

Ten New Species of Parasitic Cyclopoid Copepods (Crustacea) Belonging to the Families Bomolochidae, Philichthyidae, and Taeniacanthidae from Marine Fishes in Korea

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Abstract – Ten new species of cyclopoid copepods are described as parasites of marine fishes from Korea. Three new species of the family Bomolochidae are described as gill parasites: *Orbitacolax pteragogi* n. sp. from *Pteragogus flagellifer* (Valenciennes), *Orbitacolax trichiuri* n. sp. from *Trichurus lepturus* Linnaeus, and *Orbitacolax unguifer* n. sp. from *Evyinnis japonica* Tanaka. Four species of the genus *Colobomatus* Hesse, 1873 of the family Philichthyidae are described as internal parasites: *Colobomatus unimanus* n. sp. from *Pseudolabrus eoethinus* (Richardson), *Colobomatus recticaudatus* n. sp. from *Halichoeres poecilopterus* (Temminck and Schlegel), *Colobomatus floridus* n. sp. from *Haplogenyus mucronatus* (Eydoux and Souleyet), and *Colobomatus orientalis* n. sp. from *Johnius grypotus* (Richardson). Three new species of the family Taeniacanthidae, including a new species belonging to a new genus, are described as gill parasites: *Taeniacanthus singularis* n. sp. from *Halieutaea fumosa* Alcock, *Triacanthus luteus* n. gen. n. sp. from *Odontamblyopus lacepedii* (Temminck and Schlegel), and *Umazuracola geminus* n. sp. from *Stephonolepis cirrhifer* (Temminck and Schlegel).

Key words – new genera, new species, Cyclopoida, fish parasites, Korea

1. Introduction

The copepod order Cyclopoida consists of more than 80 families. Copepods of this order are generally free-living or associates of marine invertebrates. But several families of them, such as the Bomolochidae, Philichthyidae, and Taeniacanthidae, are parasites of marine fishes. The copepods of families Bomolochidae and Taeniacanthidae have an unmodified body,

with the cephalothorax forming a sucker. They usually live on the gills and in the nostrils, mouth and branchial cavities of fishes. Members of the Philichthyidae have highly transformed body in the female and are endoparasitic, living in the subcutaneous spaces around the lateral line and skull bones.

Boxshall and Halsey (2004) counted 103 species of 17 genera in the Bomolochidae, 54 species of nine genera in the Philichthyidae, and 94 species of 14 genera in the Taeniacanthidae, known in the world. In Korea, taxonomic works on these groups of copepods are scanty. Kim (1998) compiled in his book eight species of five genera in the Bomolochidae, one species in the Philichthyidae, and five species of two genera in the Taeniacanthidae, known from Korea until that time. Thus, while a total of 421 species of these three families are known in the world, only 22 species, representing about 5.6% of the world fauna, are known from Korea.

During surveys of fish-parasitic copepods in the past several years, we were able to collect a number of copepod samples from the shallow water of Korean coasts, including ten new species of cyclopoid copepods to be described in this paper, as follows:

Family Bomolochidae Sumpf, 1871

Genus *Orbitacolax* Shen, 1957

Orbitacolax pteragogi n. sp. from *Pteragogus flagellifer* (Valenciennes)

Orbitacolax trichiuri n. sp. from *Trichurus lepturus* Linnaeus

Orbitacolax unguifer n. sp. from *Evyinnis japonica* Tanaka

Family Philichthyidae Vogt, 1877

Genus *Colobomatus* Hesse, 1873

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- Colobomatus unimanus* n. sp. from *Pseudolabrus eoethinus* (Richardson)
- Colobomatus recticaudatus* n. sp. from *Halichoeres poecilopterus* (Temminck and Schlegel)
- Colobomatus floridus* n. sp. from *Hapalogenys mucronatus* (Eydoux and Souleyet)
- Colobomatus orientalis* n. sp. from *Johnius grypotus* (Richardson)
- Family Taeniacanthidae Wilson, 1911
- Genus *Taeniacanthus* Sumpf, 1871
- Taeniacanthus singularis* n. sp. from *Halieutaea fumosa* Alcock
- Triacanthus* n. gen.
- Triacanthus luteus* n. gen. n. sp. from *Odontamblyopus lacepedii* (Temminck and Schlegel)
- Genus *Umazuracola* Ho, Ohtsuka and Nakadachi, 2006
- Umazuracola geminus* n. sp. from *Stephonolepis cirrhifer* (Temminck and Schlegel)

