contrast to 2 setae in *L. lepidotus* **sp. nov.**), and *L. brevicaudatus* **sp. nov.** has 3 claws on the terminal segment of the antenna (cf. 4 claws in *L. lepidotus* **sp. nov.**).

Two diagnostic features allow *L. lepidotus* **sp. nov.** to be easily distinguished from its congeners. One of these, the possession of 1 claw and 3 setae on the third segment (the second endopodal segment) of the antenna, is unique within the genus. The other diagnostic feature is having the two distal setae on the exopod of leg 5 extremely unequal. In about half of *Lichomolgus* species the exopod of leg 5 is armed with two setae (the remaining half are armed with 1 spine and 1 seta) and the longer seta is at most about twice the length of the shorter seta. The possession of an enlarged inner seta on the exopod of leg 5 (about 3.5 times longer than the outer seta), is another unique feature of *L. lepidotus* **sp. nov.**

Antarctomolgus gen. nov.

Diagnosis. Lichomolgidae. Body cyclopiform. Urosome 5-segmented in female, 6-segmented in male. Caudal ramus with 6 setae; 2 median terminal setae (setae IV and V) flattened, tape-like. Rostrum distinct. Antennule 7-segmented, with armature formula 3, 10, 5, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc in female. Male antennule with 3 additional aesthetascs: 2 on second segment and 1 on fourth. Antenna 4-segmented; third segment (second endopodal segment) with 1 setiform claw and 3 setae; terminal segment with 4 claws and 3 setae. Mandible with elongate distal lash and 1 spine on outer side at base of blade. Maxillule with 4 setae. Maxilla consisting of syncoxa and basis; basis with elongate, spinulose distal lash and 3 setae; inner seta (seta I) large. Maxilliped 3-segmented in female and 4 segmented (fourth segment as claw) in male, as in *Lichomolgus*. Legs 1-4 biramous, with 3-segmented rami. Third endopodal segment of leg 1 armed with 1 spine and 5 setae (formula I, 1, 4) in female and with 2 spines and 4 setae (formula I, I, 4) in male. Third exopodal segment of leg 3 armed with 3 spines and 5 setae (formula II, I, 5). Third endopodal segment of leg 4 armed with 3 spines. Armature formula for legs 1-4 of female as follows:

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

Leg 5 consisting of dorsolateral seta on fifth pedigerous somite and 1-segmented free exopod armed with 1 spine and 1 seta distally. Leg 6 represented by 2 setae and 1 denticle on genital operculum.

Type species. *Antarctomolgus molgulae* **gen. et sp. nov**. by original designation.

Etymology. The new name combines the Antarctic, the region from which the type species was collected and *–molgus*, a common suffix of lichomolgid genera. Gender masculine.

Remarks. In the Lichomolgidae eight genera have a 3-segmented endopod of leg 4, as in *Antarctomolgus* **gen. nov**. These eight genera are *Diogenella* Stock, 1968, *Diogenidium* Edwards, 1891, *Henicoxiphium*, *Herrmannella* Canu, 1891, *Lichomolgidium*, *Modiolicola* Aurivillius, 1882, *Protomolgus*, and *Pterioidicola*. Of these, *Henicoxiphium* has a single spine on the third endopodal segment of leg 4 (armature formula for the endopod 0-1; 0-1; 0, I, 0) and almost all species of the remaining six genera have two spines on the third endopodal segment (armature formula 0-1; 0-1; 0, II, 0), except a single species of *Herrmannella*, *H. panopeae* (Illg, 1949), which bears 3 spines on the same segment (armature formula 0-1; 0-1; I, II, 0), as in *Antarctomolgus molgulae* **gen. et sp. nov**. Humes & Stock (1973) mentioned that the future discovery of similarly armed species would indicate generic separation of *H. panopeae* from the genus *Herrmannella*. *Herrmannella* consists of 28 known species (Boxshall & Halsey, 2004; Kim & Sato, 2010; Varela, 2011), all of which are associated with bivalve molluscs (Humes & Stock, 1972; 1973; Humes & Boxshall, 1996).

Antarctomolgus molgulae **gen. nov. et sp. nov**. cannot be assigned to *Herrmannella* due to three important differences. Firstly, the terminal segment of the antenna of the new genus has 4 slender claws, in contrast to 1 strong claw and 1 or 2 setiform claws in *Herrmannella* (Humes & Stock, 1973; Humes & Boxshall, 1996). Secondly, the third exopodal segment of leg 3 is armed with 3 spines and 5 setae (formula II, I, 5), compared to 4 spines and 5 setae (formula III, I, 5) in *Herrmannella*. Thirdly, the mandible of *Antarctomolgus molgulae* **gen. et sp. nov**. has a spiniform outer scale, which is lacking in *Herrmannella*. In the Lichomolgidae the presence of the outer scale on the mandible has been reported only in the genera *Botulosoma*, *Zygomolgus* and *Neomenicola* Avdeev & Avdeev, 1991 (Boxshall & Halsey, 2004), although the latter genus appears to belong to the family Anthessiidae since it possesses a distal aesthetasc on the fourth antennular segment. On the basis of this evidence, *Antarctomolgus* **gen. nov.** is established to accommodate *A. molgulae* **gen. et sp. nov**.

Antarctomolgus molgulae gen. et sp. nov.

(Figs. 30–32)

Type material. Holotype ♀ (MNHN-IU-2009-5724) and paratypes (1 ♀, 8 ♂♂, MNHN-IU-2014-21604) plus 1 ♀ and 1 ♂ dissected paratypes (MNHN-IU-2014-21490) from *Molgula pedunculata* (Herdman, 1881) MNHN-IT-2008-5697 (= MNHN S3/MOL A/389): Antarctic, 65°29´S, 139°24´E, CEAMARC Expedition, Terre Adélie, RV "Aurora Australis", Stn 86EEV518, depth 781-835 m, IPEV-AAD-MNHN coll. 16 January 2008.

Etymology. The generic name of the ascidian host provides the name of the new species.

Description of female. Body (Fig. 30A) moderately broad. Body length of dissected specimen 1.57 µm (other 2 specimens 1.56 and 1.60 mm); prosome ovoid, 972×658 µm. Dorsal suture line between cephalosome and first pedigerous somite indistinct. Epimera of second pedigerous somite with slightly extended posterolateral corners. Urosome (Fig. 30B) 5-segmented; fifth pedigerous somite 183 µm wide; genital double-somite 212×190 µm, widest in middle, with laterally expanded anterior two-thirds and narrower posterior third; genital apertures positioned dorsolaterally, slightly anterior to middle. Three free abdominal somites 61×100, 48×92, and 77×89 µm, respectively. Genital double-somite and first 2 abdominal somites each bearing narrow membranous fringe along posterior border. Caudal ramus (Fig. 30C) broad, about 3.3 times longer than wide (137×41 µm); armed with 6 naked setae; outer lateral seta located about at 70% of ramus length; 2 mid-terminal setae (setae IV and V) flattened, tape-like.

Rostrum (Fig. 30D) tapering towards rounded apex. Antennule (Fig. 30E) 406 µm long, 7-segmented; armature formula 3, 10, 5, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked. Antenna (Fig. 30F) 4-segmented; armature formula 1, 1, 3+claw, and 3+4 claws; claw on third segment (second endopodal segment) thin, setiform; terminal segment about 1.8 times longer than wide (77×42 µm), second and terminal segments ornamented with fine spinules along outer margin; 4 terminal claws unequal in length, inner 2 setiform.

Labrum (Fig. 30G) deeply incised, with convex lateral margins; posterior lobes with straight lateral margins and convex, sloping inner margins. Mandible (Fig. 30H) with 1 slender spine-like scale on convex side at base of

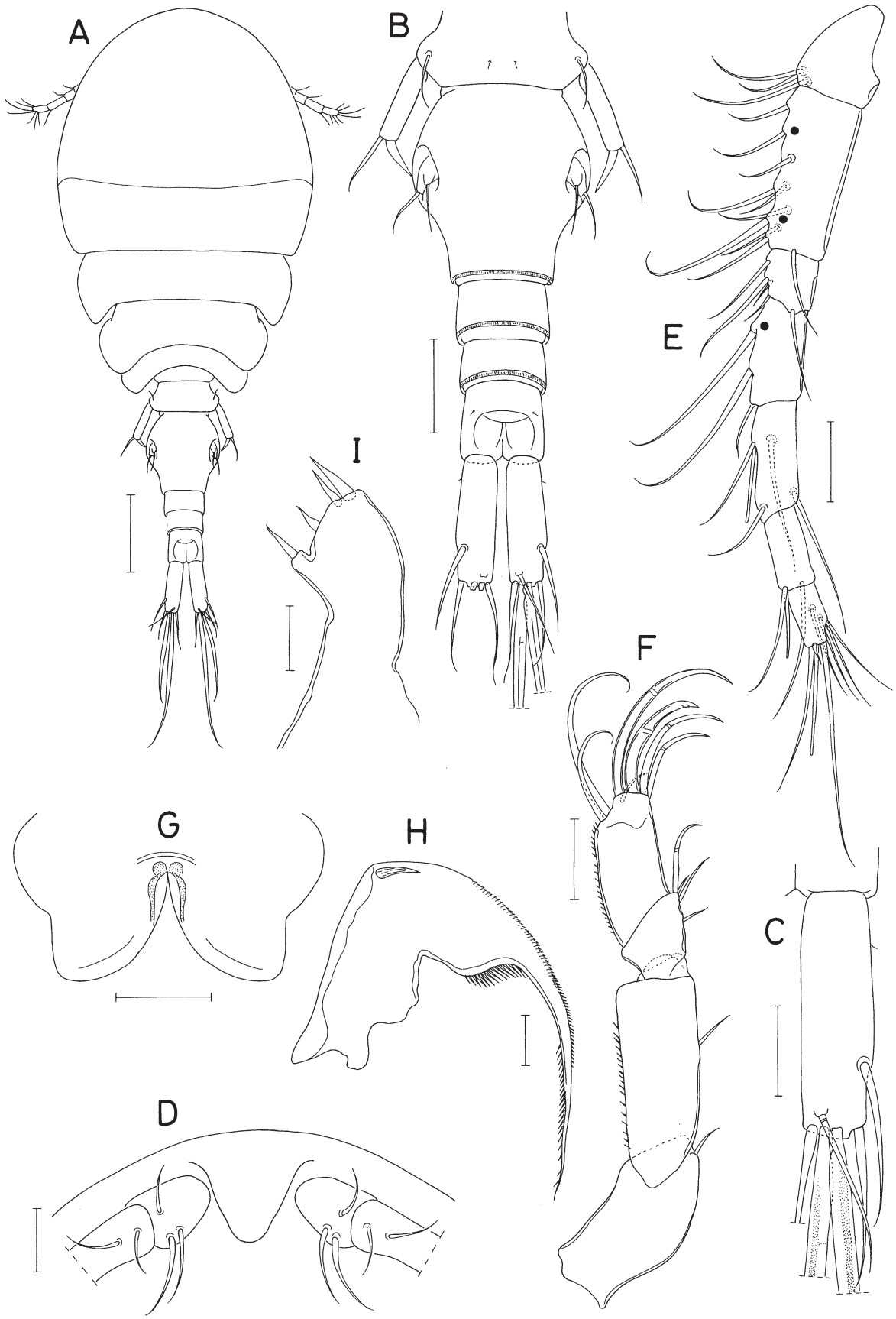

FIGURE 30. *Antarctomolgus molgulae* **gen. et sp. nov.**, female. A, habitus, dorsal; B, urosome, dorsal; C, right caudal ramus, dorsal; D, rostral area; E, antennule; F, antenna; G, labrum; H, mandible; I, maxillule. Scale bars: A, 0.2 mm; B, 0.1 mm; C–G, 0.05 mm; H, I, 0.02 mm.

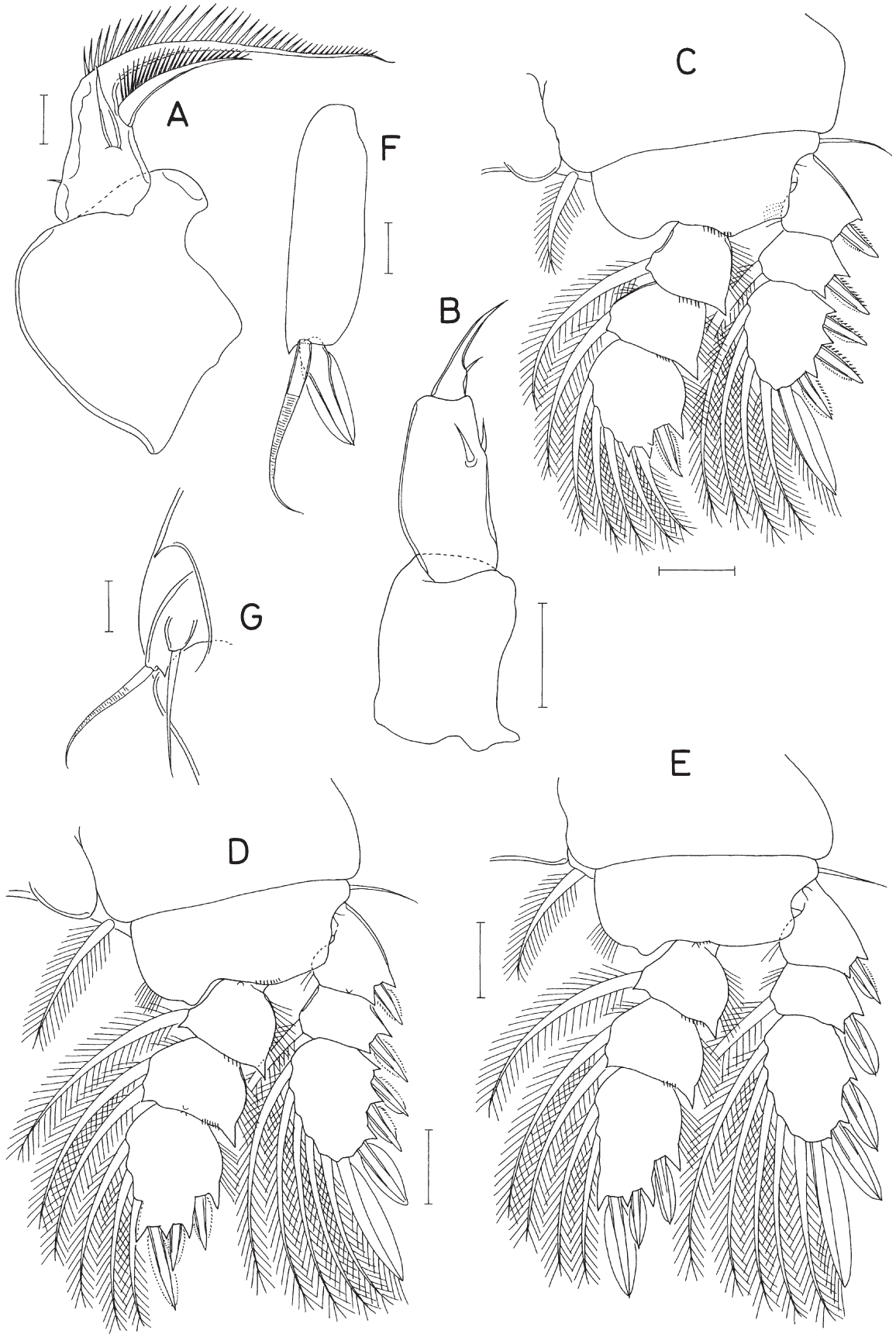

FIGURE 31. *Antarctomolgus molgulae* **gen. et sp. nov.**, female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, leg 3; F, exopod of leg 5; G, left genital aperture, dorsal. Scale bars: A, F, G, 0.02 mm; B–E, 0.05 mm.

