

# Three new species of *Myzomolgus* (Copepoda, Cyclopoida, Catiniidae) associated with sipunculan worms from a tidal flat in Phuket, Thailand

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Three new species of *Myzomolgus* are described as associates of sipunculans from a tidal flat in Phuket, Thailand. As diagnostic features, *Myzomolgus leptocercosus* n. sp. has elongate caudal rami which are 10.7 times longer than wide, 5 setae and a conical process on the first antennular segment, an armature formula 1, 0, 1 + sucker, and 6 of antenna, and an inner coxal seta on all swimming legs. *Myzomolgus spatulatus* n. sp. lacks a rostrum, but bears 4 setae and a spatulate process on the first antennular segment, an armature formula 0, 0, 2 + sucker, and 6 of the antenna, the inner coxal seta on legs 1–3, and 5 armature elements on the third endopodal segment of legs 1–3. *Myzomolgus cucullatus* n. sp. has short caudal rami which are 1.60 times longer than wide, a broad, hood-like tergite of fourth pedigerous somite, 4 setae only on the first antennular segment, the armature formula 0. 0. 2 + sucker, and 6 of the antenna, and no inner coxal seta on the swimming legs.

Keywords: Andaman Sea, copepod associates, intertidal, new species, sipunculan hosts

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## INTRODUCTION

*Myzomolgus* Bocquet & Stock, 1957 is a genus belonging to the family Catiniidae Bocquet & Stock, 1957, along with the genera *Catinia* Bocquet & Stock, 1957, *Cotylomyzon* Stock, 1982, *Cotylomolgus* Humes & Ho, 1967, *Echiuricopus* Kim I.H., 2016, and *Goidelia* Embleton, 1901. Species of the genus *Myzomolgus* are associated exclusively with sipunculan worms. This genus currently comprises four known species: the type species *M. stuspendus* Bocquet & Stock, 1957 associated with *Sipunculus nudus* Linnaeus, 1766 on the Channel Coast of France (Bocquet and Stock, 1957); *M. sipunculensis* Kihara, Björnberg & Kawachi, 2007 associated with *Sipunculus nudus* and *Sipunculus phalloides phalloides* (Pallas, 1774) on the Brazilian coast (Kihara *et al.*, 2007); and *M. orientalis* Kim I.H., 2001 and *M. tenuis* Kim I.H., 2001 associated with *Siphonosoma cumanense* (Keferstein, 1867) and *Sipunculus nudus*, respectively, on the northern coast of Jeju Island, Korea (Kim, 2001).

Kim and Hong (2014) reported several species of copepods associated with invertebrates from a northeastern tidal flat in Phuket Island, Thailand. We revisited

this area in 2015 and collected copepods associated with tubicolous invertebrates, among which three species of *Myzomolgus* were identified from external washings of sipunculan worms. These three species of *Myzomolgus* are described as new in the present paper.

## MATERIALS AND METHODS

For a couple of hours during the low tide time on 13 July 2015, mud-dwelling invertebrates, such as polychaetes, crustaceans, sipunculans, and echinoderms, were dug out with a shovel from sandy muds on the Ban Pa Khok tidal flat on the northeastern coast of Phuket Island. Collected sipunculans were placed in a separate plastic bag and subsequently fixed in alcohol. Later, they were agitated in the liquid to isolate the copepod associates. The unidentified sipunculan hosts probably consisted of 2–3 species, more than 30 in number, and 5–20 cm in length when alive.

Copepod specimens were immersed in lactic acid before microscopic observation and dissection. Dissections were done using the reverse slide method (Humes and

Gooding, 1964). All drawings were made using a drawing attachment equipped on a microscope. Type specimens have been deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea. In the descriptions body length was measured from the anterior apex of the cephalothorax to the posterior margin of the caudal rami, excluding caudal setae. In the formula for the armature of legs 1–4, Roman numerals indicate spines and Arabic numerals represent setae. Terminology for mouthparts of copepods follows Humes and Boxshall (1996).

## SYSTEMATIC ACCOUNTS

Order Cyclopoida Burmeister, 1834

Family Catiniidae Bocquet & Stock, 1957

Genus *Myzomolgus* Bocquet & Stock, 1957

### *Myzomolgus leptocercosus* n. sp. (Figs. 1–3)

**Material examined.** 27 ♀♀, 7 ♂♂ from washings of unidentified sipunculid worms, northeastern tidal flat in Phuket, Thailand (approximately 8°01'25"N, 98°24'53"E), 13 July 2015. Holotype (♀, MABIK CR00247440) and paratypes (24 ♀♀, 5 ♂♂, MABIK CR00247441). Dissected paratypes (2 ♀♀, 2 ♂♂) are retained in the collection of the junior author.

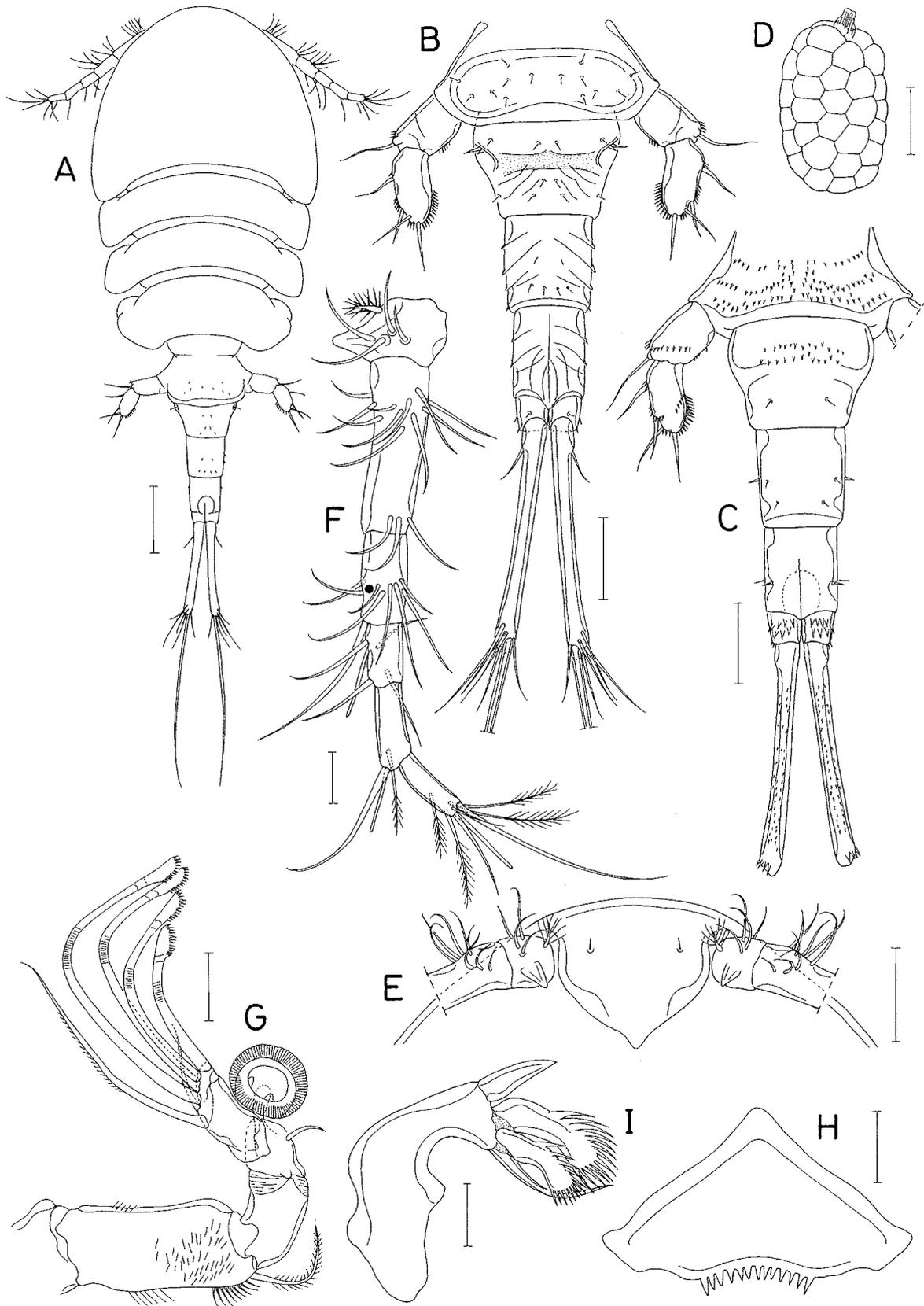
Female. Body (Fig. 1A) dorsoventrally flattened. Body length 0.92 mm. Prosoma broad, 4-segmented, occupying 58% of body length. Cephalothorax distinctly wider than long, consisting of completely fused cephalosome and first pedigerous somite, without dorsal suture line between them. Four prosomal somites with well-developed epimera bearing round corners. Urosome (Fig. 1B) narrow, 5-segmented. Fifth pedigerous somite 140 µm wide, tapering laterally, much wider than genital double-somite, with raised dorsal surface, more than 10 sensilla on dorsal raised region, and numerous minute spinules on ventral surface. Genital double-somite wider than long (60 × 90 µm), with broader anterior and narrower posterior halves, horizontal sclerotization band between genital areas, several sensilla on dorsal surface, 3 oblique membranes on both sides of dorsal surface, and minute spinules on anterior region of ventral surface (Fig. 1C); genital apertures positioning dorsolaterally in middle of double-somite length. Three free abdominal somites 60 × 55, 53 × 45, and 23 × 41 µm, respectively. First and second free abdominal somites each with 3 oblique membranes on each side of dorsal surface and 1 or 2 pairs of spinules on lateral surfaces. Anal somite very short, with deep median incision and patch of rather prominent spinules on ventral surface (Fig. 1C). Caudal rami (Fig. 1B, C) elongate, slightly divergent, with 4 spinules on posteroventral