2. Materials and Methods

Copepod specimens studied in the present paper were all taken from marine fishes caught in the coasts of Korea. Some of the specimens were taken from fishes purchased at fish markets located in coastal regions. At collection localities, fish samples were fixed with 95% ethanol. Copepods were picked out after washing the gills of fishes and examining the gills under a dissecting microscope. Then, copepod specimens were preserved in 80% ethanol.

Copepods were immersed in lactic acid for at least 30 minutes and then dissected using the reverse slide method of Humes and Gooding (1964). Female specimens of *Colobomatus* and some of *Orbitacolax* were observed and figured *in situ*, without dissections. The drawings were made with the aid of a drawing tube equipped on the compound microscope (Olympus BH-2). After drawing, the dissections were mounted in lactophenol and later sealed with Hoyer's mounting medium. Host nomenclature was checked against the World Register of Marine Species (WoRMS). In the formula for the armature of legs 1-4 in the descriptions, Roman numerals indicate spines and Arabic numerals represent setae. Abbreviations exp. and enp. are used for exopod and endopod, respectively. The type specimens have been deposited in the National Institute of Biological Resources, Incheon, Korea.

3. Systematic Accounts

Order *Cyclopoida* Burmeister, 1835

Family **Bomolochidae** Sumpf, 1871

Genus ***Orbitacolax*** Shen, 1957

Remarks

Pseudoeucanthus spinosus Byrnes, 1986, known as parasite of *Acanthopagrus latus* (Houttuyn) from Australia (Byrnes, 1986), is here transferred to the genus *Orbitacolax*. It does not significantly differ from species of *Orbitacolax*, but differs from four known species of *Pseudoeucanthus* in that the following distinguishing features of *Pseudoeucanthus* are absent: (1) the prosome is somewhat narrow, not expanded laterally; (2) the second segment of female maxilliped is narrow, not expanded proximally; (3) the terminal hook of female maxilliped lacks an accessory process; (4) all elements on the third exopodal segment of legs 2-4 are setae; and (5) endopods of legs 2-4 are shorter than exopods of these legs.

Species of *Orbitacolax* are not easy to distinguish from one another. The body form, mouthparts, and other appendages, except for legs 2-4, are not significantly different among species. We collected about 30 specimens in 17 samples. Included are three females in three samples from *Microcanthus strigatus* (Cuvier) and five females in two samples from *Pseudolabrus sieboldi* Mabuchi and Nakaba and all of these female specimens showed different leg setations. We could not determine whether these differences of the leg setation revealed species-specific characters or infraspecific variations, which led us to withdraw from describing them. Nevertheless, we describe the following three species, because they show a consistency of characteristics within a sample or clear species-specific features.

***Orbitacolax pteragogi* n. sp.** (Figs. 1-4)

Material examined

Three ♀♀, 2 ♂♂ from gill chambers of the cocktail wrasse *Pteragogus flagellifer* (Valenciennes) (1 individual), Gosan (approximately 33°19'N, 128°09'E), Jeju Island, collected by M.-K. Choe, 25 June 2009. Holotype (♀, NIBRIV0000209110), allotype (♂, NIBRIV0000216875), and paratype (♀, NIBRIV0000216874) have been deposited in the National Institute of Biological Resources (NIBR), Incheon. Dissected paratypes (1♀, 1♂) are kept in the collection of the senior author.