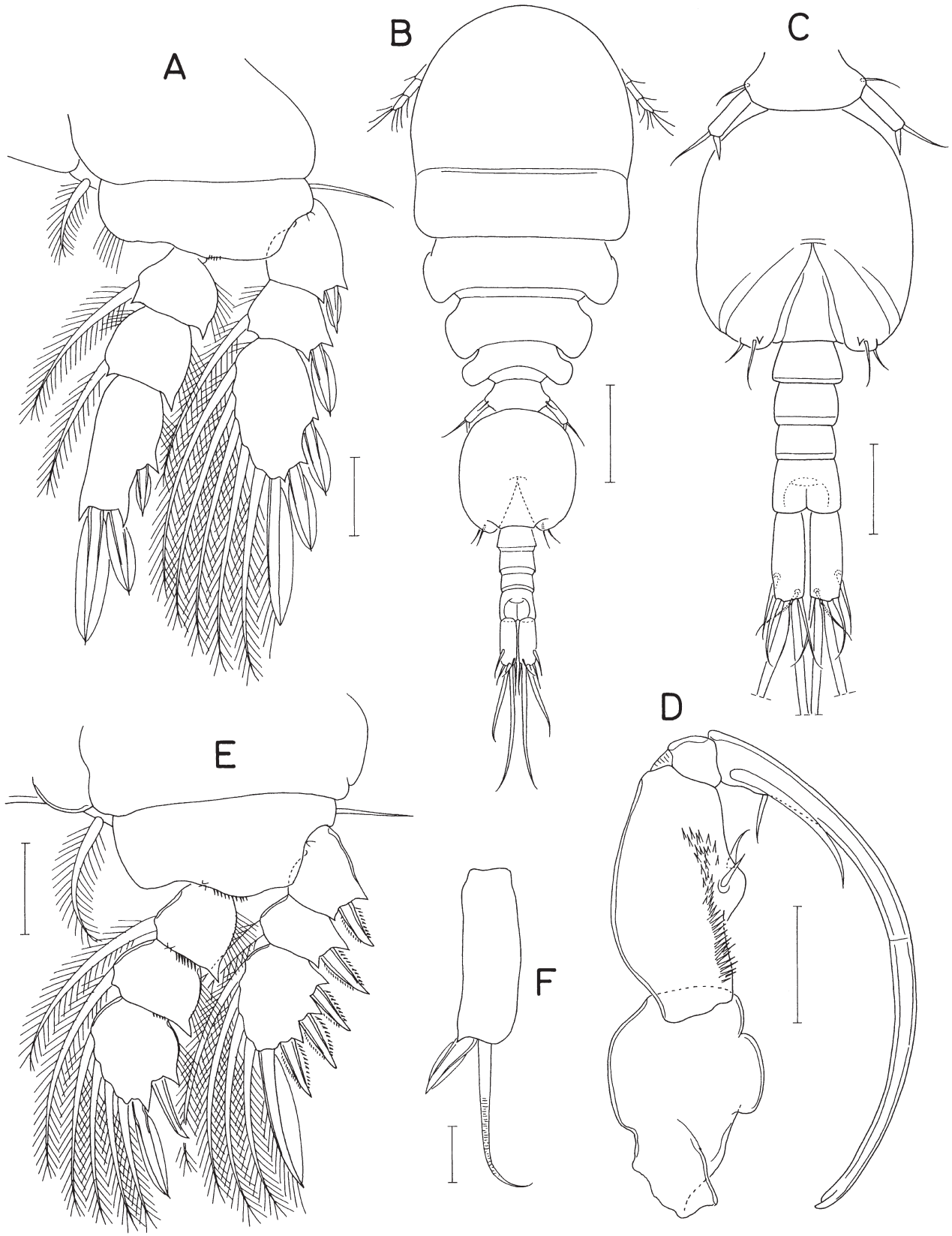

FIGURE 32. *Antarctomolgus molgulae* **gen. et sp. nov.**, female. A, leg 4. Male: B, habitus, dorsal; C, urosome, ventral; D, maxilliped; E, leg 1; F, exopod of leg 5. Scale bars: A, D, E, 0.05 mm; B, 0.2 mm; C, 0.1 mm; F, 0.02 mm.

blade; broadened blade with elongate, slender distal lash, finely serrate along outer margin and setulose on inner margin. Maxillule (Fig. 30I) broadening distally, with oblique distal margin bearing 4 naked setae. Maxilla (Fig. 31A) consisting of syncoxa and basis; syncoxa unarmed; basis with elongate distal lash bearing long spinules along outer margin, and armed with 3 setae; inner seta (seta I) about half as long as distal lash, bearing row of spinules along outer margin; anterior seta (seta II) slightly broadened along proximal half; proximal seta (seta III) minute. Maxilliped (Fig. 31B) 3-segmented; first segment unarmed; second segment with 2 equal setae at distal third of inner side; third segment acutely pointed, bearing 1 small seta proximally.

Legs 1–4 (Figs. 31C–E, 32A) with 3-segmented rami. Inner coxal setae distinct, pinnate. Outer seta on basis of legs 1-4 naked. Third exopodal segment of legs 3 and 4 armed with 3 spines and 5 setae. Leg 4 (Fig. 32A) endopod as long as exopod; third endopodal segment armed with 1 small outer spine and 2 larger distal spines. Armature formula for legs 1–4 as follows:

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

Leg 5 (Fig. 30B) consisting of dorsolateral seta on fifth pedigerous somite and free exopod; exopodal segment (Fig. 31F) elongate, about 3.2 times longer than wide (97×30 μm), distally with 1 dentiform process, and armed with 1 naked, wrinkled seta (78 μm long) and 1 spine (45 μm long) with membranous flanges bilaterally. Leg 6 (Fig. 31G) represented by 2 naked setae and 1 denticle on genital operculum.

Description of male. Body (Fig. 32B) narrower than that of female; body length 1.35 mm. Prosome 764×445 μm; lateral margins of cephalothorax nearly parallel. Urosome (Fig. 32C) 6-segmented; fifth pedigerous somite narrow, 135 μm wide; genital somite subcircular, 261×241 μm. Four abdominal somites unornamented, 48×79, 46×73, 38×67, and 62×77 μm, respectively. Caudal ramus broad, about 2.8 times longer than wide (108×38 μm), armed as in female.

Rostrum as in female. Antennule with 3 short, additional aesthetascs: 2 on second segment and 1 on fourth, as indicated by dots in Fig. 30E. Antenna as in female.

Labrum, mandible, maxillule, and maxilla as in female. Maxilliped (Fig. 32D) 4-segmented; first segment unarmed, with convex swellings along inner margin and convex outer margin; second segment with spinules on inner side and 2 equal setae near roundly produced part of inner margin; small third segment unarmed; fourth segment as slender, elongate, arched claw bearing 2 unequal, naked setae proximally.

Leg 1 (Fig. 32E) with third endopodal segment armed with 2 spines and 4 setae (armature formula I, I, 4); outer spine smooth, but distal spine with membranous flanges. Legs 2–4 as in female.

Leg 5 similar to that of female; exopodal segment (Fig. 32F) about 3.0 times longer than wide (63×21 μm). Leg 6 (Fig. 32C) represented by 2 small setae and 1 denticle on genital operculum.

Remarks. The host ascidian *Molgula pedunculata* serves as host to four other species of copepods from the Monniot collection: *Archinotodelphys antarcticus* Kim & Boxshall, 2020, *Bonnierilla tahitiensis* Kim & Boxshall, 2020, *Doropygus tuberculatus* Kim & Boxshall, 2020, and *D. kerguelensis* Schellenberg, 1922 (Kim & Boxshall, 2020a, b).

Didemnomolgus gen. nov.

Diagnosis. Lichomolgidae. Morphological features as in *Lichomolgus*, except as follows: Terminal segment of antenna armed with 1 claw and 6 setae. Distal lash of maxilla bearing 1 large spine proximally. Leg 4 with 3-segmented exopod and 2 segmented endopod; third exopodal segment armed with 4 spines and 5 setae (formula III, I, 5); endopod armed with inner seta on proximal segment and 1 spine and 1 seta distally on distal segment (formula 0-1; 0, I+1, 0).

Type species. *Didemnomolgus crenulatus* **gen. et sp. nov.** by original designation.

Etymology. The name of the new genus is derived from the generic name of the host ascidian plus *–molgus*, the suffix of many lichomolgid genera. Gender masculine.

Remarks. In the Lichomolgidae many genera are differentiated from one another by the structure and armature of the endopod of leg 4. The endopod of leg 4 of *Didemnomolgus crenulatus* **gen. et sp. nov.** is 2-segmented and armed with 1 inner seta on the first segment and 1 spine plus 1 seta distally on the second segment (formula being 0-1; 0, I+1, 0). This armature condition is unique within the Lichomolgidae. The armature of 4 spines and 5 setae (formula III, I, 5) on the third exopodal segment of leg 4 is an additional diagnostic feature of the new genus, since this feature is very unusual in the Lichomolgidae, shared only with *Paclabius* and *Heteranthessius*.

***Didemnomolgus crenulatus* gen. et sp. nov.**
(Figs. 33–35)

Type material. Holotype ♀ (MNHN-IU-2014-21605) and 2 ♀♀ plus 1 ♂ dissected paratypes (MNHN-IU-2014-21491) from *Didemnum molle* (Herdmann, 1886) MNHN-IT-2008-3125 (= MNHN A2/DID.C/226): Open reef 1 km West of Murex Resort, West of Manado town, Sulawesi, Indonesia OCDN 1260-F, Site Manado 3, depth 10 m, CRRF coll., 09 May 1993

Etymology. The name is derived from the Latin *cren* (=a notch), referring to the distally notched claw of the antenna.

Description of female. Body (Fig. 33A) narrow; body length 1.75 mm; prosome 1.13 mm long, with maximum width 691 μm. Cephalothorax 669 μm long, with faint dorsal suture line between cephalosome and first pedigerous somite. Second pedigerous somite with slightly extended, angular posterolateral corners. Urosome (Fig. 33B) 5-segmented; fifth pedigerous somite 314 μm wide, as wide as genital double-somite. Genital double-somite longer than wide (364×318 μm), with markedly expanded anterior two-thirds and narrower posterior third; genital apertures located dorsally slightly anterior to middle. Three free abdominal somites becoming shorter from anterior to posterior, 159×173, 95×152, and 68×143 μm, respectively. Caudal ramus (Fig. 33C) very short, about 1.7 times wider than long (30×51 μm); armed with 7 naked setae; seta I small, setule-like; setae II-VI positioned distally or subdistally.

Rostrum (Fig. 33D) strongly tapering; apex obscure, almost fused to ventral surface of cephalothorax. Antennule (Fig. 33E) slender, 409 μm long, 7-segmented; armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked. Antenna (Fig. 33F) 4-segmented, with armature formula 1, 1, 4, and 5+claw; all setae small, setule-like; segments narrowing gradually from proximal to distal; terminal segment (Fig. 33G) 3.25 times longer than wide (65×20 μm); terminal claw 42 μm long, annulated near middle, with notch at tip.

Labrum (Fig. 33H) with tapering posterior lobes separated by deep and broad medial incision; ornamented with transverse row of fine spinules along highly sclerotized median proximal region. Mandible (Fig. 33I) with elongate distal lash, 2 rows of densely arranged spinules along convex outer margin, and 1 row of spinules along inner margin. Paragnath (Fig. 33J) as setulose lobe. Maxillule (Fig. 33K) with 1 minute seta subdistally and 2 stiff setae and 1 nipple-shaped process distally. Maxilla (Fig. 33L) consisting of syncoxa and basis; syncoxa unarmed; basis with elongate distal lash and 2 setae (inner and anterior setae); distal lash bearing 1 large spine proximally followed by row of spinules along proximal half of outer margin; inner seta (seta I) more than half length of distal lash, with thick spinules (or denticles) along outer margin; anterior seta (seta II) small; seta III absent. Maxilliped (Fig. 34A) 3-segmented; first segment unarmed; second segment longest, narrowing distally, with 2 small setae; third segment with 1 minute seta proximally and tipped with 1 claw articulated from segment.