margin and numerous minute spinules on ventral surface; each ramus 10.7 times longer than wide (150 × 14 µm), armed with 7 naked setae; proximal lateral seta (seta I) small, positioning 10% region of ramus length; other 6 setae (seta II–VII) positioning distally or subdistally; seta V distinctly longer than caudal ramus, but other setae small, much shorter than ramus. Egg sac (Fig. 1D) flattened, 260 × 158 µm, double eggs-layered.

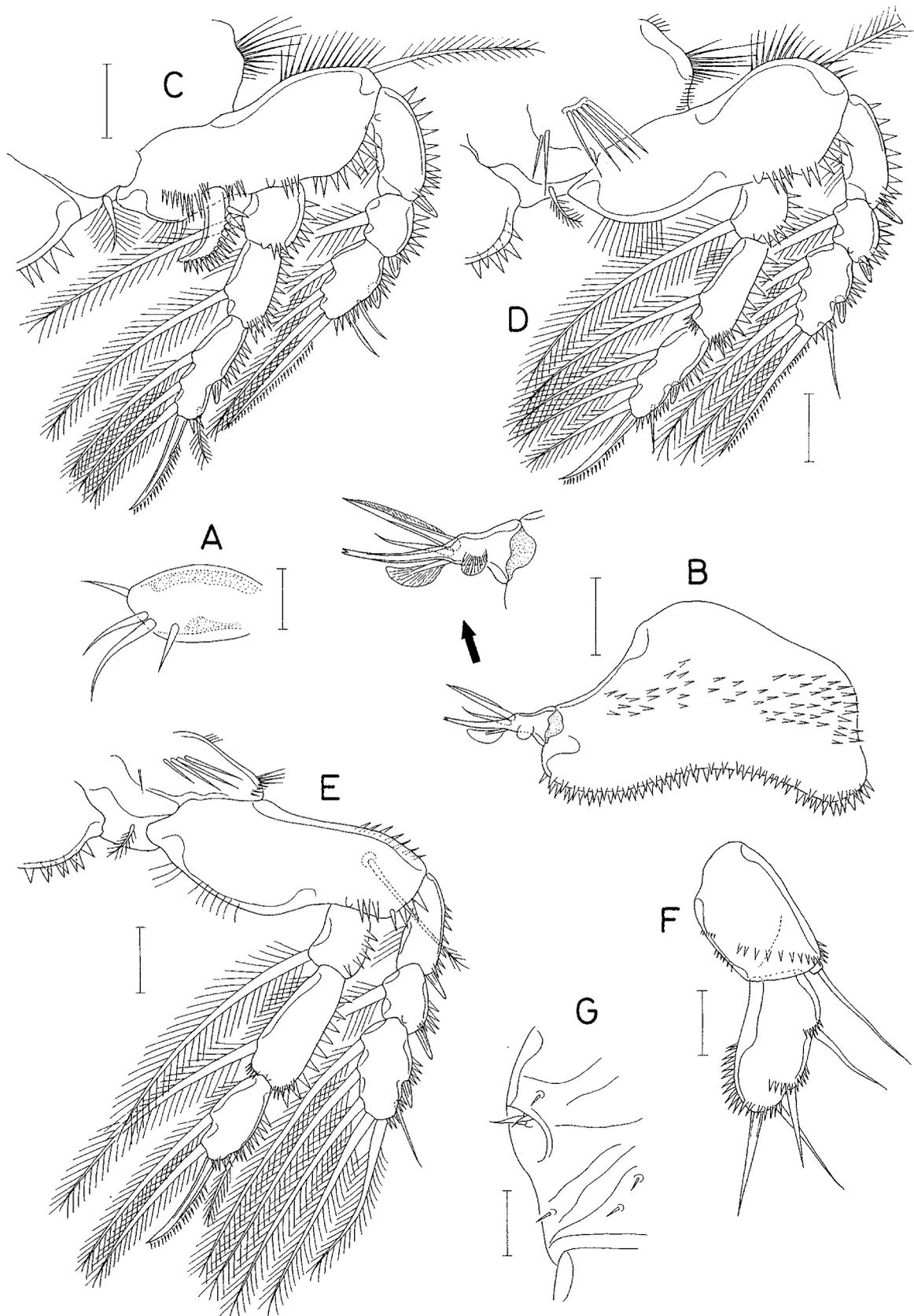
Rostrum (Fig. 1E) broad; lateral margins parallel along its proximal third, but strongly tapering along distal two-thirds, with pointed distal apex. Antennule (Fig. 1F) slender, 6-segmented, flexed between penultimate and terminal segments; armature formula 5, 14, 9, 4 + aesthetasc, 2 + aesthetasc, and 7 + aesthetasc; first segment with conical process on ventral margin; proximalmost seta of first segment short, plumose; 2 distal segments bearing pinnate setae, 1 on fifth and 4 on sixth segments. Antenna (Fig. 1G) 4-segmented, consisting of basis and 3-segmented endopod; basis the longest segment, armed distally with 1 pinnate seta and ornamented with unequal setules on surfaces; first endopodal segment smooth and unarmed; second endopodal segment with 1 small seta on inner margin and 1 large, pediculate sucker; third endopodal segment with 2 very unequal setae and 4 curved, spiniform setae of unequal lengths; each spiniform seta terminating by pad-like expansion, bearing spinulose inner margin.

Labrum (Fig. 1H) much wider than long, triangular, with 13 teeth along mid-region of posterior margin. Mandible (Fig. 1I) strongly curved, unsegmented, armed distally with 4 elements: 1 naked, conical ventral spine, 2 broad, spinulose, plate-like middle elements, and slender, setiform dorsal element. Maxillule (Fig. 2A) as small lobe bearing 4 naked setae. Maxilla (Fig. 2B) 2-segmented; proximal segment (syncoxa) large, unarmed, but ornamented with numerous spinules on ventral surface and posterior margin; distal segment (basis) small, terminating in slender, spiniform process bearing minutely bifurcate tip, armed with 3 setae (1 simple and 2 unilaterally flanged with membrane) and 1 membranous flap. Maxilliped absent.