Description

Female. Body (Fig. 1A) flat and gradually narrowing

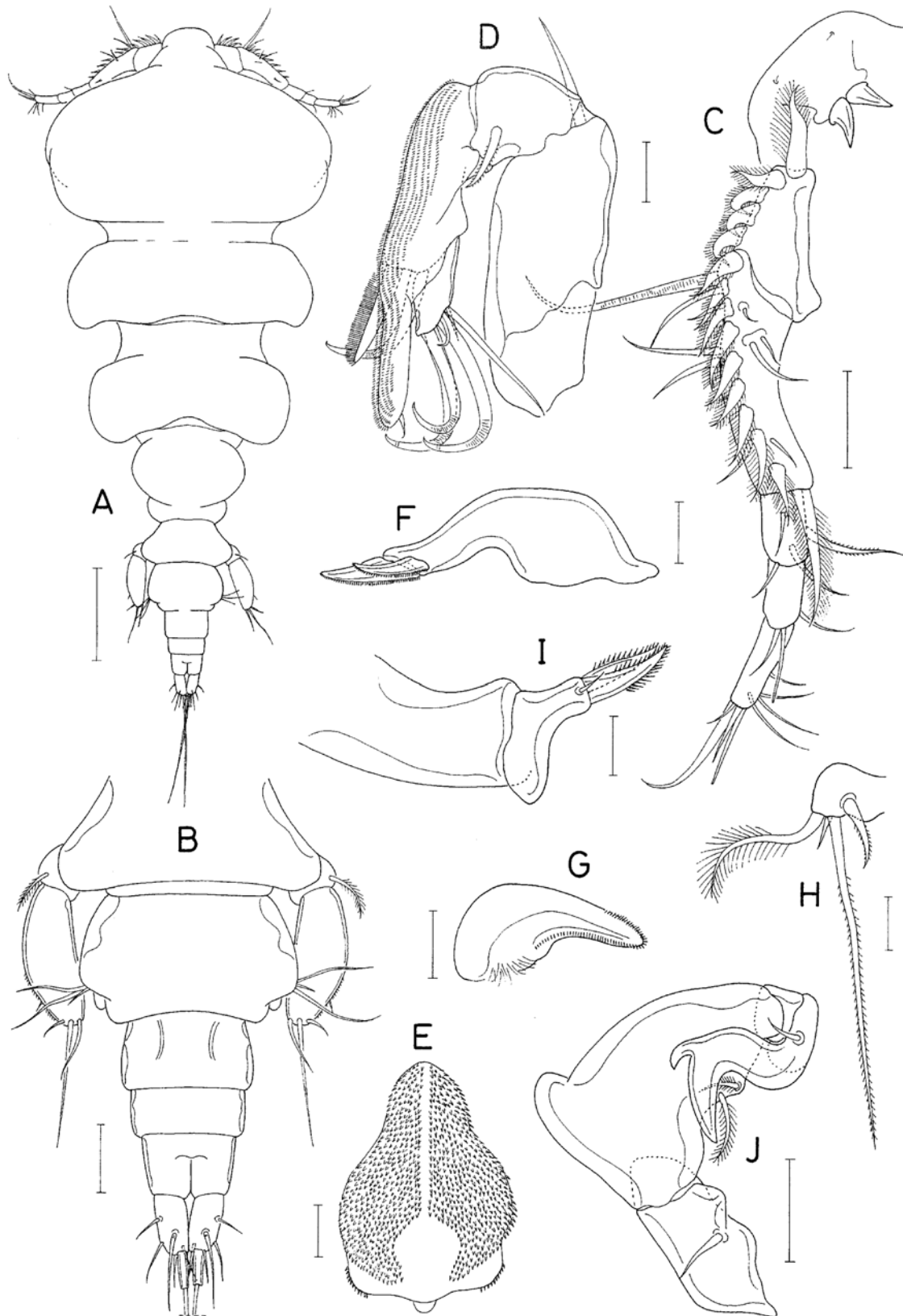


Fig. 1. *Orbitacolax pteragogi* n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, rostrum and antennule; D, antenna; E, labrum; F, mandible; G, paragnath; H, maxillule; I, maxilla; J, maxilliped. Scales: A, 0.2 mm; B, C, J, 0.05 mm; D-I, 0.02 mm

from anterior to posterior. Body length of dissected paratype 1.43 mm. Other 2 specimens 1.54 (holotype) and 1.58 mm (paratype), respectively. Cephalothorax $425 \times 610 \mu\text{m}$, with distinct rostral prominence on apex of cephalothorax. Second to fourth pedigerous somites 525, 430, and $245 \mu\text{m}$ wide, respectively. Urosome (Fig. 1B) 5-segmented, occupying about 27% length of body. Fifth pedigerous somite wider than genital double-somite. Genital double-somite $92 \times 158 \mu\text{m}$, with convex lateral margins. Three free abdominal somites 50×94 , 34×83 , and $46 \times 67 \mu\text{m}$, respectively, from anterior to posterior, each with spinules on ventral surface. Caudal rami convergent; each ramus $44 \times 23.8 \mu\text{m}$, 1.85 times as long as wide, with spinules on ventral surface and 1 large and 5 small setae. Egg sac $925 \times 300 \mu\text{m}$, flat, multiseriata but as thick as 1 egg.