Legs 1-3 with 3-segmented rami (Fig. 34B, C). Outer seta on basis of leg 1-4 naked. Most of spines on rami of legs 1-3 naked, without serrations or membranous flanges. Leg 3 different from leg 2 in having 3 spines and 2 setae on third endopodal segment. Leg 4 (Fig. 34D) with 3-segmented exopod and 2-segmented endopod; inner coxal seta thin and naked; third exopodal segment armed with 4 spines and 5 setae; endopod small, armed with 1 inner seta on proximal segment and 1 spine and 1 seta on distal segment. Armature formula for legs 1–4 as follows:

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

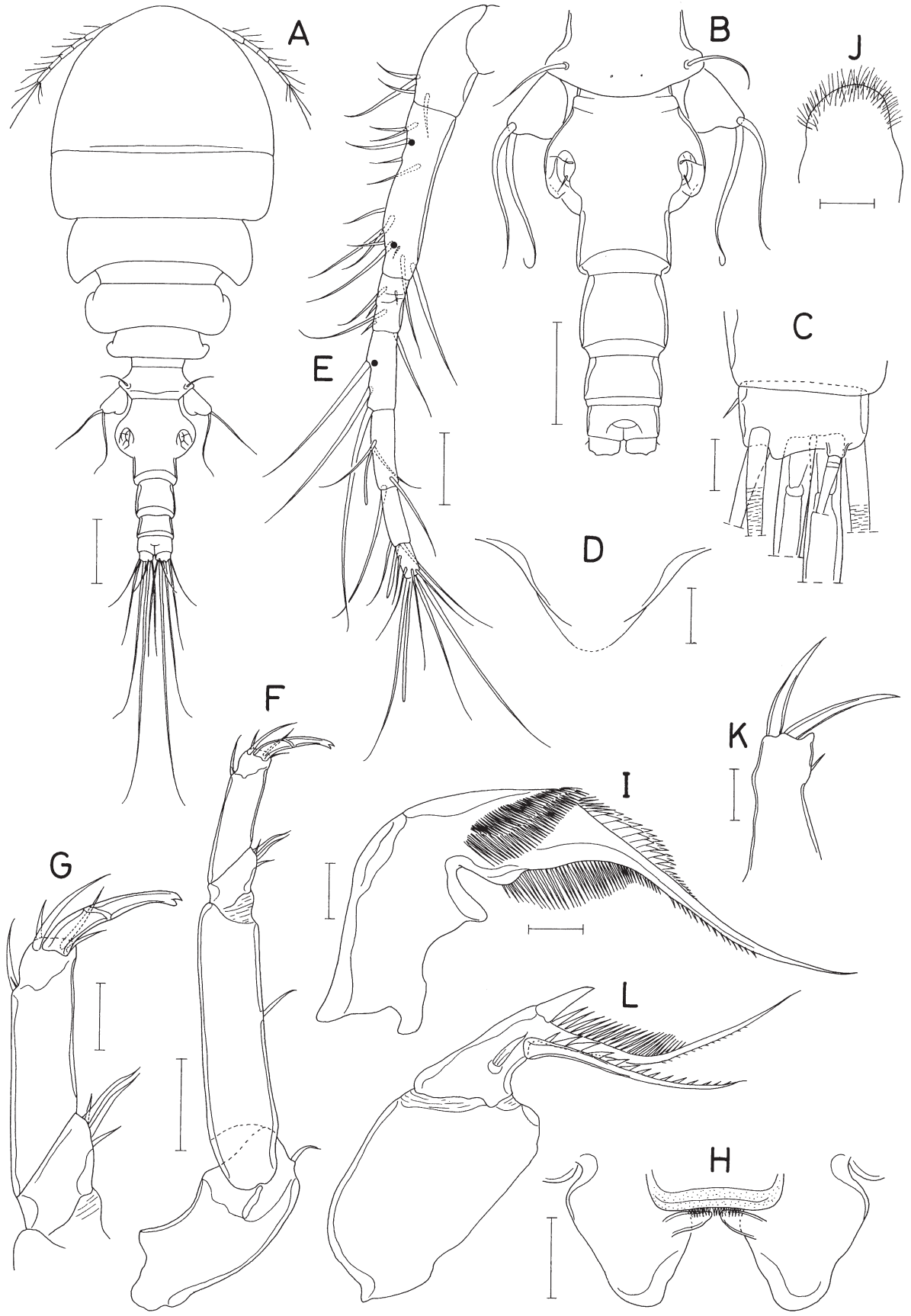

FIGURE 33. *Didemnomolgus crenulatus* **gen. et sp. nov.**, female. A, habitus, dorsal; B, urosome, dorsal; C, left caudal ramus, dorsal; D, rostrum; E, antennule; F, antenna; G, distal part of antenna; H, labrum; I, mandible; J, paragnath; K, maxillule; L, maxilla. Scale bars: A, B, 0.2 mm; C, G, I–L, 0.02 mm; D–F, H, 0.05 mm.

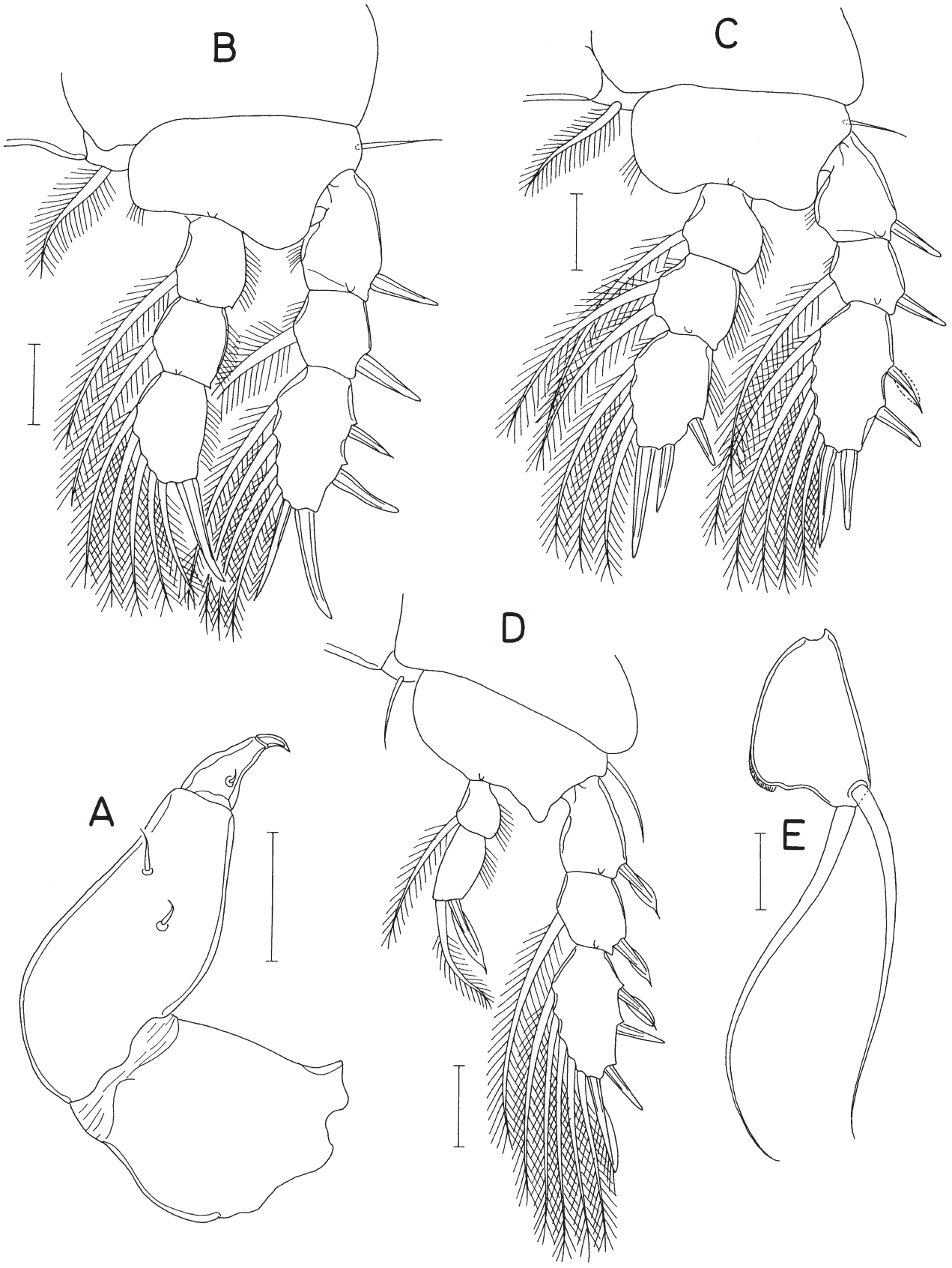

FIGURE 34. *Didemnomolgus crenulatus* **gen. et sp. nov.**, female. A, maxilliped; B, leg 1; C, leg 2; D, leg 4; E, exopod of leg 5. All scale bars: 0.05 mm.

Leg 5 (Fig. 33B) consisting of dorsolateral seta on fifth pedigerous somite and free exopod; exopodal segment (Fig. 34E) 1.55 times longer than wide (118×76 μm), with straight outer margin and strongly inflated inner margin bearing narrow membranous flange near apex; armed with 2 large, naked setae distally, setae more than twice as long as exopodal segment. Leg 6 represented by 2 small setae on genital operculum.

Description of male. Body (Fig. 35A) narrower than that of female; body length 986 μm; prosome 590×391 μm. Urosome (Fig. 35B) 6-segmented; fifth pedigerous somite 130 μm wide; genital somite 159×186 μm; 4 abdominal somites 52×93, 48×88, 25×80, and 23×77 μm, respectively. Caudal ramus about 1.8 times wider than long (18×32 μm).

Rostrum as in female. Antennule with 3 additional aesthetascs: 2 on second segment and 1 on fourth, as indicated by dots in Fig. 33E. Antenna (Fig. 35C) armed as in female, but all 4 setae on second endopodal segment well-developed.

Labrum, mandible, maxillule, and maxilla as in female. Maxilliped (Fig. 35D) 4-segmented; first segment unarmed; second segment with 2 longitudinal rows of minute spinules on inner surface, distinct projection on inner margin tipped with 1 stout, claw-like spine bearing small setule near middle, and 1 small seta near base of projection; small third segment unarmed; fourth segment as elongate claw bearing 1 minute and 1 large seta proximally.

Legs 1–4 as in female. Leg 5 exopod (Fig. 35E) fusiform, about 2.3 times longer than wide (64×28 μm); armed with 2 large setae distally, both setae more than twice length of exopodal segment. Leg 6 (Fig. 35B) represented by 2 unequal setae on genital operculum.

Remarks. The lengths of the distal setae on the free exopodal segment of leg 5 are a distinctive feature of this species: they are more than twice as long as the segment itself in both sexes.

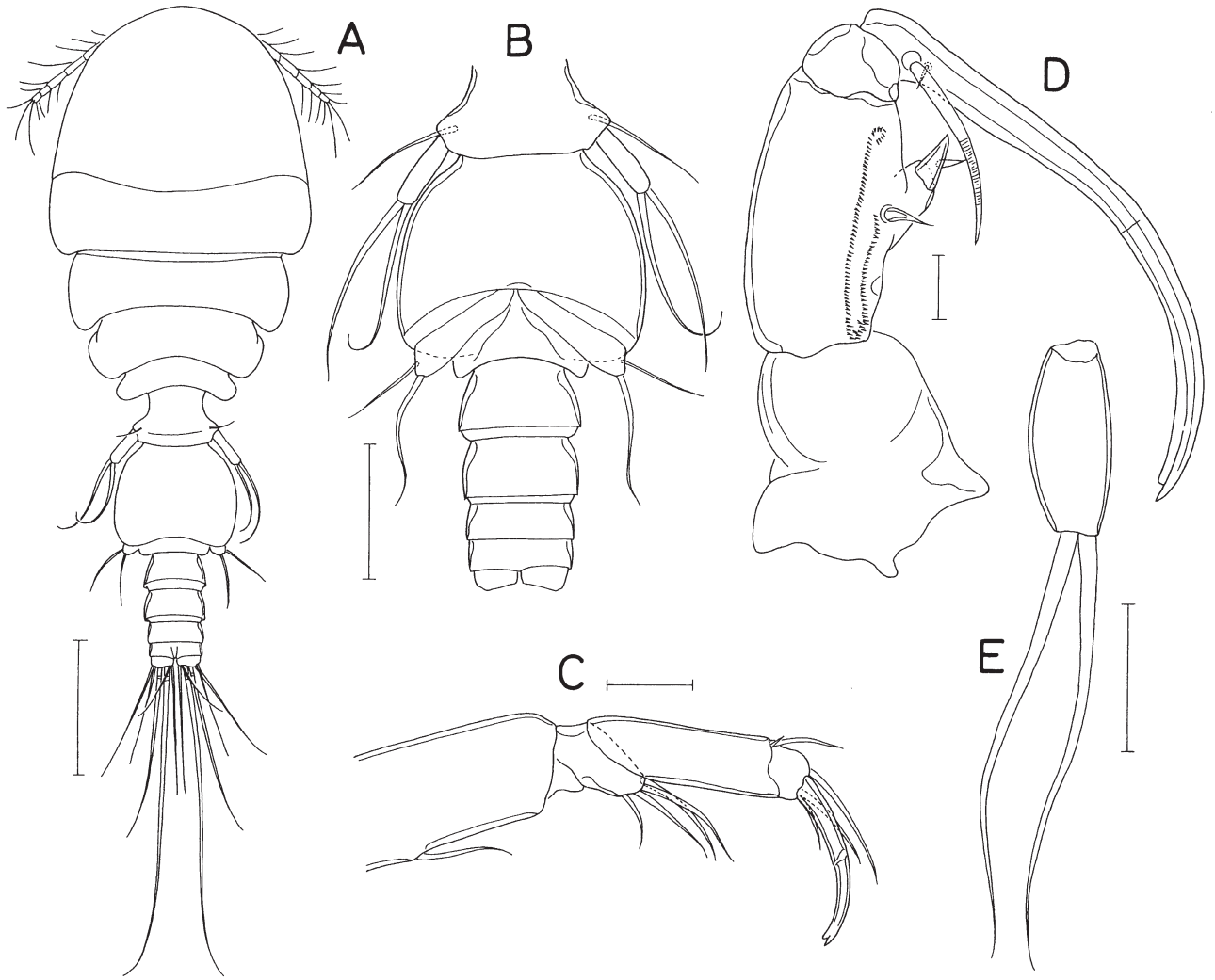

FIGURE 35. *Didemnomolgus crenulatus* **gen. et sp. nov.**, male. A, habitus, dorsal; B, urosome, ventral; C, distal part of antenna; D, maxilliped; E, exopod of leg 5. Scale bars: A, 0.2 mm; B, 0.1 mm; C, D, 0.02 mm; E, 0.05 mm.