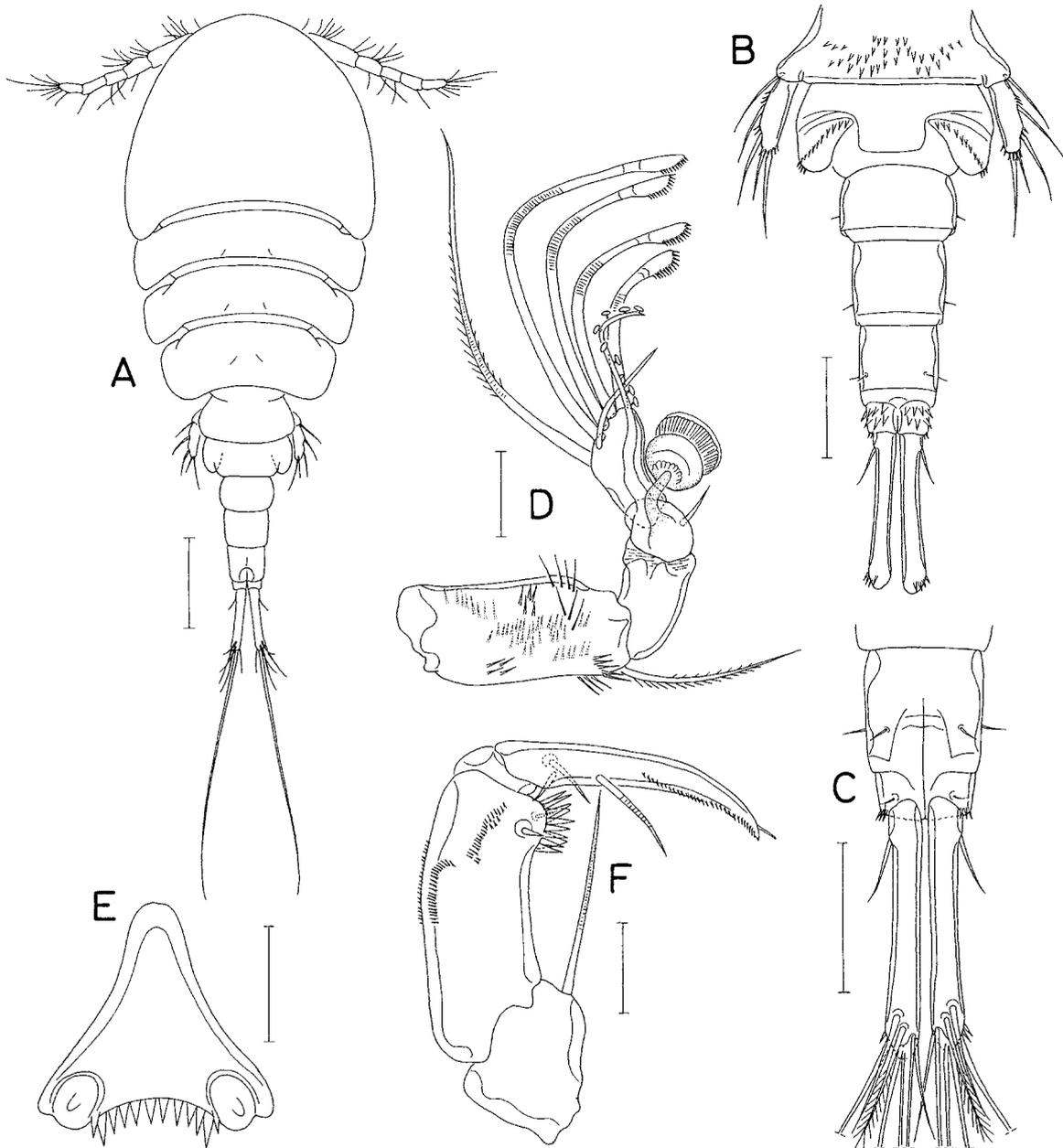
Legs 1–4 with 3-segmented rami (Fig. 2C–E). Endopods longer than exopods. Leg 3 same as leg 2 in armature and ornamentation. Coxae with setulose outer margin in legs 1–4, several long spinules on ventral surface in legs 2–4, and small inner seta in legs 1–4. Intercostal plates bearing spinules along distal margin. Basis obliquely elongate, spinulose along distal margin; outer margin setulose in legs 1–3, but spinulose in leg 4. Basis of leg 1 with large, medially curved inner distal spine bearing spinules along its outer margin. Outer margins of rami of legs 1–4 densely spinulose. Outer spines on rami small and naked. Outer setae on rami small. Armature formula for legs 1–4 as follows:



**Fig. 1.** *Myzomolgus leptocercosus* n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, urosome, ventral; D, egg sac; E, rostral area, ventral; F, antennule; G, antenna; H, labrum; I, mandible. Scale bars: A, D, 0.1 mm; B, C, E, 0.05 mm; F-H, 0.02 mm; I, 0.01 mm.



**Fig. 2.** *Myzomolgus leptocercosus* n. sp., female. A, maxillule; B, maxilla; C, leg 1; D, leg 2; E, leg 4; F, leg 5; G, left genital area, dorsal. Scale bars: A, 0.01 mm; B-G, 0.02 mm.



**Fig. 3.** *Myzomolgus leptocercosus* n. sp., male. A, habitus, dorsal; B, urosome, ventral; C, distal part of urosome, dorsal; D, antenna; E, labrum; F, maxilliped. Scale bars: A, 0.1 mm; B, C, 0.05 mm; D-F, 0.02 mm.

	Coxa	Basis	Exopod	Endopod
Leg 1	0-1	1-1	I-0; I-1; I+2, I, 3	0-1; 0-1; I+1, I, 3
Legs 2 & 3	0-1	1-0	I-0; I-1; I+1, I, 4	0-1; 0-1; I+1, I, 3
Leg 4	0-1	1-0	I-0; I-1; I+1, I, 6	0-1; 0-1; I, I, 2

Leg 5 (Fig. 2F) 2-segmented, consisting of protopod and exopod; protopod directed posterolaterally (Fig. 1B), distinctly articulated from somite, with spinules on distal surfaces, armed with 1 long, simple posterolateral seta; exopod directed posteriorly, 1.91 times longer than wide

(44 × 23 μm), with round distal margin, armed with 4 simple setae, and ornamented with rows of spinules on outer and distal margins; 4 setae on exopod 30, 25, 33, and 33 μm, respectively, from outer proximal to distal. Leg 6 (Fig. 2G) represented by 2 small setae in genital aperture.

Male. Body (Fig. 3A) similar to that of female. Body length of largest dissected specimen 0.72 mm. Prosome 439 × 276 μm, comprising unsegmented cephalothorax and second to fourth pedigerous somites, gradually narrowing posteriorly. Urosome (Fig. 3B) 6-segmented,

consisting of fifth pedigerous somite, genital somite, and 4 abdominal somites. Fifth pedigerous somite 114  $\mu\text{m}$  wide, distinctly wider than genital somite, with scattered spinules on ventral surface. Genital somite much wider than long (45  $\times$  98  $\mu\text{m}$ ) with oblique row of spinules on ventral surface of each genital operculum. Four abdominal somites 34  $\times$  58, 42  $\times$  47, 40  $\times$  40, and 14  $\times$  31  $\mu\text{m}$ , respectively. Proximal 3 abdominal somites lacking spinules on ventral surface. Anal somite small, with spinules on ventral surface, incompletely articulated from third abdominal somite on dorsal surface (Fig. 3C). Caudal ramus (Fig. 3C) 7.08 times longer than wide (85  $\times$  12  $\mu\text{m}$ ), armed as in female, but dorsal seta (seta VII) pinnate.

Rostrum as in female. Antennule as in female, except bearing 1 additional seta on third segment at place of dark circle in Fig. 1F. Antenna (Fig. 3D) different from that of female in having on second endopodal segment 1 curved, additional setiform element bearing row of 8 minute, pedunculate suckers.

Labrum (Fig. 3E) elongated, with pair of suckers posterolaterally on ventral surface; posterior margin concave, with row of 12 spinules. Mandible, maxillule, and maxilla as in female. Maxilliped (Fig. 3F) consisting of 3 segments and terminal claw; first segment (syncoxa) short, wider than long, with 1 long, naked seta at inner distal corner; second segment (basis) nearly rectangular, with 2 small setae at inner subdistal region and patch of about 10 spinules at inner distal region, and ornamented with 3 rows of minute spinules on distal surfaces; short third segment (endopod) unarmed; terminal claw large, weakly curved, with 3 unequal setae on proximal region, row of minute spinules on distal half of inner margin, and 1 small setule subdistally.

Legs 1–4 shaped and armed as in female. Leg 5 (Fig. 3B) consisting of 1 dorsolateral seta of fifth pedigerous somite and 1-segmented, free exopod; exopodal segment about 3.5 times longer than wide, armed and ornamented as in female. Leg 6 absent (Fig. 3B).

**Etymology.** The specific name is a combination of the Greek words *lepto* (= slender) and *cerco* (= tail), alluding to the slender caudal rami of the new species.

**Remarks.** *Myzomolgus leptocercosus* n. sp. closely resembles *M. orientalis* Kim, 2001 in sharing similar forms of the body, mandible and maxilla, and the elongate caudal rami, five setae (rather than 4 setae as in other congeners) on the first antennular segment, and a seta on the basis of the antenna (*M. tenuis* Kim, 2001 also has one seta on the basis, but other four congeners lack the seta). Nevertheless, *M. leptocercosus* n. sp. and *M. orientalis* cannot be considered to be a same species, due to the significant differences between them, as follows: (1) the caudal ramus of *M. leptocercosus* n. sp. are relatively longer than that of *M. orientalis*, 10.7 times longer than wide, com-

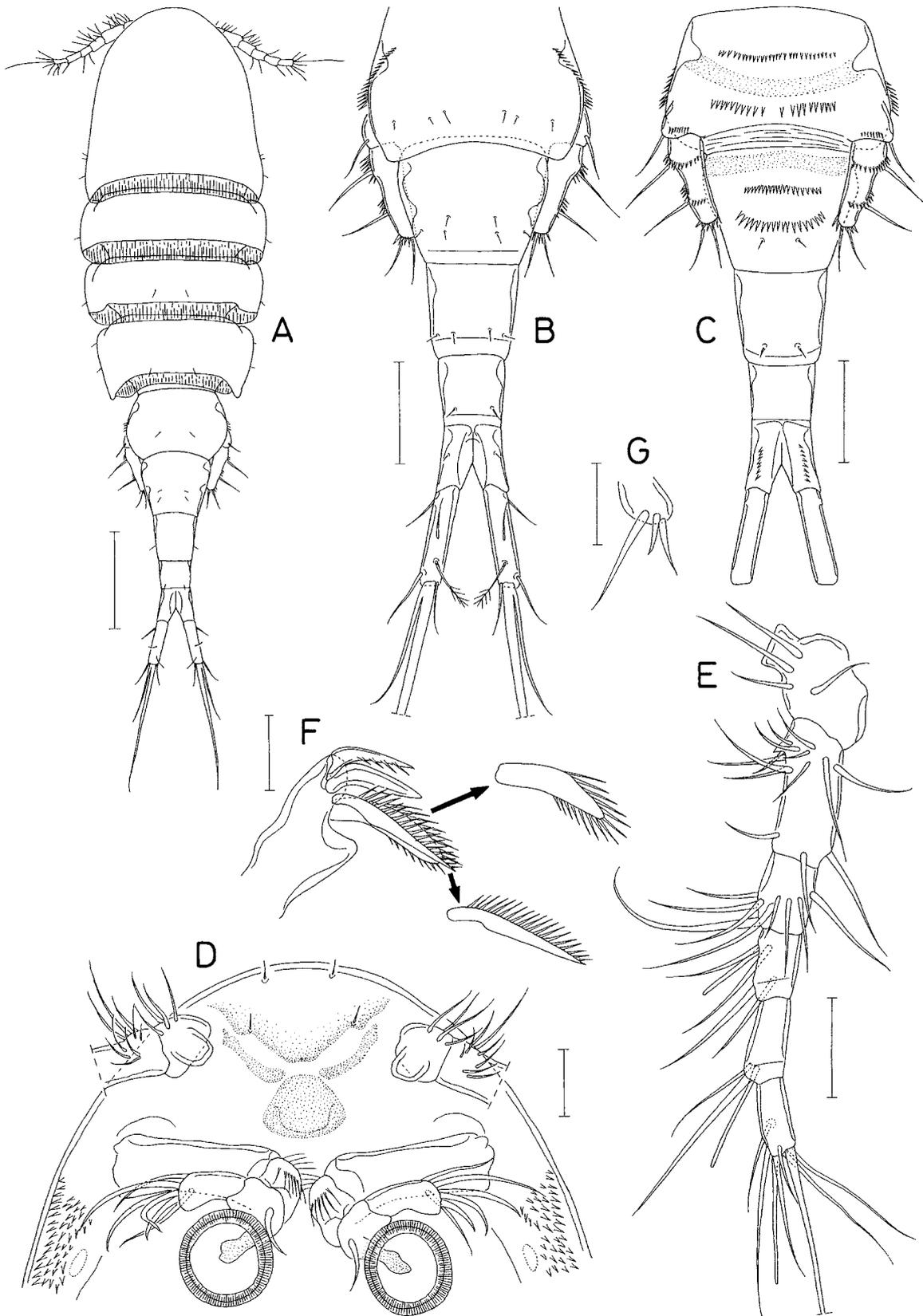
pared to 7.14 times longer than wide in the latter species (Kim, 2001); (2) the second segment of the antennule is armed with 14 setae in *M. leptocercosus* n. sp. in contrast to 11 setae in *M. orientalis*, as recorded by Kim (2001); (3) all swimming legs of *M. leptocercosus* n. sp. are armed with an inner coxal seta, whereas legs 3 and 4 of *M. orientalis* lack the inner coxal seta; and (4) the first to third abdominal somites of the male of *M. leptocercosus* n. sp. are smooth, without any spinular ornamentation, but in *M. orientalis* the first and second abdominal somites of the male are ornamented with a transverse row of spinules along the posteroventral border.

#### *Myzomolgus spatulatus* n. sp. (Figs. 4–6)

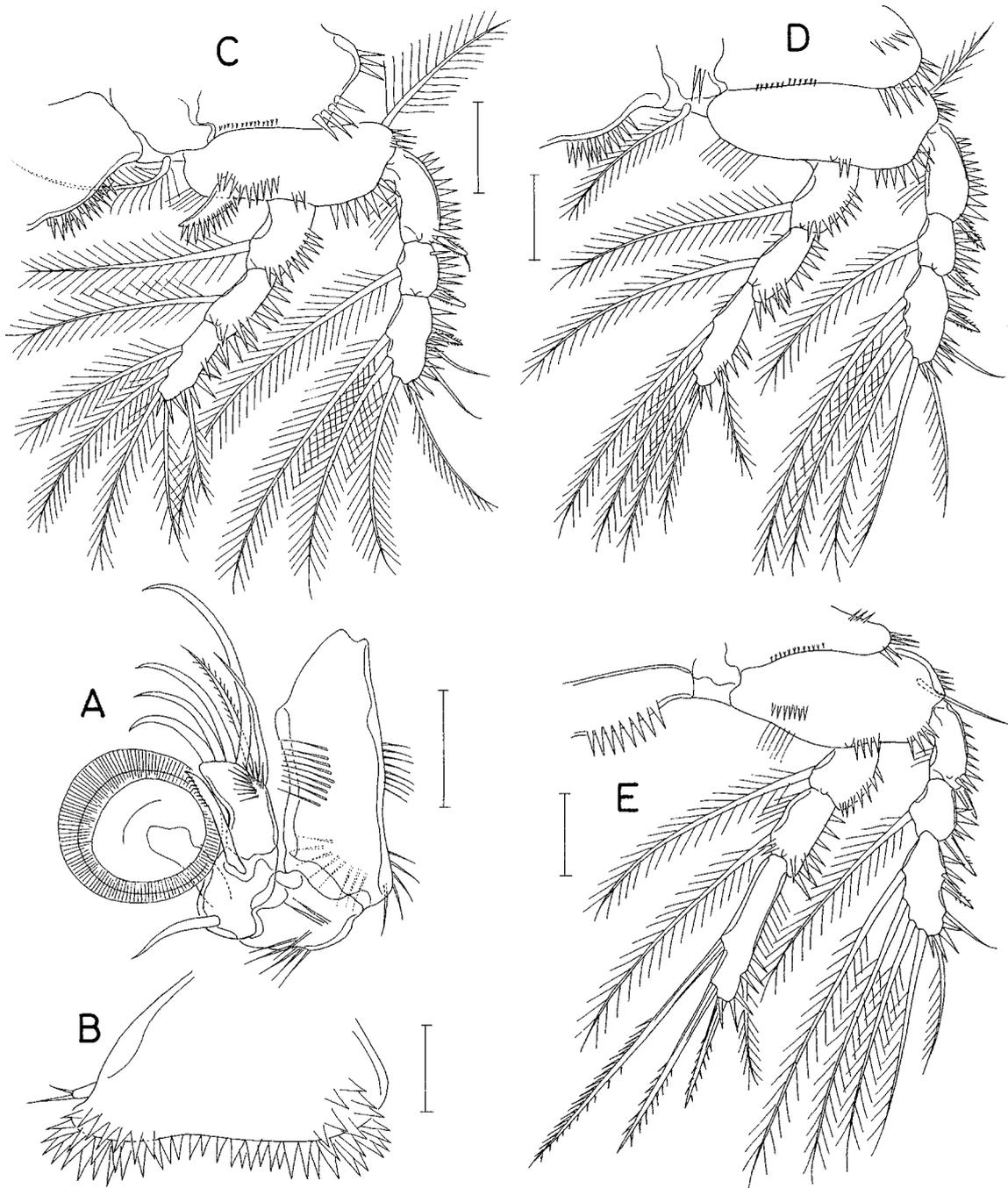
**Material examined.** 2♀♀, 1♂♂ from washings of sipunculid worms, northeastern tidal flat in Phuket, Thailand (approximately 8°01'25"N, 98°24'53"E), 13 July 2015. Holotype (♀, MABIK CR00247442). Dissected paratypes (1♀, 1♂) are retained in the collection of the junior author.