***Spheromolgus* gen. nov.**

Diagnosis (female)**.** Lichomogidae. Body cyclopiform. Prosome inflated. Urosome 5-segmented. Caudal rami with 6 setae. Rostrum well-developed. Antennule 7-segmented, with armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc. Antenna 4-segmented, with armature formula 1, 1, 4, and 3+3 claws. Labrum broad, with 2 posterior lobes. Mandible with moderately long distal lash; blade slightly broadened, with inner margin perpendicular to distal lash. Maxillule with 3 setae. Maxilla 2-segmented; basis with elongated, distal lash bearing long spinules, and armed with distinct inner and anterior setae. Maxilliped 3-segmented; terminal segment claw-like. Leg 1-3 with 3-segmented rami. Leg 4 with 3-segmented exopod and 2-segmented endopod. Leg 4 endopod small, armed with inner seta on proximal segment and 1 spine distally on distal segment. Armature formula for legs 1-4 as follows:

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

Leg 5 consisting of dorsolateral seta on fifth pedigerous somite and 1-segmented free exopod armed with 1 spine and 1 seta distally. Leg 6 represented by 2 setae and 2 dentiform cusps on genital operculum.

Type species. *Spheromolgus rarus* **gen. et sp. nov.** by original designation.

Etymology. The name of the new genus is derived from Greek *spher* (=a ball) and *–molgus*, the suffix of many generic names in the Lichomolgidae. It alludes to the spherical cephalothorax of the female of the type species. Gender masculine.

Remarks. *Spheromolgus* **gen. nov.** has one inner seta on the proximal segment and one spine on the compound distal segment of the 2-segmented endopod of leg 4. This armature is shared with three existing genera in the Lichomolgidae, *Botulosoma*, *Debruma*, and *Gelastomolgus*. Two of these, *Botulosoma* and *Gelastomolgus*, have reduced armature on the anterior swimming legs, whereas *Debruma* has a complete armature on legs 1-3, as in *Spheromolgus* **gen. nov.** Nevertheless, the new genus can be separated from *Debruma* by the 3-segmented condition of the female maxilliped, which is only 2-segmented with a blunt distal segment in *Debruma* (as in *Gelastomolgus* and *Lichomolgidium*), the mandible has a distal lash (cf. distal lash absent or very short in *Debruma*), and the maxilla has a large inner seta on the basis (cf. this seta is absent or rudimentary in *Debruma*). We consider that these differences support the recognition of *Spheromolgus rarus* **gen. et sp. nov.** as representing a new genus, distinct from *Debruma*.

***Spheromolgus rarus* gen. et sp. nov.**
(Figs. 36, 37)

Type material. Holotype ♀ (MNHN-IU-2014-21606, dissected and mounted on a slide) from *Diplosoma simile* (Sluiter, 1909): Iles Mescha, Djibouti, intertidal, Monniot coll., October 1996

Additional non-type material. 1 ♀ (MNHN-IU-2014-21492, dissected) in *D. simile* (MNHN-IT-2008-3609 = MNHN A2/DIP.A/55), Canal Woodin, Grande Terre, New Caledonia, Stn NC 23, depth 3 m, Monniot coll., 18 September 1985.

Etymology. The name is derived from the Latin *rar* (=rare), alluding to the discovery of only single specimens of the new species at each of the two localities.

Description of female. Body (Fig. 36A) broad; body length 1.01 mm; prosome 690×536 μm, occupying 68% of body length. Cephalothorax spherical, 490 μm long. Urosome (Fig. 36B) stocky, 5-segmented; fifth pedigerous somite 120 μm wide; genital double-somite wider than long (140×153 μm), widest at about 70% of length of double-somite; genital apertures large, located dorsolaterally at widest region. Three free abdominal somites 25×71, 20×66, and 45×71 μm, respectively; anal somite with large anal region and row of spinules along posteroventral margin (Fig. 36C). Caudal ramus (Fig. 36C) broad, about 1.5 times longer than wide (46×30 μm), and ornamented

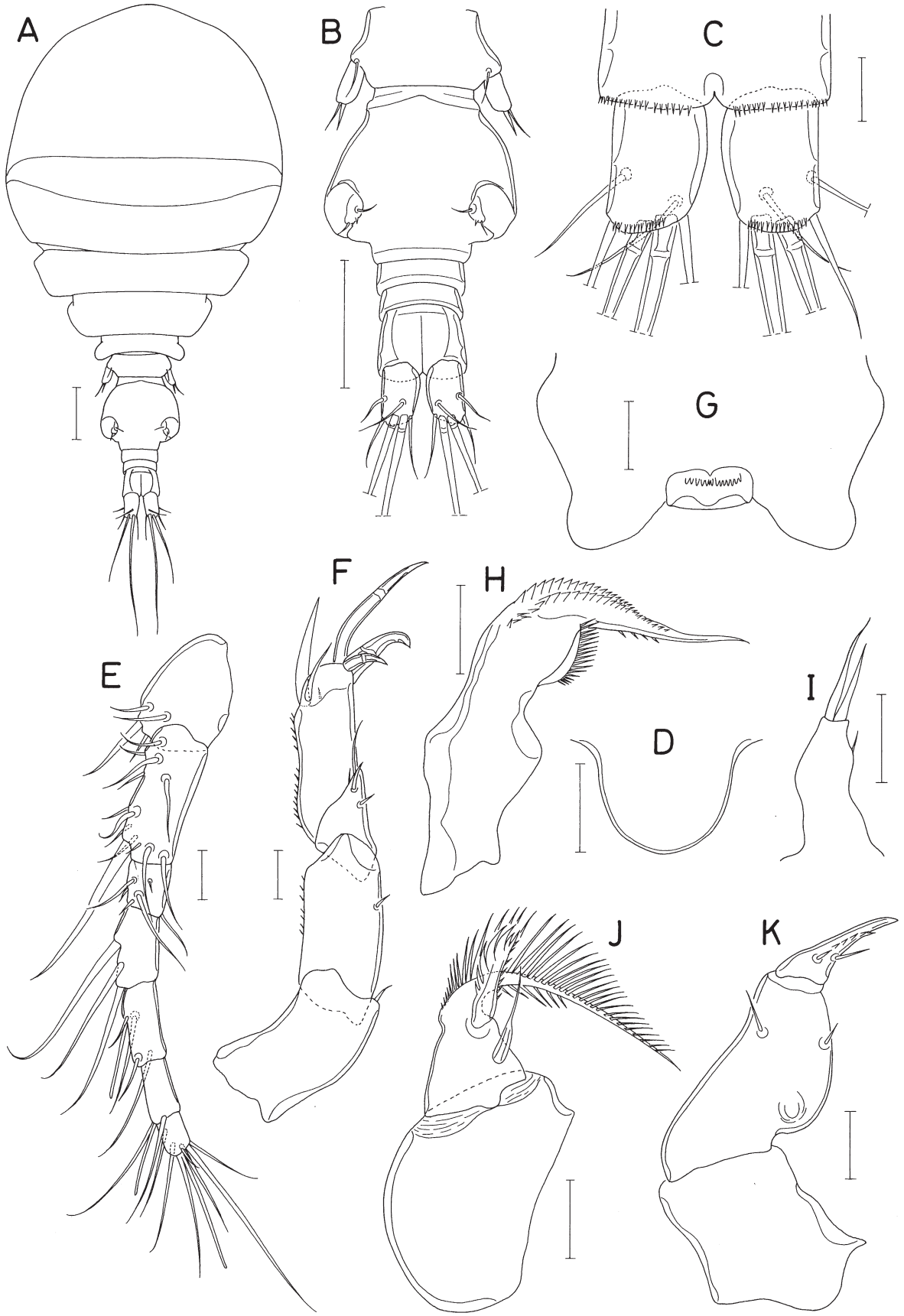

FIGURE 36. *Spheromolgus rarus* **gen. et sp. nov.**, female. A, habitus, dorsal; B, urosome, dorsal; C, caudal rami, ventral; D, rostrum; E, antennule; F, antenna; G, labrum; H, mandible; I, maxillule; J, maxilla; K, maxilliped. Scale bars: A, B, 0.1 mm; C, E–K, 0.02 mm; D, 0.05 mm.

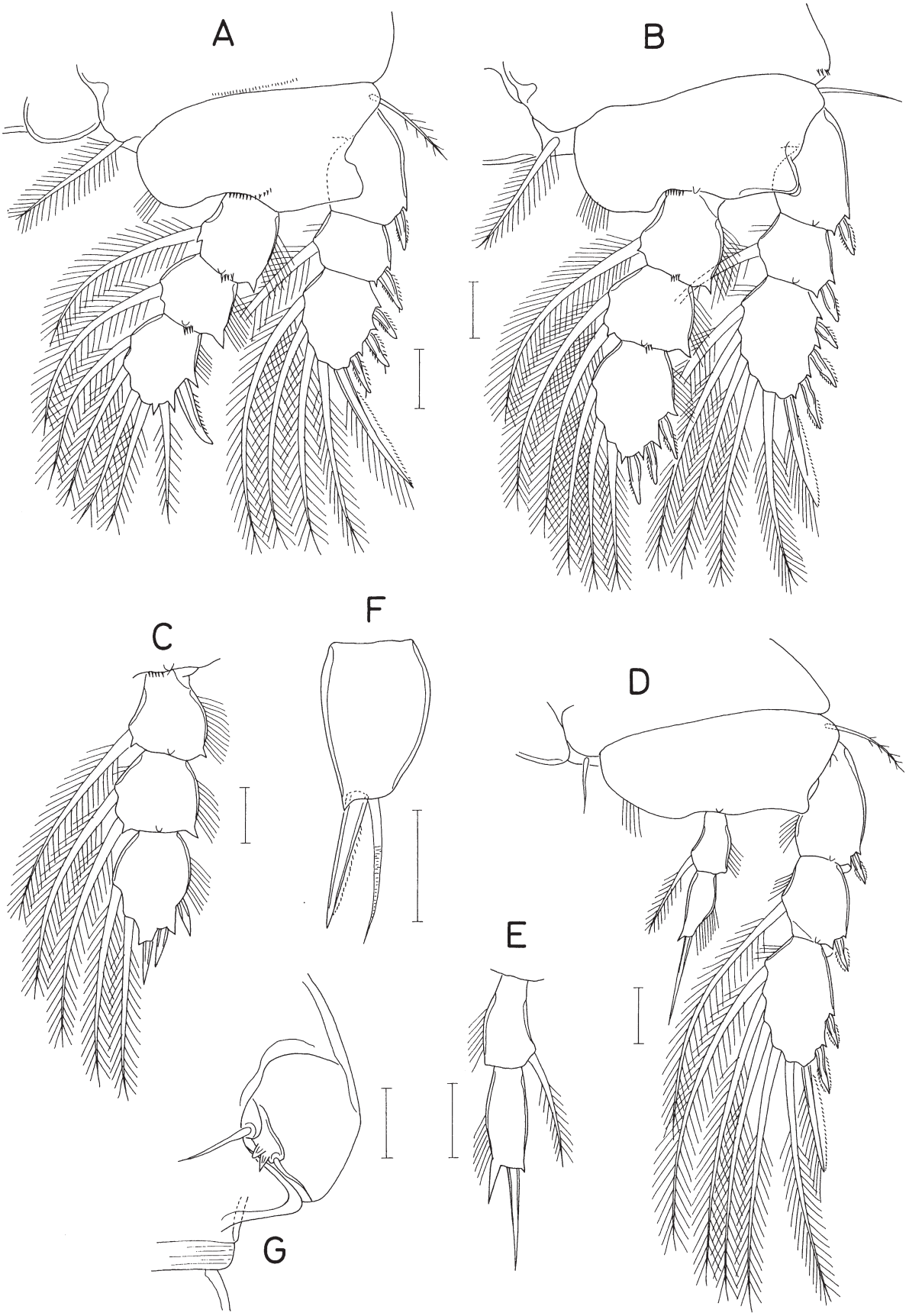

FIGURE 37. *Spheromolgus rarus* **gen. et sp. nov.**, female. A, leg 1; B, leg 2; C, endopod of leg 3; D, leg 4; E, endopod of leg 4; F, exopod of leg 5; G, right genital aperture, dorsal. All scale bars: 0.02 mm.

with row of spinules along posteroventral margin; armed with 6 naked setae, lateral seta (seta II) positioned at 65% of ramus length.

Rostrum (Fig. 36D) broad, semicircular. Antennule (Fig. 36E) 218 μm long, 7-segmented; first segment broadened; armature formula 4, 13, 6, 3, 4+aesthetasc. 2+aesthetasc, and 7+aesthetasc; all setae naked. Antenna (Fig. 36F) 4-segmented, with armature formula 1, 1, 4, and 3+3 claws; terminal segment about 2.2 times longer than wide (59×27 μm); 3 terminal claws annulated, unequal in length and thickness, 64, 31, 18 μm long, respectively; 1 seta on each of third and terminal segments minute, setule-like.

Labrum (Fig. 36G) with relatively small posterolateral lobes, separated by broad, shallow median incision; with transverse row of minute spinules at mid-posterior region. Mandible (Fig. 36H) blade slightly broadened with spinulose inner margin perpendicular to distal lash; lash rather short bearing 2 rows of denticles along convex outer margin and few minute spinules on inner margin. Maxillule (Fig. 36I) with 1 minute subdistal and 2 distal setae. Maxilla (Fig. 36J) consisting of syncoxa and basis; syncoxa broad, unarmed; basis terminating in recurved distal lash and 2 setae (setae I and II); distal lash thin, elongate, with row of long spinules along outer margin and several, shorter spinules on proximal part of inner margin; inner seta (seta I) spiniform, ornamented with broad spinules along outer margin and small spinules along inner margin; anterior seta (seta II) abruptly narrowed from middle, with thin, needle-like distal half. Maxilliped (Fig. 36K) 3-segmented; fist segment unarmed; second segment with protruding, convex inner margin bearing 1 blunt tubercle proximally plus 2 small setae; terminal segment claw-like, narrowing distally, with 2 small setae proximally, and ornamented with row of about 5 spinules in distal half.