Female. Body (Fig. 4A) narrow, dorsoventrally flattened. Body length 0.69 mm. Prosome 400  $\times$  193  $\mu\text{m}$ , with nearly parallel lateral margins. Cephalothorax narrowing anteriorly, consisting of completely fused cephalosome and first pedigerous somite, 190  $\times$  184  $\mu\text{m}$ , slightly narrower than second pedigerous somite. Prosomal somites (cephalothorax and second to fourth pedigerous somites) bearing broad membranous flange along posterodorsal margin. Urosome (Fig. 4B, C) 5-segmented. Fifth pedigerous somite large, wider than genital double-somite, ornamented with 1 oblique row of spinules on lateral margins, 2 horizontal rows of spinules on ventral surface, and 1 sclerotization band ventrally (Fig. 4C). Genital double-somite wider than long (61  $\times$  74  $\mu\text{m}$ ), gradually narrowing posteriorly, with 2 horizontal rows of spinules on ventral surface and 1 sclerotization band proximally on ventral surface. Genital apertures not seen in dorsal and ventral views of urosome, probably positioning laterally. Three free abdominal somites 46  $\times$  45, 34  $\times$  33, and 32  $\times$  35  $\mu\text{m}$ , respectively. Anal somite with deep postero-medial incision and longitudinal row of several spinules on each side of ventral surface (Fig. 4C). Caudal rami divergent, rectangular, 4.55 times longer than wide (50  $\times$  11  $\mu\text{m}$ ), armed with 7 setae; seta II positioning dorsally near middle of ramus length; seta VII weakly pinnate, other 6 setae naked; seta IV the longest, 130  $\mu\text{m}$  long, feused at base with second longest seta V (57  $\mu\text{m}$  long).

Rostrum (Fig. 4D) absent. Ventral rostral area bearing tapering sclerotized region. Antennule (Fig. 4E) 6-segmented; armature formula 4, 14, 9, 4 + aesthetasc, 2 + aesthetasc, and 7 + aesthetasc; all setae naked; first segment with massive, spatulate process on ventral surface; second segment with 1 cusp on proximal fourth of



**Fig. 4.** *Myzomolgus spatulatus* n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, urosome, ventral; D, cephalic region, ventral; E, antennule; F, mandible; G, maxillule. Scale bars: A, 0.1 mm; B, C, 0.05 mm; D, E, 0.02 mm; F, G, 0.01 mm.

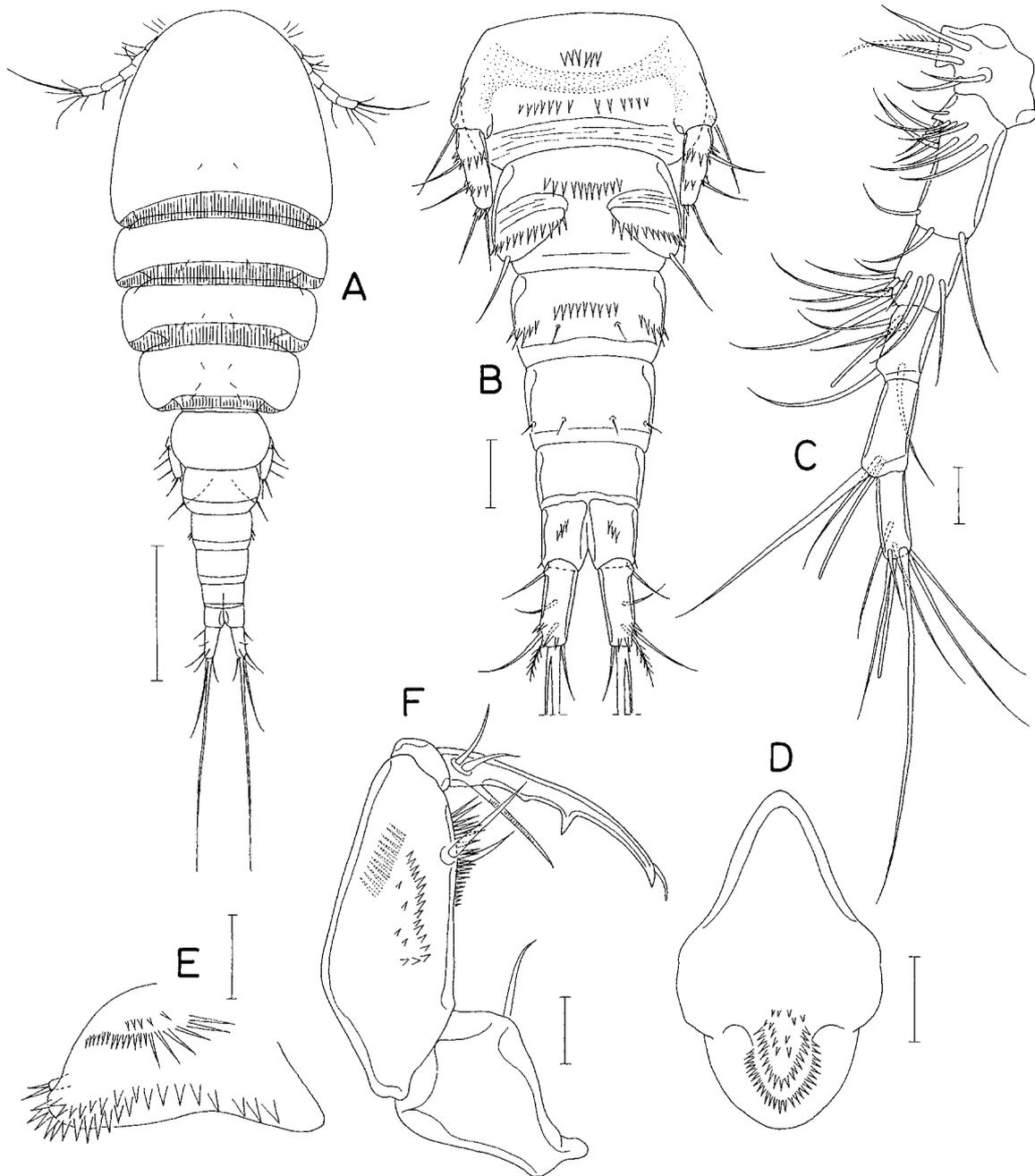


**Fig. 5.** *Myzomoligus spatulatus* n. sp., female. A, antenna; B, maxilla; C, leg 1; D, leg 2; E, leg 4. Scale bars: A, C–E, 0.02 mm; B, 0.01 mm.

anterior margin. Antenna (Fig. 5A) strongly recurved, consisting of coxobasis and 3-segmented endopod; coxobasis the largest segment, unarmed, but ornamented with several rows of setules on surfaces; first endopodal segment unarmed, with several setules on inner side; second endopodal segment armed with 1 large, pedunculated sucker, 1 simple seta, and 1 flattened seta bearing spinules distally; third endopodal segment with 6 setae (1 pinnate

and 5 naked, including stiffened distal 4 of latter) and ornamented with 1 patch of setules at outer distal corner.

Labrum missing. Mandible (Fig. 4F) with protrusion subdistally on dorsal side and distally armed with 4 elements: 2 shorter ventral spines, 1 broader, bilaterally spinulose element, and 1 setiform, unilaterally spinulose element. Maxillule (Fig. 4G) as small lobe bearing 2 small and 1 longer, simple setae. Maxilla (Fig. 5B) 2-seg-



**Fig. 6.** *Myzomolgus spatulatus* n. sp., male. A, habitus, dorsal; B, urosome, ventral; C, antennule; D, labrum; E, maxilla; F, maxilliped. Scale bars: A, 0.1 mm; B, 0.02 mm; C–F, 0.01 mm.

mented; proximal segment (syncoxa) large, unarmed, but ornamented with numerous large spinules on posterior surface; distal segment (basis) rudimentary, tipped with 2 small setae. Maxilliped absent.

Legs 1–4 with 3-segmented rami (Fig. 5C–E). Leg 3 same as leg 2 in form and armature. Coxae ornamented with spinules on outer side; inner coxal seta present in legs 1–3, but absent in leg 4. Intercoxal plate with

spinules along distal margin. Basis with spinules on outer and distal margins; outer seta pinnate in legs 1–3, but naked in leg 4. Inner distal spine on basis of leg 1 broad, spinulose along outer margin. Endopods slightly longer than exopods; both rami spinulose along outer margin. Third endopodal segment of leg 4 elongate, as long as proximal 2 segments together. Armature formula for legs 1–4 as follows:

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

Leg 5 (Fig. 4B, C) consisting of short protopod and 1-segmented, free exopod; protopod fused with somite, with discernible outer margin but lacking inner margin, armed with 1 naked seta at posterolateral corner; exopodal segment 2.65 times longer than wide ( $45 \times 17 \mu\text{m}$ ), gradually narrowing distally, armed with 4 naked setae (2 outer and 2 distal), and ornamented with 3 transverse rows of spinules. Leg 6 invisible.

Male. Body (Fig. 6A) similar to that of female. Body length  $485 \mu\text{m}$ . Urosome (Fig. 6B) 6-segmented, gradually narrowing posteriorly. Fifth pedigerous somite broader than genital somite,  $73 \mu\text{m}$  wide, with 2 rows of spinules on ventral surface. Genital somite  $33 \times 57 \mu\text{m}$ , with 3 rows of spinules, 1 row on anterior ventral surface and 2 rows each on genital operculum. Four abdominal somites  $28 \times 46$ ,  $25 \times 39$ ,  $18 \times 32$ , and  $18 \times 28 \mu\text{m}$ , respectively. First abdominal somite with 3 rows of spinules, 1 row on ventral surface and 2 rows each ventrolaterally. Caudal ramus 2.5 times longer than wide ( $25 \times 10 \mu\text{m}$ ), armed as in female, and ornamented with 4 spinules, 2 distally and 2 subdistally.

Rostrum as in female. Antennule (Fig. 6C) with 2 additional setae each on first and third segments; thus, armature formula 5, 14, 10, 4 + aesthetasc, 2 + aesthetasc, and 7 + aesthetasc; one of setae on first segment pinnate, positioning on ventral process. Antennae missing (damaged).

Labrum elongate longitudinally; posterior part semicircular, with patch of spinules on its ventral surface. Mandible and maxillule as in female. Maxilla (Fig. 6E) similar to that female, but with 2 additional rows of spinules on ventral surface and fewer spinules on posterior surface. Maxilliped (Fig. 6F) consisting of 3 segments and terminal claw; first segment (syncoxa) with narrowed proximal part, armed with 1 naked seta on subdistal inner margin; second segment (basis) armed with 2 unequal naked setae subdistally and ornamented with 3 rows of spinules, each row on inner, anterior, and posterior margins; small third segment (endopod) unarmed; terminal claw as long as basis, weakly curved, with 3 setae proximally, 1 cusp near middle of inner margin, and 1 setule subdistally on outer margin.

Legs 1–4 as in female. Leg 5 (Fig. 6B) also similar to that of female. Leg 6 (Fig. 6B) represented by 1 naked seta on distal apex of genital operculum.

**Etymology.** The specific name *spatulatus* is derived from the Latin *spatula* (= a spoon), alluding to the spatulate process on the first segment of the antennule.

**Remarks.** The armature conditions of swimming legs of *Myzomolgus spatulatus* n. sp. are unique within the ge-

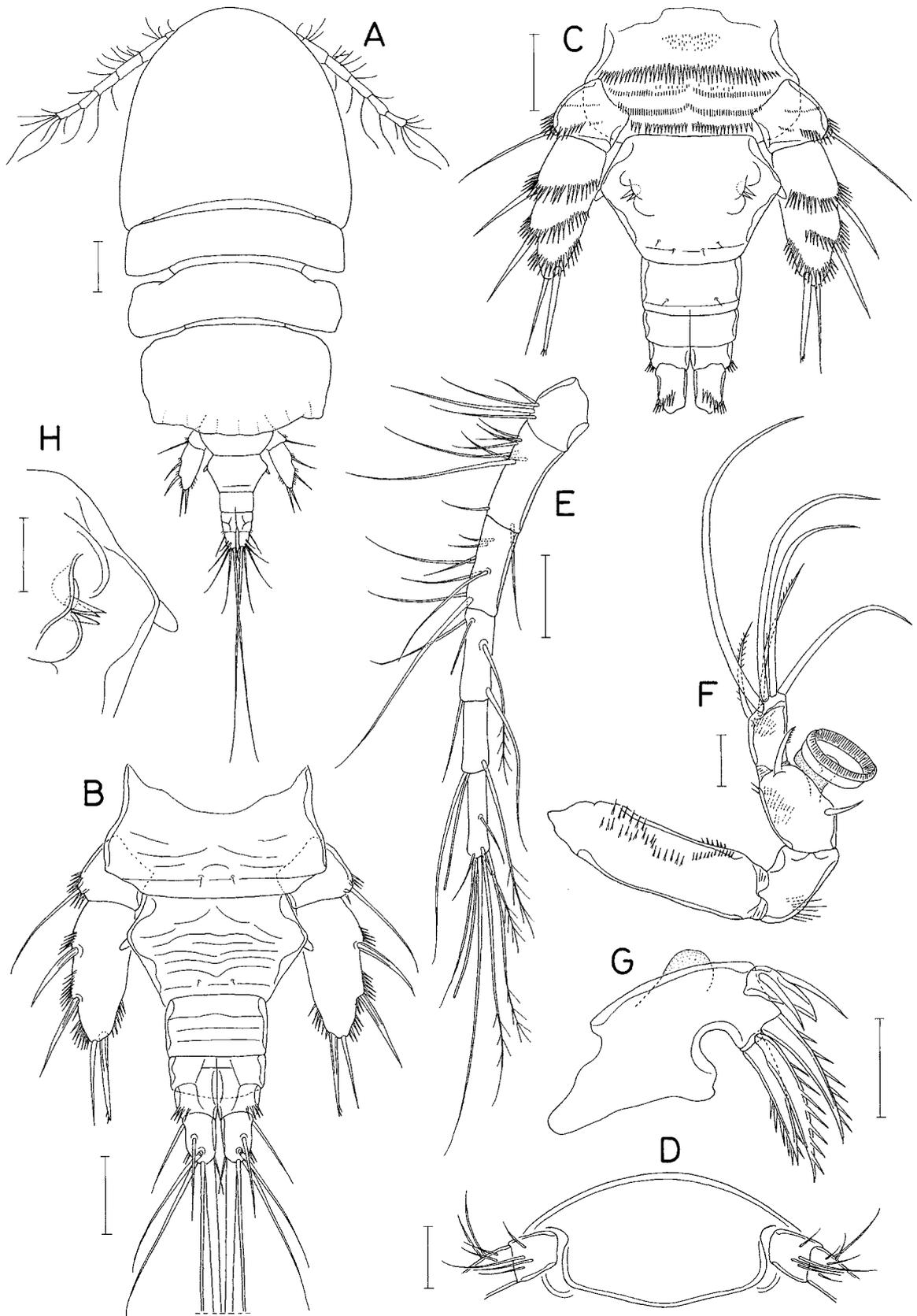
nus. In the new species the inner coxal seta of swimming legs is present in legs 1–3. This armature condition of *M. spatulatus* n. sp. differs from that of *M. orientalis* where only legs 1 and 2 bear the inner coxal seta, that of *M. Leptocercosus* n. sp. where all of legs 1–4 bear the inner coxal seta, and those of other four species where no swimming legs bear the inner coxal seta. The third endopodal segments of legs 1–3 of *M. spatulatus* n. sp. are armed each with 5 setae, which is another unique armature condition, because the numbers of armature elements (setae or spines) on the same segments of legs 1–3 are four in *M. tenuipes* and six in the remaining five congeners.