Legs 1, 2 (Fig. 37A, B) and 3 with 3-segmented rami. Leg 3 same as leg 2 except third endopodal segment bearing 3 spines and 2 setae (Fig. 37C). Leg 4 (Fig. 37D) with 3-segmented exopod and 2-segmented endopod. Inner coxal seta of legs 1-3 well-developed, pinnate, that of leg 4 small and naked. Outer seta on basis sparsely pinnate in legs 1 and 4, but naked in legs 2 and 3. Leg 4 endopod small, less than half length of exopod; second endopodal segment of left leg 4 bearing small dentiform process at inner distal corner (Fig. 37D), but same segment of right leg 4 bearing large distal process at outer distal corner (Fig. 37E); terminal spine on distal endopodal segment naked, as long as distal segment. Armature formula for legs 1–4 as follows:

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

Leg 5 consisting of dorsolateral seta on fifth pedigerous somite and free exopodal segment (Fig. 37F) 1.45 times longer than wide (29×20 μm), narrowing distally, with convex outer margin; distally with 1 dentiform process, 1 spine (24 μm long) and 1 naked seta (26 μm long). Leg 6 (Fig. 37G) represented by 2 setae and 2 denticles on genital operculum.

Male. Unknown.

Remarks. The asymmetry of leg 4 is unusual: in the left leg the second endopodal segment bears a small dentiform process at the inner distal corner whereas on the right leg this segment has a large process at the outer distal corner. The figured specimen may simply be aberrant but more material will be needed to confirm this.

Alupa gen. nov.

Diagnosis (female)**.** Lichomolgidae. Body cyclopiform. Urosome 5-segmented. Caudal ramus with 6 setae. Rostrum well-developed. Antennule 7-segmented, with armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc. Antenna 4-segmented; armature formula 1, 1, 4, and 3+4 claws; 4 terminal claws small, annulated. Labrum with broad median incision separating narrow posterolateral lobes; transverse row of spinules present on posteromedial margin. Mandible slender with elongate distal lash. Maxillule with 1 inner margin seta and 2 distal spines. Maxilla consisting of syncoxa and basis; syncoxa unarmed; basis with elongate, spinulose distal lash plus large, spinulose inner seta and small anterior seta. Maxilliped 3-segmented; first segment unarmed; second segment with 2 small setae; third segment small, claw-like, with 2 small setiform elements proximally. Legs 1-3 with 3-

segmented rami. Leg 4 with 3-segmented exopod and small, 2-segmented endopod; proximal segment of endopod unarmed; distal segment armed with 1 naked seta distally. Armature formula for legs 1-4 as follows:

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

Leg 5 consisting of dorsolateral seta on fifth pedigerous somite and 1-segmented free exopod armed with 2 setae distally. Leg 6 represented by 2 seta and 1 small denticle on genital operculum.

Type species. *Alupa geminata* **gen. et sp. nov.** by original designation.

Etymology. The generic name is an anagram of "Palau", the type locality of the type species. Gender feminine.

Remarks. In five genera of Lichomolgidae (*Botulosoma*, *Debruma*, *Gelastomolgus*, *Paraphiloconcha*, and *Spheromolgus* **gen. nov.**) the compound distal segment of the 2-segmented endopod of leg 4 is armed with a single setation element (spine or seta), as in the new genus. But all these other genera also carry an inner seta on the proximal segment of the endopod. The type species of *Alupa* **gen. nov.** cannot be accommodated in any of these five genera due to the lack of the inner seta on the proximal endopodal segment of leg 4.

Alupa geminata gen. et sp. nov.

(Figs. 38, 39)

Type material. Holotype ♀ (MNHN-IU-2014-21607, intact), paratype ♀ (MNHN-IU-2014-21493, dissected) from *Leptoclinides madara* Tokioka, 1953 (MNHN-IT-2008-4797 = MNHN A2/LEP/73): Palau (07°30.58´N, 134°29.66´E), OCDN 3954-1, depth 0.5 m, CRRF coll., 11 June 1996.

Etymology. The specific name is derived from the Latin *gemin* (=twin), indicating that it was described on the basis of two specimens.

Description of female. Body (Fig. 38A) rather narrow; body length 891 μm; prosome 482×316 μm. Cephalothorax with round anterior and lateral margins and faint dorsal suture line delimiting cephalosome and first pedigerous somite. Epimera of second pedigerous somite with slightly produced posterolateral corners. Urosome (Fig. 38B) 5-segmented; fifth pedigerous somite 120 μm wide. Genital double-somite slightly longer than wide (136×124 μm), with laterally expanded anterior two-thirds and narrower posterior third; genital apertures positioned dorsolaterally at about 40% of length of double-somite; broader anterior part with angular posterolateral extension on each side. Three free abdominal somites characteristically subequal in length, 71×57, 73×48, and 76×47 μm, respectively, each somite longer than wide. Genital double-somite and abdominal somites with serrate membranous flange along posteroventral margins (Fig. 38C). Caudal ramus (Fig. 39A) about 3.6 times longer than wide (72×20 μm), rectangular, with parallel lateral margins, and ornamented with 5 spinules along posteroventral margin; armed with 6 naked setae, outer lateral seta positioned at 73% of ramus length.

Rostrum (Fig. 38D) longer than wide, with subparallel lateral margins and convex posterior margin. Antennule (Fig. 38E) 187 μm long, 7-segmented; armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked; aesthetascs slender, setiform. Antenna (Fig. 38F) 4-segmented, consisting of coxobasis and 3-segmented endopod; armature formula 1, 1, 4, and 3+4 claws; terminal segment about twice as long as wide (33×16 μm), with longer outer margin and much shorter inner margin; 4 terminal claws small and annulated (2 thick and 2 slender).

Labrum (Fig. 38G) with broad posteromedian incision and narrow posterolateral lobes each tipped with medially directed, digitiform process; posteromedial border with transverse row of spinules. Mandible (Fig. 38H) with narrow blade and elongate distal lash; blade and lash ornamented with row of spinules along each margin. Maxillule (Fig. 38I) with 1 small seta on inner margin and 2 broad apical spines (or setae bearing membranous flange) of unequal length; larger spine 1.8 times longer than smaller. Maxilla (Fig. 38J) consisting of syncoxa and basis; syncoxa unarmed; basis with elongate distal lash and 2 setae; distal lash directed at right angle to proximal part of basis,

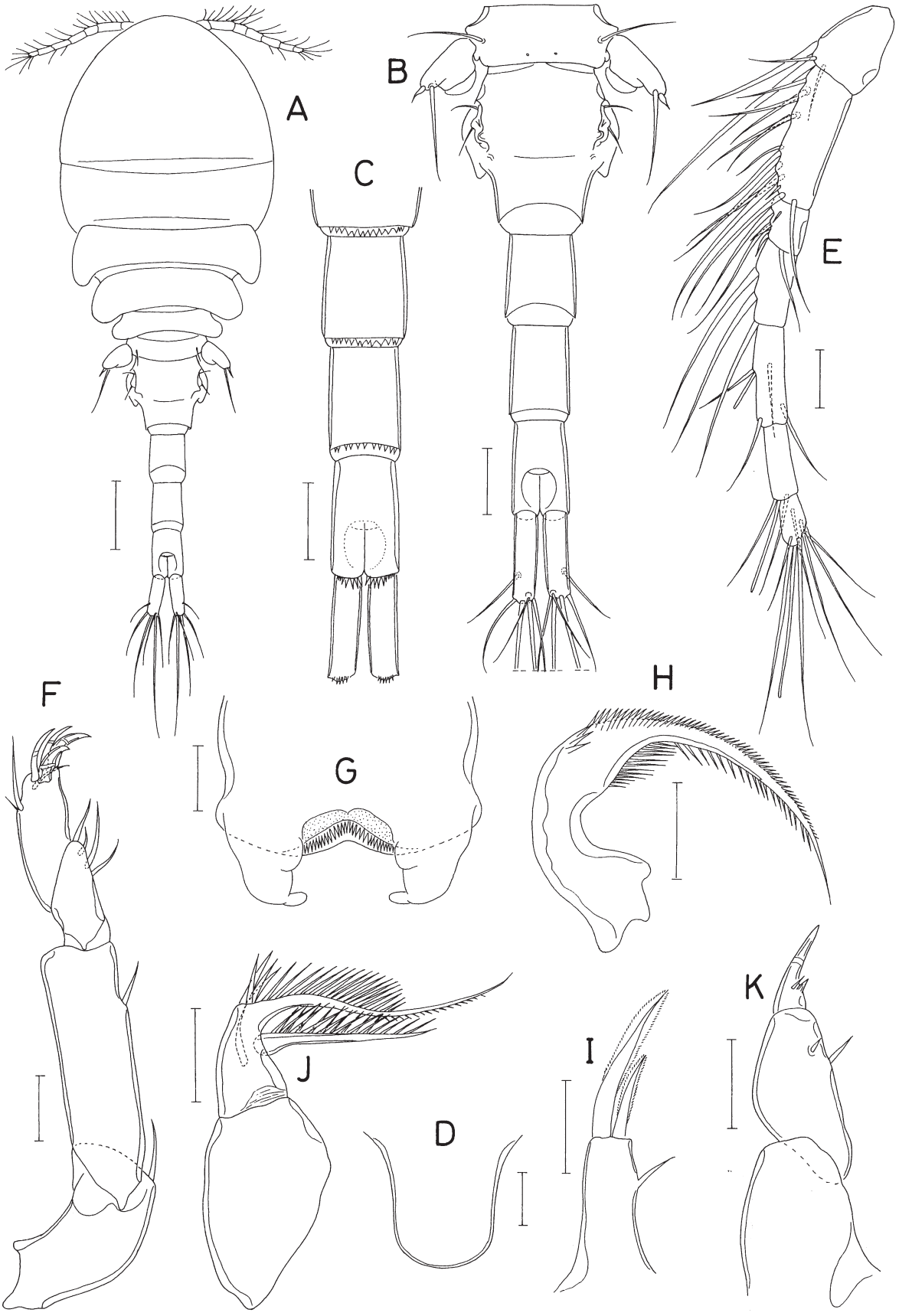

FIGURE 38. *Alupa geminata* **gen. et sp. nov.**, female. A, habitus, dorsal; B, urosome, dorsal; C, abdomen, ventral; D, rostrum; E, antennule; F, antenna; G, labrum; H, mandible; I, maxillule; J, maxilla; K, maxilliped. Scale bars: A, 0.1 mm; B, C, 0.05 mm; D–K, 0.02 mm.

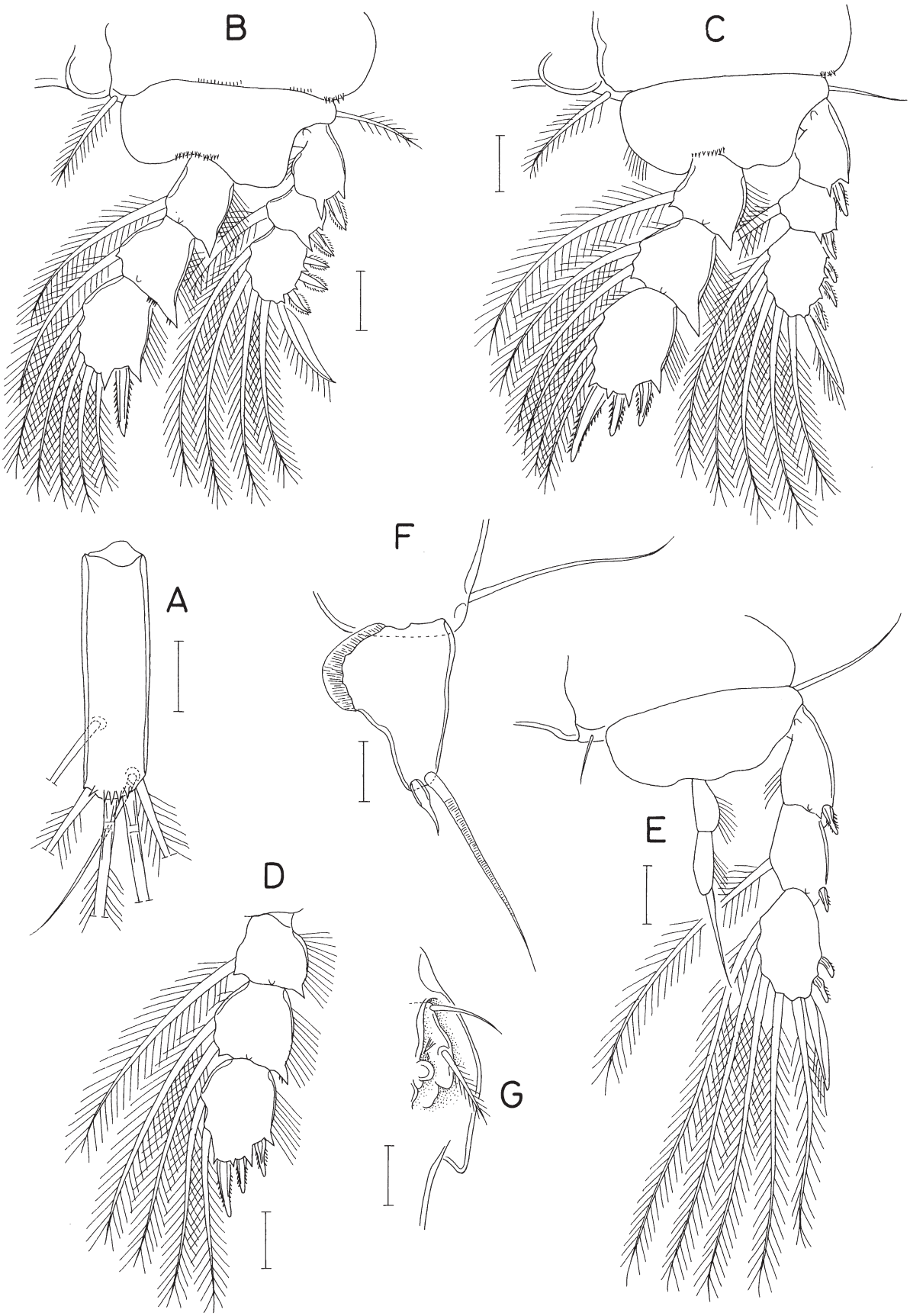

FIGURE 39. *Alupa geminata* **gen. et sp. nov.**, female. A, right caudal ramus, ventral; B, leg 1; C, leg 2; D, endopod of leg 3; E, leg 4; F, leg 5; G, right genital aperture, dorsal. All scale bars: 0.02 mm.

ornamented with 4 thicker spinules proximally followed by thinner spinules along half of outer margin; inner margin of lash with fine spinules; inner seta (seta I) spiniform, about 0.6 times as long as lash, with 2 rows of spinules along its outer margin; small anterior seta naked. Maxilliped (Fig. 38K) 3-segmented; first segment unarmed; second segment with 2 small, unequal setae; terminal segment attenuated, claw-like, proximally with 1 small, spinule-like process and 1 minute seta.

Legs 1, 2 (Fig. 39B, C) and 3 with 3-segmented rami. Leg 3 same as leg 2 except third endopodal segment bearing 3 spines and 2 setae (Fig. 39D). Leg 4 (Fig. 39E) with 3-segmented exopod and small, 2-segmented endopod; endopod slender, less than half length of exopod; proximal endopodal segment unarmed; distal segment with 1 naked seta at apex. Inner coxal seta of legs 1-3 well-developed, pinnate, but that of leg 4 small and naked. Outer seta on basis pinnate in leg 1, but naked in legs 2-4. Outer spines on exopods small. Armature formula for legs 1–4 as follows:

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

Leg 5 (Fig. 39F) consisting of dorsolateral seta on somite and free exopodal segment; exopod with prominent, semicircular inner expansion proximally bearing broad membranous flange along margin; armed with 2 very unequal naked setae distally, inner seta 20 μm long and outer seta 77 μm. Leg 6 (Fig. 39G) represented by 1 naked seta, 1 pinnate seta, and 1 denticle on genital operculum.

Male. Unknown.

Remarks. This is the first report of any copepod associated with this host, *Leptoclinides madara*. The host was originally described from Japan and is also known to occur in Australia (originally recorded as *L. variegatus* Kott, 2001) so Palau, the type locality of *Alupa geminata* **gen. et sp. nov**., lies close to the centre of the geographical distribution of the host.

Genus *Lobomolgus* Ho & Kim I.H., 2009

Diagnosis. As in Ho & Kim I.H. (2009), but with slight emendation as follows: Caudal ramus typically with 7 setae, sometimes reduced. Endopod of leg 4 absent or 1-segmented. Armature formula of last exopodal segment of leg 4 being III, I, 5 or III, 1, 3 in female, and II, I, 5 or II, I, 4 in male. Leg 5 represented by tiny lobe tipped with 2 elements.

Type species. *Lobomolgus okinawaensis* Ho & Kim I.H., 2009 by original designation.

Remarks. The type species of *Lobomolgus*, *L. okinawaensis* was based on specimens found in association with the compound ascidian *Didemnum molle* (Herdmann, 1886) in Okinawa (Ho & Kim I.H, 2009). We describe below a second species associated with the same ascidian host species.

Lobomolgus foveolatus sp. nov.

(Figs. 40–42)

Type material. Holotype ♀ (MNHN-IU-2014-21608, body with appendages of right side), and paratype (♂ (MNHN-IU-2014-21494, dissected) from *Didemnum molle* (Herdmann, 1886) MNHN-IT-2008-3125 (= MNHN A2/DID.C/226): 13 miles West of Murex Resort, West of Manado town, North Sulawesi, Indonesia, OCDN 1260-F, Site MANADO 5, depth 43 m, CRRF coll. 17 May 1993.

Etymology. The specific name is derived from the Latin *fove* (=a pit), referring to the presence of numerous pits on the exoskeleton of the new species.

Description of female. Body (Fig. 40A, B) large, body length 3.48 mm; gradually narrowing from anterior to posterior; body surface ornamented with numerous small pits. Prosome expanded dorsally (Fig. 40B); maximum

width 1.26 mm (across first pedigerous somite). Prosomal somites each with well-developed dorsal tergite. Cephalosome and first pedigerous somite clearly defined from each other by dorsal suture. First to fourth pedigerous somites well-separated from one another by broad arthrodial membrane. Second to fourth pedigerous somites with posterolateral extensions, short in second and third pedigerous somites, but elongate, digitiform in fourth pedigerous somite. Urosome 5-segmented; fifth pedigerous somite 409 μm wide; genital double-somite 382×555 μm, with expanded anterior half and narrower posterior half; genital apertures positioned dorsolaterally in anterior region. Three free abdominal somites 227×318, 145×255, and 136×236 μm, respectively. Caudal ramus (Fig. 40C) about 2.7 times longer than wide (263×98 μm), gradually narrowing distally; armed with 5 thin, naked setae; setae I and II absent.

Rostrum (Fig. 41A) small, directed ventrally, sub-globular in ventral view. Antennule (Fig. 40D) 590 μm long, gradually narrowing, 7-segmented; armature formula 4, 8, 4, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae small and naked. Antenna (Fig. 40E) 4-segmented; armature formula 1, 1, 2, 2+2 claws; 2 distal segments (second and third endopodal segments) distinctly narrower than proximal segments; terminal segment about 2.5 times longer than wide (68×27 μm); 2 terminal claws very unequal in length, 50 μm (inner) and 18 μm (outer).

Labrum (Fig. 40F) broad, with broad median incision separating semicircular posterolateral lobes; with 1 transverse row of minute spinules in middle. Mandible (Fig. 40G) with elongate distal lash, distinct inner proximal notch; inner margin of blade with densely arranged broad spinules; convex outer margin of lash with 3 rows of denticles, inner margin with spinules distally. Maxillule (Fig. 40I) with 1 minute seta on inner margin and 2 apical spatulate setae. Maxilla (Fig. 40J, K) consisting of syncoxa and basis; syncoxa large but unarmed; basis strongly recurved, with globular structure (transformed inner seta) and pale, leaf-like scale (transformed anterior seta); distal lash directed proximally, with more than 10 leaf-like scales proximally on convex margin. Maxilliped (Fig. 41B) 3-segmented; first segment unarmed; second segment with 2 small setae and irregularly wavy outer margin; third segment tapering, with 1 minute spinule in middle, and terminating in digitiform process.

Legs 1–3 (Fig. 41C–E) with 3-segmented rami. Outer side of coxa of legs 1-3 markedly protruded. Inner coxal seta absent in legs 1–4. First and second endopodal segments in legs 1 and 2 and first endopodal segment of leg 3 lacking inner seta. Leg 4 (Fig. 41F) with 3-segmented exopod; endopod lacking. Inner seta on second exopodal segment of legs 1-4 minute. Spines and setae on legs thin and naked. Armature formula for legs 1–4 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1:	0-0	1-0	I-0; I-1; II, 5	0-0; 0-0; 1, 2, 2
Leg 2:	0-0	1-0	I-0; I-1; II, 6	0-0; 0-0; 1, 2, 3
Leg 3:	0-0	1-0	I-0; I-1; II, 6	0-0; 0-1; 1, 2, 3
Leg 4:	0-0	1-0	I-0; I-1; III, 4	(absent)

Leg 5 (Fig. 41G) consisting of dorsolateral seta on somite and small, lobate exopod fused to somite; armed with 1 small and 1 minute seta apically. Leg 6 (Fig. 41G) represented by 1 seta, 1 setule, and 1 small spinule on genital operculum.

Description of male. Body (Fig. 42A) narrower and much smaller than that of female; body length 1.53 mm; prosome 864×477 μm. Body lacking surface ornamentation of pits present in female. Cephalothorax circular in dorsal outline. Fourth pedigerous somite with digitiform lateral processes. Urosome 6-segmented; fifth pedigerous somite 220 μm wide; genital somite 167×237 μm, with convex lateral margins. Four abdominal somites 79×133, 76×118, 52×103, and 67×121 μm, respectively. Caudal rami widely divergent, about 4.1 times longer than wide (197×48 μm), armed with 5 setae as in female.

Rostrum (Fig. 42B) semicircular. Antennule (Fig. 42C) 7-segmented, with armature formula 4, 12, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; setae small. Antenna with 3 setae on third segment (second endopodal segment), otherwise as in female.

Labrum, mandible, maxillule and maxilla as in female. Maxilliped (Fig. 42D) 4-segmented; first and third segments unarmed; second segment with 2 small setae; fourth segment as long claw bearing 1 seta and 1 setule proximally.

Legs 1-4 (Figs 42E-H) segmented as in female; outer side of coxa not inflated. Inner seta on first endopodal segment of legs 1-3 minute. Armature formula for legs 1-4 differing from that of female as follows (third endopodal segment of leg 3 damaged):

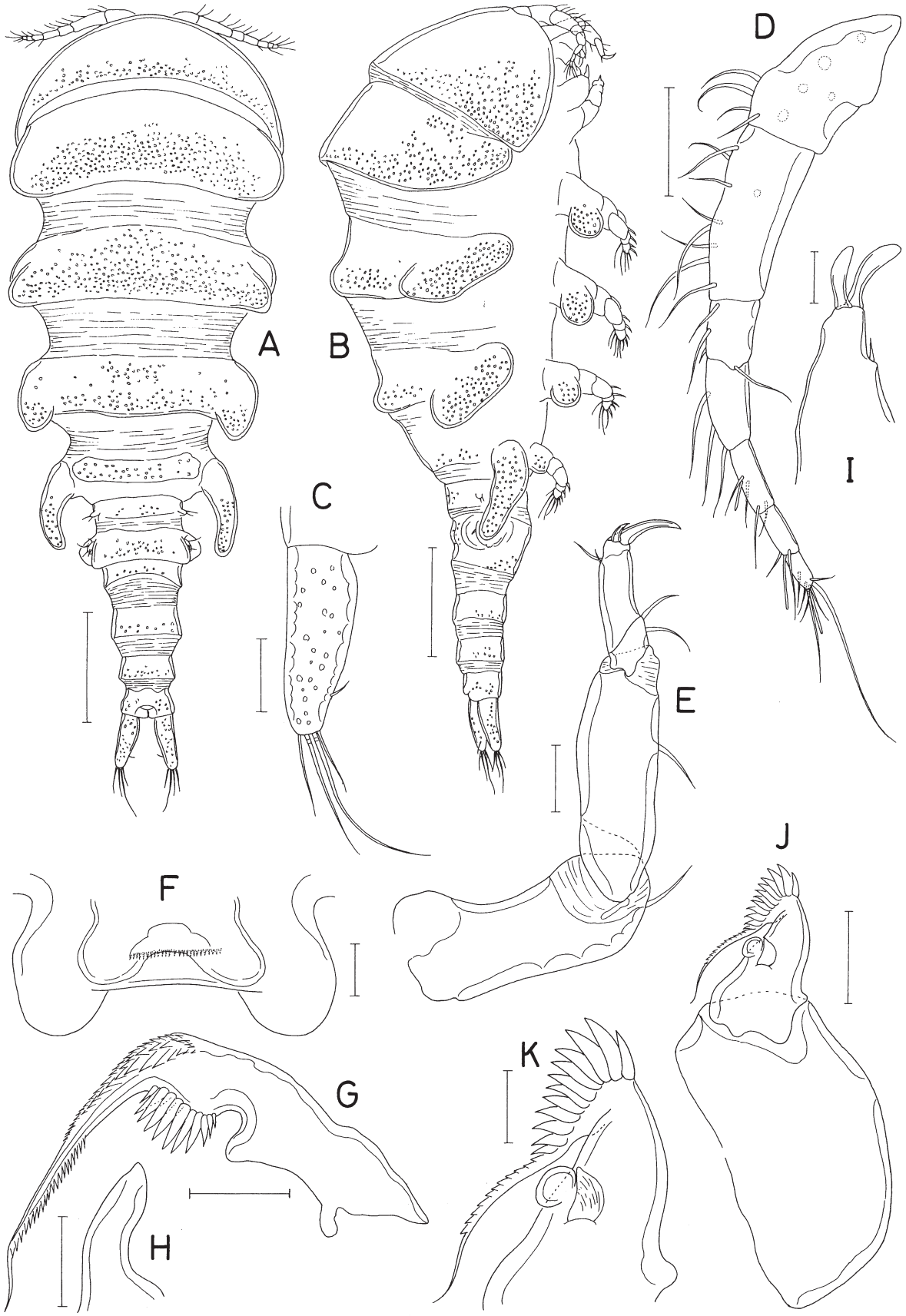

FIGURE 40. *Lobomolgus foveolatus* **sp. nov.**, female. A, habitus, dorsal; B, habitus, right; C, left caudal ramus, dorsal; D, antennule; E, antenna; F, labrum; G, mandible; H, paragnath; I, maxillule; J, maxilla; K, basis of maxilla. Scale bars: A, B, 0.5 mm; C, D, 0.1 mm; E, G, J, 0.05 mm; F, H, I, K, 0.02 mm.