It is notable that *M. spatulatus* n. sp. is similar in body form (with narrow, fusiform) to *M. tenuis*. However, in addition to the differences in leg armatures, there are various differences, such as the absence of the rostrum (as in *M. sipunculensis*, but well-developed in *M. tenuis* and other congeners), the possession of the longer caudal rami (4.55 times as long as wide, against 1.46 times in *M. tenuipes*), the possession of the 14 setae on the second antennular segment (cf. 11 setae in *M. tenuipes*), and the absence of a seta on the basis of the antenna (cf. the seta present in *M. tenuipes*, *M. orientalis*, and *M. leptocercosus* n. sp.).

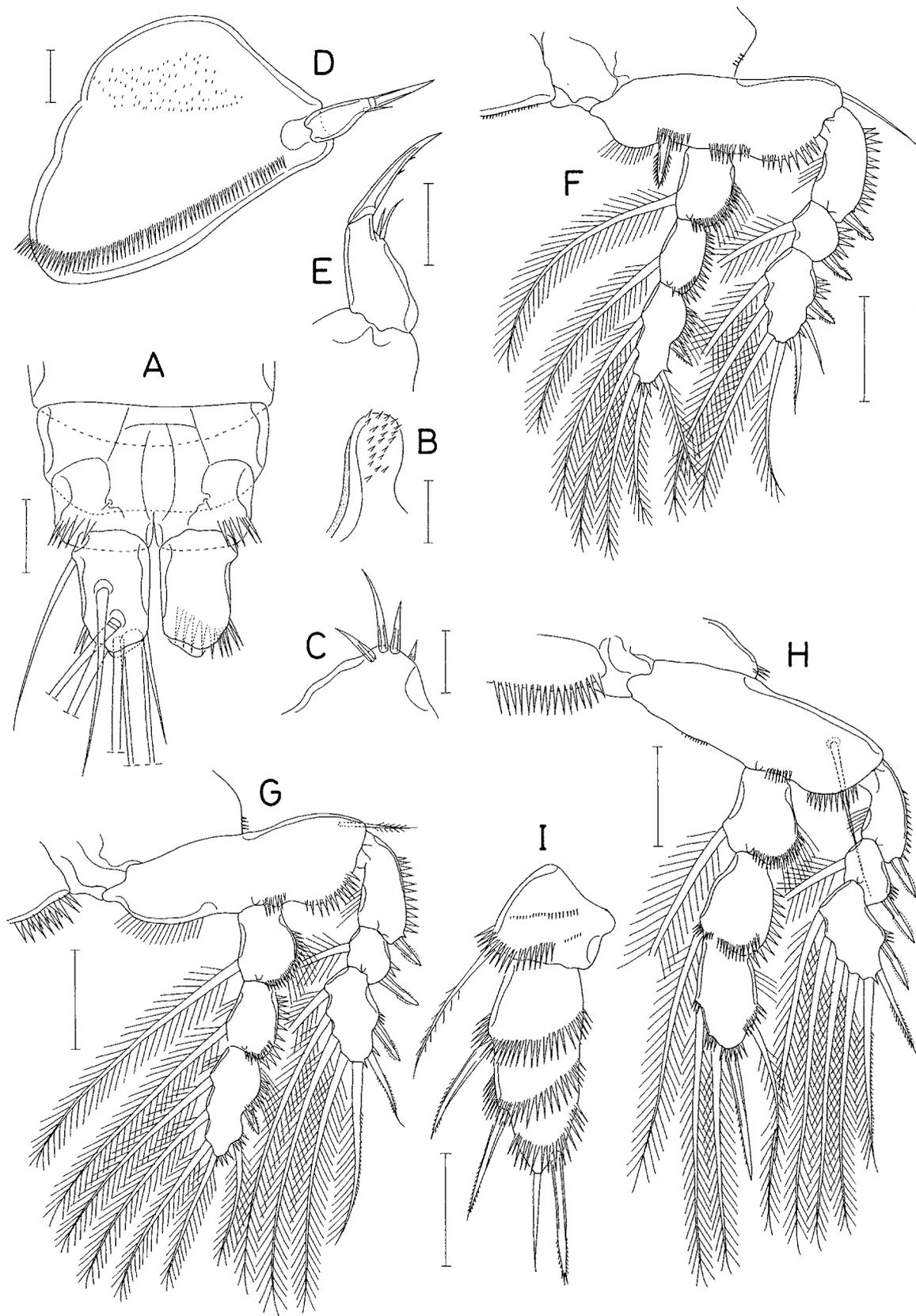
#### *Myzomolgus cucullatus* n. sp. (Figs. 7, 8)

**Material examined.** 2♀♀ from washings of sipunculid worms, northeastern tidal flat in Phuket, Thailand (approximately  $8^{\circ}01'25''\text{N}$ ,  $98^{\circ}24'53''\text{E}$ ), 13 July 2015. Holotype (♀, MABIK CR00247443). Dissected paratype (♀) retained in the collection of the junior author.

Female. Body (Fig. 7A) dorsoventrally flattened, consisting of broad prosome and small urosome. Body length 1.07 mm. Prosome  $795 \times 448 \mu\text{m}$ , occupying 74% of body length. Prosomal somites with well-developed epimera. Cephalothorax consisting of completely fused cephalosome and first abdominal somite, lacking dorsal suture line. Tergite of fourth pedigerous somite hood-like, slightly narrower but distinctly longer than those of second and third pedigerous somites. Urosome (Fig. 7B, C) 5-segmented. Fifth pedigerous somite  $132 \mu\text{m}$  wide, wider than genital double-somite, with 3 faint membranes on each side of dorsal surface and 4 transverse rows of spinules (including 2 middle rows consisting of minute spinules) on ventral surface (Fig. 7C). Genital double-somite hexagonal, tapering laterally, with lateral apex at 40% region of double-somite length, small transparent lobe at lateral apex, and several membranes on dorsal surface; genital apertures positioning ventrally (Fig. 7C). Three free abdominal somites  $34 \times 66$ ,  $23 \times 62$ , and  $15 \times 54 \mu\text{m}$ , respectively. Anal somite (Fig. 8A) obscurely articulated dorsally from second free abdominal somite, with several spinules at outer distal corners. Caudal ramus (Fig. 8A)



**Fig. 7.** *Myzomolgus cucullatus* n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, urosome, ventral; D, rostral area, ventral; E, antenna; F, antenna; G, mandible; H, right genital area, ventral. Scale bars: A, 0.1 mm; B-E, 0.05 mm; F-H, 0.02 mm.



**Fig. 8.** *Myzomoligus cucullatus* n. sp., female. A, anal somite and caudal rami, dorsal; B, paragnath; C, maxillule; D, maxilla; E, distal segment of maxilla; F, leg 1; G, leg 2; H, leg 4; I, leg 5. Scale bars: A, D, E, 0.02 mm; B, C, 0.01 mm; F-I, 0.05 mm.

1.60 times longer than wide ( $32 \times 20 \mu\text{m}$ ), armed with 7 naked setae, and ornamented with row of spinules subdistally; seta V the longest,  $427 \mu\text{m}$  long; seta IV the second longest  $136 \mu\text{m}$  long.

Rostrum (Fig. 7D) extremely broad, much broader than long, unornamented, with slightly convex posterior margin. Antennule (Fig. 7E) slender,  $298 \mu\text{m}$  long, 6-segmented; armature formula 4, 9, 8, 4 + aesthetasc, 2 + aesthetasc, and 7 + aesthetasc; setae thin, 5 of them pinnate (1 on fourth, 1 on fifth, and 3 on sixth segments); aesthetascs extremely thin, confusable with setae; first segment lacking any process. Antenna (Fig. 7F) consisting of coxobasis and 3-segmented endopod; spinulose coxobasis and setulose first endopodal segment unarmed; second endopodal segment armed with 1 large pecunculate sucker and 2 setae (1 proximal and 1 distal); third endopodal segment  $27 \times 15 \mu\text{m}$ , armed with 6 setae (2 smaller ones weakly pinnate, 4 larger ones naked).

Labrum missing (easily destroyed). Mandible (Fig. 7G) with membranous flap on ventral side, distally armed with 4 elements: 1 stout ventral spine bearing 2 large setules and 3 longer, spinulose dorsal spines (or spiniform setae). Paragnath (Fig. 8B) as small, spinulose digitiform lobe. Maxillule (Fig. 8C) as short lobe bearing 4 naked setae apically. Maxilla (Fig. 8D) 2-segmented; proximal segment (syncoxa) large, tapering medially, with 1 row of spinules along posterior surface and numerous minute spinules on anterior side of ventral surface; distal segment (basis; Fig. 8E) small, tapering distally, tipped with 1 spine, and bearing 2 small setae subdistally. Maxilliped absent.

Legs 1–4 with 3-segmented rami (Fig. 8F–H). Coxa lacking inner seta in legs 1–4, but with few small spinules on outer margin. Intercoxal plate fringed with spinules along distal margin. Basis broadened, with spinules on distal margin. Inner distal spine on basis of leg 1 small, straight, with spinules on both margins. Rami of legs 1–4 spinulose along outer margin. Endopods slightly longer

than exopods. Leg 3 same as leg 2 in segmentation and armature condition. Endopod of leg 4 incompletely articulated between second and third segments. Armature formula for legs 1–4 as follows:

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

Leg 5 (Fig. 8I) relatively large, consisting of protopod and 1-segmented exopod; protopod distinctly articulated from somite, bearing 1 pinnate seta at outer distal corner and 1 row of spinules on outer side; exopod nearly fusiform, 2.21 times longer than wide ( $93 \times 42 \mu\text{m}$ ) extending over distal margin of genital double-somite, armed with 3 spines and 1 seta, and ornamented with 3 transverse rows of spinules; lengths of spines and seta 55, 51, 45 (seta), and  $55 \mu\text{m}$ , from outer proximal to distal. Leg 6 (Fig. 7H) represented by 3 small, spinule-like setae in genital aperture.

Male. Unknown.

**Etymology.** The specific name is derived from the Latin *cucullus* (= a hood), alluding to the expanded, hood-like dorsal tergite of the fourth pedigerous somite.

**Remarks.** The proximal two segments of the antenna (the basis and the first endopodal segment) of *M. cucullatus* n. sp. are unarmed. This feature of *M. cucullatus* n. sp. is shared with three congeners (*M. stupendus*, *M. sipunculensis*, and *M. spatulatus* n. sp.). *Myzomolgus spatulatus* n. sp. may be excluded from a further comparison with *M. cucullatus* n. sp., because the first antennular segment in *M. spatulatus* n. sp. bears a spatulate process, legs 1–3 bear an inner coxal seta (this seta is absent in *M. stupendus*, *M. sipunculensis*, and *M. cucullatus* n. sp.), and the third endopodal segment of legs 1–3 is armed with five armature elements (not six as in the three latter species).

The caudal ramus of *M. stupendus* is six times longer

**Table 1.** Major morphological differences between *Myzomolgus* species.

Species	L/W of ♀ caudal ramus	Rostrum	Armature of 1 <sup>st</sup> antennular segment	Armature formula of antenna	Legs with coxal seta	Armature of 3 <sup>rd</sup> endopodal segment of legs 1–3	Protopod of ♀ leg 5	♂ leg 6
<i>M. orientalis</i>	7.14 : 1	Large	5 setae + conical process	1, 0, 1 + S, 6	legs 1 & 2	6	Free	X
<i>M. sipunculensis</i> (♂)	?	X	4 setae	0, 0, 3 + S, 6	X	6	?	1 seta
<i>M. stupendus</i>	6 : 1	Large	4 setae	0, 0, 2 + S, 6	X	6	Free	X?
<i>M. tenuis</i>	1.46 : 1	Large	4 setae + crest	1, 1, 1 + S, 6	X	4	Not free	1 seta
<i>M. leptocercosus</i> n. sp.	10.7 : 1	Large	5 setae + conical process	1, 0, 1 + S, 6	legs 1–4	6	Free	X
<i>M. spatulatus</i> n. sp.	4.55 : 1	X	4 setae + spatulate process	0, 0, 2 + S, 6	legs 1–3	5	Not free	1 seta
<i>M. cucullatus</i> n. sp.	1.60 : 1	Large	4 setae	0, 0, 2 + S, 6	X	6	Free	?

symbols: ? = missing data; X = absent; S = sucker, L/W = length to width ratio

than wide (Bocuet and Stock, 1957), much longer than that of *M. cucullatus* n. sp. (1.60 times longer than wide). The rostrum is absent in *M. sipunculensis*, whereas it is well-developed in *M. cucullatus* n. sp. Therefore, *M. cucullatus* n. sp. can easily be differentiated from *M. stupendus* and *M. sipunculensis*. Most of all, *M. cucullatus* n. sp. may be distinguished from all congeners by its three outstanding features, the hood-like, broad tergite of the fourth pedigerous somite, the presence of a small lobe at lateral apice of the genital double-somite, and the ventrally positioned female genital apertures.

Major morphological differences between seven known species of *Myzomolgus* are summarized in Table 1.

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### REFERENCES

- Bocquet, C. and J.H. Stock. 1957. Copépodes parasites d'invertébrés des côtes de France. IVa-b. Le double parasitisme de *Sipunculus nudus* L. par *Myzomolgus stupendus* nov. gen., nov. sp., et *Catinia plana* nov. gen., nov. sp., copépodes cyclopoïdes très remarquables. Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen, Series C, Biological Sciences, Amsterdam 60(3):410-431.
- Humes, A.G. and G.A. Boxshall. 1996. A revision of the lichomolgoid complex (Copepoda: Poecilostomatoida), with the recognition of six new families. Journal of Natural History 30:175-227. <https://doi.org/10.1080/00222939600771131>
- Humes, A.G. and R.U. Gooding. 1964. A method for studying the external anatomy of copepods. Crustaceana 6:238-240. <https://doi.org/10.1163/156854064X00650>
- Kihara, T.C., T.K.S. Björnberg and G.Y. Kawauchi. 2007. *Myzomolgus sipunculensis* sp. nov. (Cyclopoida, Catinidae), a new copepod associated with sipunculan worms from Brazil. Revista Brasileira de Zoologia 24(3):591-600.
- Kim, I.-H. 2001. Redescription of *Catinia plana* Bocquet and Stock, 1957 and description of two new species of *Myzomolgus* (Copepoda, Poecilostomatoida, Catinidae) associated with sipunculans in Korea. The Korean Journal of Systematic Zoology 17(1):71-89.
- Kim, I.-H. and J.-S. Hong. 2014. Copepods (Crustacea, Copepoda, Cyclopoida) associated with marine invertebrates from Thailand. Animal Systematics, Evolution and Diversity 30(4):274-318. <https://doi.org/10.5635/ASED.2014.30.4.274>

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