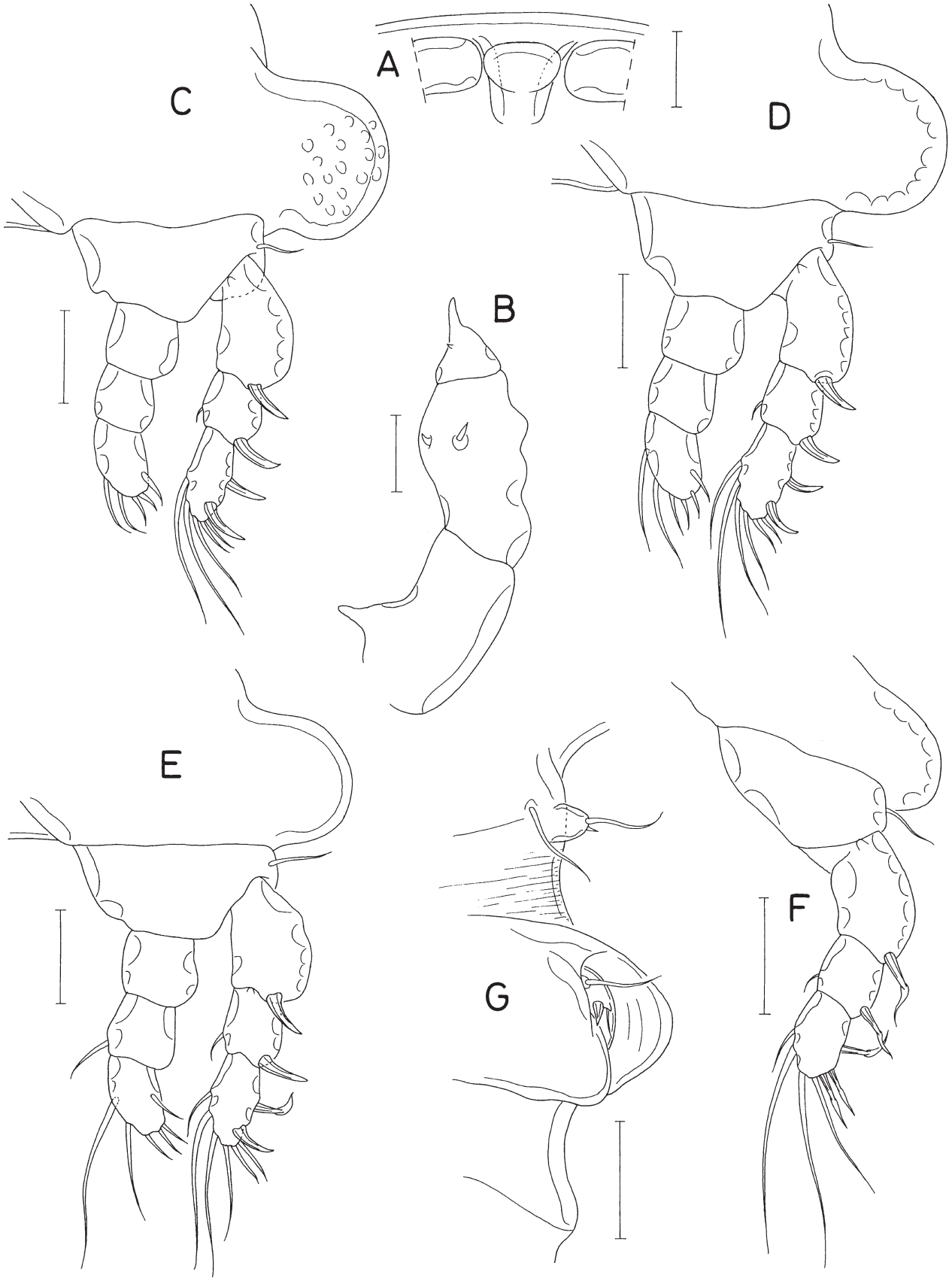

FIGURE 41. *Lobomolgus foveolatus* **sp. nov.**, female. A, rostral area, ventral; B, maxilliped; C, leg 1; D, leg 2; E, leg 3; F, leg 4; G, right leg 5 and genital aperture, dorsal. Scale bars: A, C–G, 0.1 mm; B, 0.05 mm.

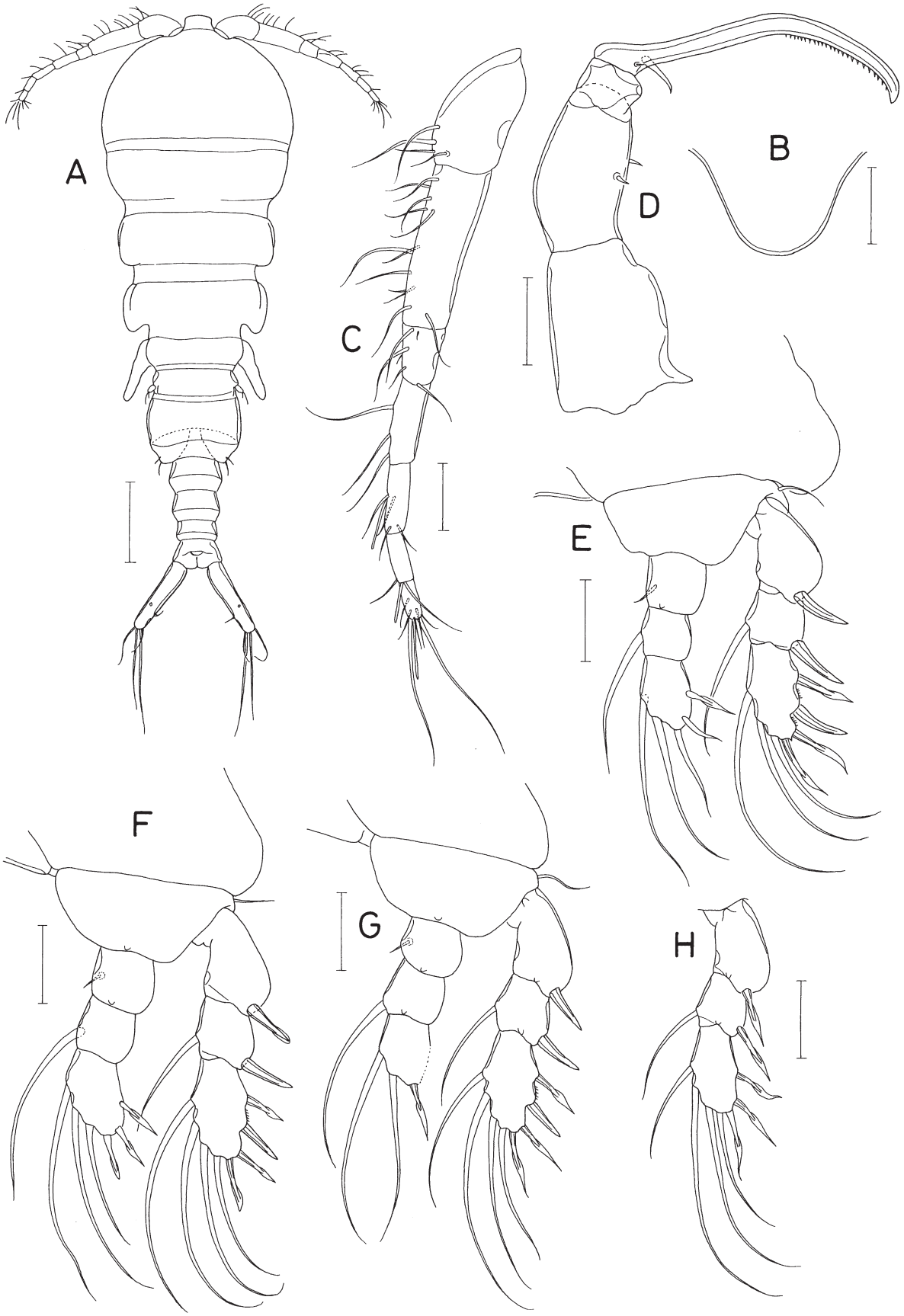

FIGURE 42. *Lobomolgus foveolatus* **sp. nov.**, male. A, habitus, dorsal; B, rostrum; C, antennule; D, maxilliped; E, leg 1; F, leg 2; G, leg 3; H, exopod of leg 4. Scale bars: A, 0.2 mm; B–H, 0.05 mm.

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

Leg 5 as in female. Leg 6 represented by 2 small setae on genital operculum.

Remarks. *Lobomolgus okinawaensis* and *L. foveolatus* **sp. nov.** are no doubt congeneric. They share the characteristic antenna, labrum, mandible, and maxilla. Nevertheless, they exhibit various differences, mainly in the leg armature, as summarised in Table 1.

TABLE 1. Summary of differences between *Lobomolgus okinawaensis* Ho and Kim I.-H., 2009 and *L. foveolatus* **sp. nov.**

Character	*L. okinawaensis*	*L. foveolatus* **sp. nov.**
Body length	♀ 3.65 mm; ♂ 1.07 mm	♀ 3.53 mm; ♂ 1.53 mm
Lateral processes on 3rd pedigerous somite (♀)	Prominent	Weak
♀ caudal ramus, L/W ratio	3.96:1	2.68:1
♂ antennule	3 additional aesthetascs	No additional aesthetascs
♀ leg 1 rami, armature formula	Exopod: I-0; I-1; III, I, 4 Endopod: 0-1; 0-1; I, 2, 3	Exopod: I-0; I-1; II, 5 Endopod: 0-0; 0-0; 1, 2, 2
♀ leg 2 rami, armature formula	Exopod: I-0; I-1; III, I, 5 Endopod: 0-1; 0-1; I, II, 3	Exopod: I-0; I-1; II, 6 Endopod: 0-0; 0-0; 1, 2, 3
♀ leg 3 rami, armature formula	Exopod: I-0; I-1; III, I, 5 Endopod: 0-1; 0-1; 0, I, 2	Exopod: I-0; I-1; II, 6 Endopod: 0-0; 0-1; 1, 2, 3
♀ leg 4 rami, armature formula	Exopod: I-0; I-1; II, I, 5 Endopod: 1	Exopod: I-0; I-1; III, 4 Endopod: absent
♂ leg 1 rami, armature formula	As in female	Exopod: I-0; I-1; III, I, 3 Endopod: 0-1; 0-1; I, 2, 2
♂ leg 2 rami, armature formula	As in female	Exopod: I-0; I-1; III, I, 4 Endopod: 0-1; 0-1; I, II, 3
♂ leg 3 rami, armature formula	As in female	Exopod: I-0; I-1; III, I, 4 Endopod: 0-1; 0-1; (I, II, 2?)
♂ leg 4 rami, armature formula	As in female	Exopod: I-0; I-1; II, I, 4 Endopod: absent

Genus *Zygomolgus* Humes & Stock, 1972

Diagnosis. Body cyclopiform. Urosome 5-segmented in both sexes. Caudal ramus typically elongate, with 6 setae. Rostrum well-developed. Antennule 7-segmented, with armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc in female; in male second segment with 2 additional aesthetascs so far as known. Antenna 4-segmented, with armature 1, 1, 2+claw, and 3+4 claws. Labrum with broad median incision and tapering posterolateral lobes. Mandible with elongate distal lash and 1 to 4 digitiform processes (scales) on outer side of blade. Maxillule distally with 2 setae or 3 setae plus 1 setiform process. Maxilla consisting of unarmed syncoxa and basis; basis with 3 setae and elongate distal lash; inner seta (seta I) large, spinulose; distal lash spinulose, with 3 to 5 thick spinules proximally on outer margin. Maxilliped 3-segmented, third segment claw-like. Legs 1-3 with 3-segmented rami. Leg 1 lacking sexual dimorphism. Third exopodal segment of leg 3 armed with 4 spines and 5 setae (formula III, I, 5) or 3 spines and 5 setae (formula II, I, 5); third endopodal segment armed with 3 spines and 2 setae (formula I, II, 2) or 2 spines and 2 setae (formula I, I, 2). Leg 4 with 3-segmented exopod and 2-segmented endopod; third ex-

opodal segment armed with 3 spines and 5 setae (formula II, I, 5) or 3 spines and 4 setae (formula II, I, 4); endopod armed with 1 inner seta on proximal segment and 2 spines distally on distal segment (formula 0-1; 0, II, 0). Leg 5 consisting of dorsolateral seta on surface of somite and free exopodal segment armed distally with 2 setae, or 1 spine plus 1 seta. Leg 6 represented by 2 setae and 1 denticle on genital operculum. Associated with compound ascidians, algae, or holothurians.

Type species. *Zygomolgus tenuifurcatus* (Sars G.O., 1917) by original designation.

Remarks. The genus *Zygomolgus* currently consists of six species. As differential features of this genus, the antenna has one claw on the third segment (the second endopodal segment) and 4 claws on the terminal segment, and the mandible has 1 to 4 digitiform processes (scales) on the outer side of the blade. The male is known only in *Z. cuanensis* (Gotto, 1954).

Zygomolgus dentatus Kim I.H., 2006

(Figs. 43, 44)

Material examined. 1 ♀ (MNHN-IU-2014-21495, dissected) from a compound ascidian *Diplosoma listerianum* (Milne Edwards, 1841) MNHN-IT-2008-3533 (= MNHN A2/DIP.A/30): Port de Sète, Mediterranean coast of France, Monniot coll., 12 March 1984.

Supplementary description of female. Body (Fig. 43A) with broad prosome and narrow urosome; body length 1.67 mm; prosome 1.11 mm long, strongly tapering posteriorly. Cephalothorax markedly expanded, globular, 735×815 μm. Urosome (Fig. 43B) 5-segmented; fifth pedigerous somite 175 μm wide; genital double-somite as long as wide (190×190 μm), with slightly broadened anterior half; genital apertures positioned dorsolaterally at midlength of double-somite. Three free abdominal somites 48×101, 38×88, and 84×95 μm, respectively; anal somite with 4 or 5 denticles each side on posteroventral margin (Fig. 43C). Caudal ramus (Fig. 43C) about 4.3 times longer than wide (156×36 μm) and 1.86 times longer than anal somite, and ornamented with 4 denticles on posteroventral margin; armed with 6 naked setae, lateral seta positioned slightly distal to midlength of ramus.

Rostrum (Fig. 43D) distinct, nearly semicircular. Antennule (Fig. 43E) 336 μm long, 7-segmented; armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc (deduced from setae and their insertion scars). Antenna (Fig. 43F) 4-segmented, with armature formula 1, 1, 2+claw, and 3+4 claws; terminal segment about 2.6 times longer than wide (75×29 μm); claw on third segment (second endopodal segment) rather strong, annulated; four terminal claws unequal in length and thickness, outermost claw longest, slender and setiform.

Labrum (Fig. 43G) with broad median incision and tapering posterolateral lobes fringed with membrane; mid-posterior margin with row of fine spinules. Mandible (Fig. 43H) with elongate distal lash bearing densely arranged spinules along both margins and 3 digitiform processes (scales) on convex outer side of blade. Maxillule (Fig. 43I) distally with 2 broad spiniform setae, 1 shorter spiniform process, and 1 small seta. Maxilla (Fig. 43J, K) consisting of broad, unarmed syncoxa and basis; basis with elongate distal lash and 3 setae; distal lash with 3 thick spines proximally, followed by row of spinules on outer margin; inner seta (seta I) large, slightly shorter than distal lash, spinulose along both margins; anterior seta (seta II) simple; outer proximal seta (seta III) minute. Maxilliped (Fig. 44A) 3-segmented; first segment unarmed; second segment with 2 small setae and produced into claw-like process at outer distal corner (indicated by arrowhead in Fig. 44A); small terminal segment claw-like, with 1 minute seta proximally.

Legs 1, 2 (Fig. 44B, C) and 3 with 3-segmented rami. Leg 4 (Fig. 44E) with 3-segmented exopod and 2-segmented endopod. Outer seta on basis of legs 1-4 and inner coxal seta of leg 4 small and naked, other setae pinnate. Third exopodal segment of leg 2 with bifid distal process (indicated by arrowhead in Fig. 44C). Leg 3 same as leg 2, except third endopodal segment armed with 3 spines and 2 setae (Fig. 44D). Leg 4 endopod less than half length of exopod; distal endopodal segment twice as long as wide (55×24 μm), armed with 2 distal spines 35 μm (outer) and 52 μm long (inner). Armature formula for legs 1-4 as follows (same as in *Lichomolgus*):

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

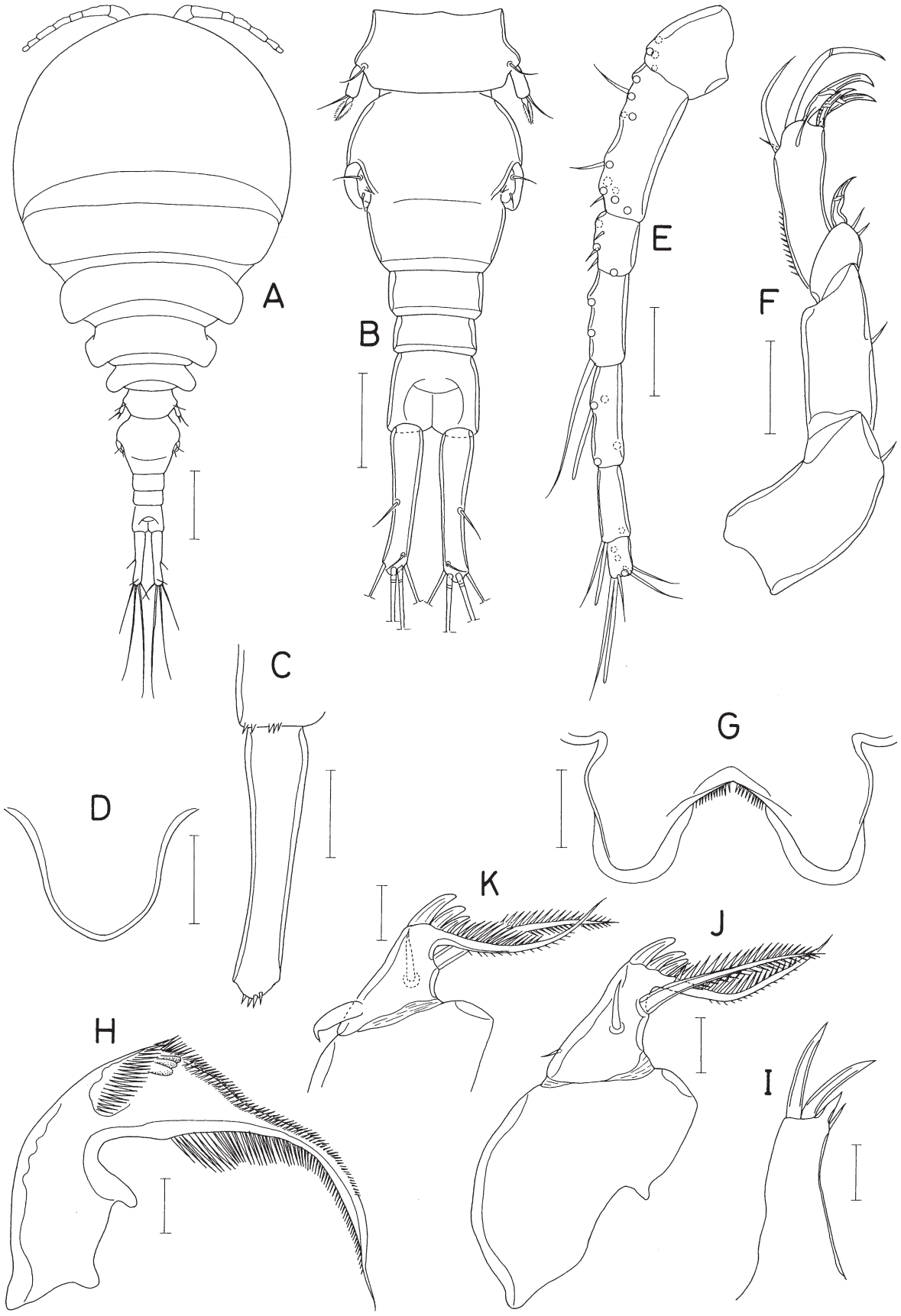

FIGURE 43. *Zygomolgus dentatus* Kim I.H., 2006, female. A, habitus, dorsal; B, urosome, dorsal; C, right caudal ramus, ventral; D, rostrum; E, antennule; F, antenna; G, labrum; H, mandible; I, maxillule; J, maxilla; K, basis of maxilla. Scale bars: A, 0.2 mm; B, 0.1 mm; C–G, 0.05 mm; H–K, 0.02 mm.

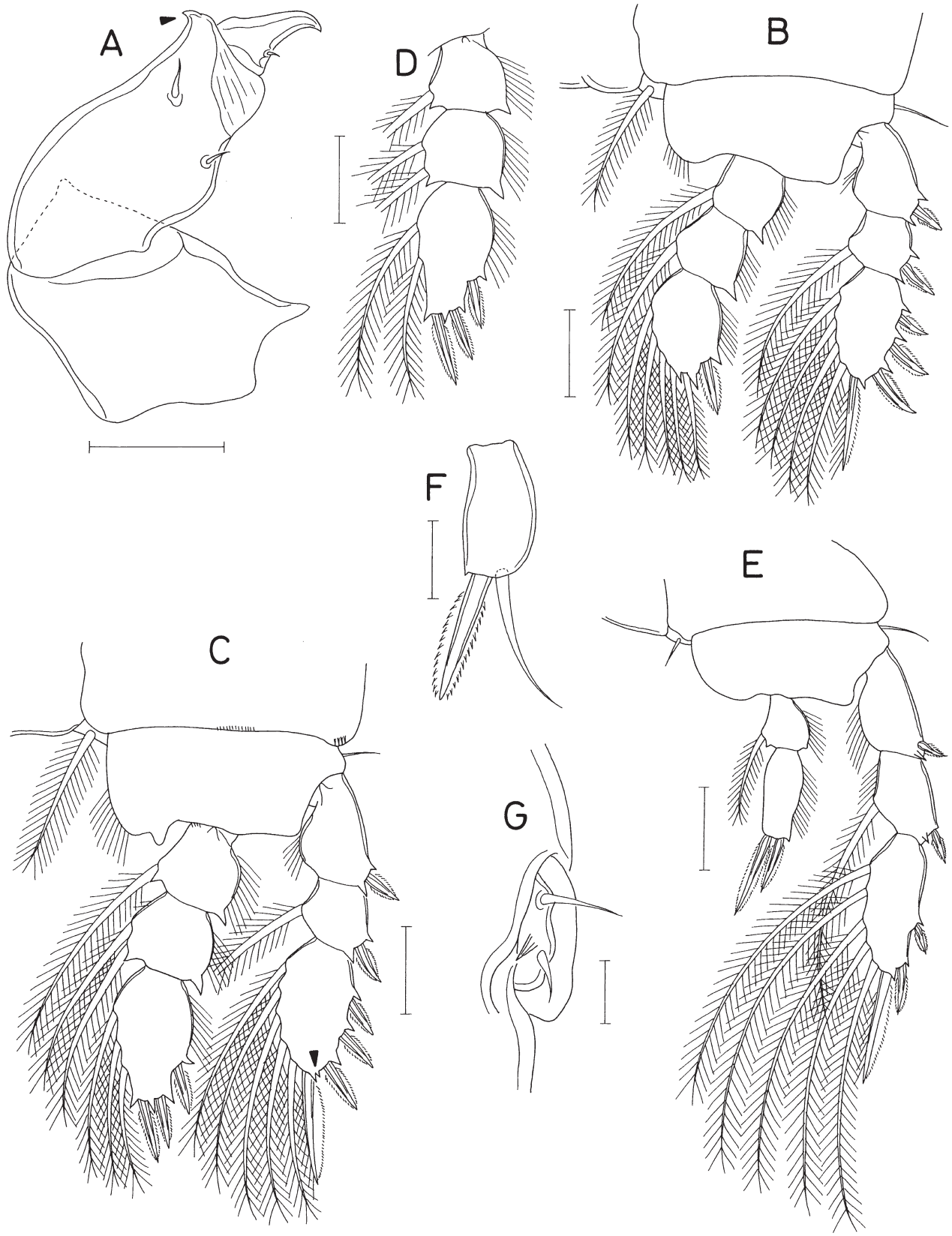

FIGURE 44. *Zygomolgus dentatus* Kim I.H., 2006, female. A, maxilliped; B, leg 1; C, leg 2; D, endopod of leg 3; E, leg 4; F, exopod of leg 5; G, right genital aperture, dorsal. Scale bars: A–E, 0.05 mm; F, G, 0.02 mm.

Leg 5 (Fig. 43B) consisting of dorsolateral seta on surface of somite and free exopodal segment; exopod (Fig. 44F) about 1.9 times longer than wide (34×18 μm), with convex outer margin, pointed inner distal corner; armed distally with 1 bilaterally serrate spine (33 μm long) and 1 naked seta (38 μm long). Leg 6 (Fig. 44G) represented by 2 naked setae and 1 denticle on genital operculum.

Male. Not found.

Remarks. Although the caudal ramus of our examined specimen is 4.33 times longer than wide, which differs from the 5.6 times in the type material of *Z. dentatus* known from Korea (Kim, I.H., 2006), our Mediterranean specimen is identified as *Z. dentatus*. The type material and our Mediterranean specimen share numerous specific morphological features, including the three proximal scales on the distal lash of the maxilla, the recurved, claw-like distal process on the second segment of the maxilliped, and the bifid terminal process on the third exopodal segment of leg 2, which suggest that they are conspecific. The host ascidian *Diplosoma listerianum* is a cosmopolitan species, whose known distribution includes the Atlantic, Mediterranean and North Pacific, and it is possible that *Z. dentatus* can be found in association with this host across its geographical range.

Gotto (1955) recorded *Zygomolgus tenuifurcatus* as an associate of the ascidian *Diplosoma listerianum* in Northern Ireland. Although our specimen from the Mediterranean was obtained from the same ascidian host, it cannot be identified as *Z. tenuifurcatus*, because, according to the original description (Sars, 1917), its caudal ramus is more elongate (more than twice as long as the anal somite), and none of the above-mentioned diagnostic features of *Z. dentatus* is observable in his illustrations.

Discussion

The addition of the four new genera of Lichomolgidae brings the total number of valid genera in the family to 34, just over a third (13) of which exclusively utilise ascidians as hosts. Including the new species described here, these thirteen genera now comprise 30 species. The genus *Lichomolgus* is unusual in utilising at least two different host taxa: prior to this study *Lichomolgus* contained 17 species found on bivalve molluscs, ten species found in association with ascidians, plus two species for which the hosts are unknown because they were collected from washings of marine invertebrates. Here we add four new *Lichomolgus* species, all from ascidians.

As discussed above, there are clusters of species within *Lichomolgus* that share particular character states, such as *L. arcanus*, *L. asaphidis*, *L. chamarum*, *L. hippopi*, *L. inflatus*, *L. spondyli*, and *L. uncus*, which all share a 3-segmented antenna, and *L. eganae*, *L. fusiformis*, *L. indicus*, *L. nakaii*, *L. brevicaudatus* **sp. nov.**, and *L. pectinatus* which all have short caudal rami with a L:W ratio of less than 1.5:1. Members of the former cluster all inhabit bivalves whereas members of the latter cluster are found only in ascidians, where the host in known. This congruence between morphological characters and host taxa, suggests that *Lichomolgus* is still rather heterogeneous and that a comprehensive revision would be timely. We also tentatively infer that *L. indicus*, which was described from washings of a mixture of marine invertebrates including echinoderms and sponges (Ummerkutty, 1962), might be associated with an ascidian host.

Acknowledgements

We acknowledge the tremendous field collecting effort of Drs Claude and Françoise Monniot (MNHN, Paris) who, during the course of several decades of research on tunicates, amassed this huge collection of symbiotic copepods. This paper deals with material belonging to two families present in the Monniot collection. We thank Danielle Defaye (MNHN) for making this unique collection available for us to study and Paula Martin-Lefevre (MNHN) for her help in providing registration numbers and in searching out additional locality data with the help of Françoise Monniot. Authors are indebted to all the chief scientists of numerous different cruises, including the captains and crew of the research vessels that provided the specimens used in this study. Part of the material in this paper originates from French Oceanographic cruises: BIOGAS 3 (10.17600/73002611); CEAMARC; MEDITS 2016 (10.17600/16011600). Specimens from PAPUA NEW GUINEA expedition were collected during biodiversity surveys of "Our Planet Reviewed", a joint initiative of Muséum National d'Histoire Naturelle (MNHN) and Pro Natura International (PNI) in partnership with diverse institutions and funders including French Ministry of Foreign

Affairs, the Total Foundation, Prince Albert II of Monaco Foundation, Stavros Niarchos Foundation, and Richard Lounsbery Foundation (http://www.laplaneterevisitee.org/).

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