Rostrum with paired hooks on ventral surface (Fig. 1C). Antennule (Fig. 1C) $282 \mu\text{m}$ long and 5-segmented, with armature formula 5, 20, 4, 2+aesthetasc, and 7+aesthetasc. Second seta on second segment largest among setae. Antenna (Fig. 1D) 4-segmented; first segment with 1 distal seta; short second segment also with 1 seta; third segment with rows of minute spinules on medial surface and distally 1 plate-like process tipped by small seta, 1 claw, and 1 spine bearing spinules along inner margin; terminal segment distally with 3 claws and 1 large and 2 small setae.

Labrum (Fig. 1E) longer than wide; ventral surface covered with spinules; posterolateral corners rounded and spinulose; posterior margin with small hemicircular lobe in middle. Mandible (Fig. 1F) with 2 tapering, plate-like spines distally. Paragnath (Fig. 1G) tapering, with tuft of setules proximally and row of spinules distally. Maxillule (Fig. 1H) lobate, bearing 4 setae consisting of elongate, weakly pinnate seta, 1 pinnate seta, and 2 smaller setae. Maxilla (Fig. 1I) 2-segmented; proximal segment with 1 small seta (not figured in Fig. 1I); distal segment with proximal protuberance on posterior side and distally 2 spinulose spines and 1 small seta. Maxilliped (Fig. 1J) 3-segmented; first segment with 1 naked seta in middle; second segment with strongly produced outer margin and 2 pinnate medial setae; small third segment unarmed; terminal segment as strongly curved claw bearing 1 seta proximally and clawlet on outer margin.

Leg 1 (Fig. 2A) with broad rami; exopod 2-segmented, but second segment with vestigial suture on outer side; endopod 3-segmented. Legs 2-4 with 3-segmented rami (Fig. 2B-D). Coxa of legs 2-4 with 1 denticiform inner process, instead of seta. Basis of legs 1-4 with 2 large patches of

minute spinules on ventral surface. Third endopodal segment legs 3 and 4 small and wider than long. Armature formula of legs 1-4 as follows:

Leg 1: coxa 0-1; basis 1-0; exp. 1-0; 3, 6; enp. 0-1; 0-1; 5

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

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

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

Leg 5 2-segmented; proximal segment with 1 pinnate distal seta; distal segment (Fig. 2E) easily flexible, with 3 patches of minute spinules and 1 small subdistal and 3 distal naked setae. Leg 6 represented by 3 setae in genital aperture (Fig. 1B).

Male. Body (Fig. 3A) narrower than that of female and $667 \mu\text{m}$ long. Cephalothorax $250 \times 258 \mu\text{m}$, with large rostral prominence. Second to fourth pedigerous somites 194, 156, and $112 \mu\text{m}$ wide, respectively. Urosome (Fig. 3B) 4-segmented. Fifth pedigerous somite $107 \mu\text{m}$ wide. Genital double-somite nearly rectangular, $743 \times 960 \mu\text{m}$. Two abdominal somites 307×714 and $406 \times 634 \mu\text{m}$, respectively. Caudal ramus $35 \times 22 \mu\text{m}$, 1.59 times as long as wide, with spinules on ventral surface as in abdominal somites.

Rostrum comparatively larger than that of female. Antennule (Fig. 3C) $156 \mu\text{m}$ long and bearing same armature formula as that of female. Antenna as in female.

Labrum, mandible, maxillule, and maxilla also as in female. Maxilliped (Fig. 4A) 4-segmented as in female, but second segment greatly swollen proximally, with dense setules on proximal part of outer margin, posteriorly directed medial protuberance, patch of blunt spinules on medial side, and 2 similar medial setae; third segment unarmed; terminal segment as strong claw bearing 2 small proximal setae.

Legs 1-5 different from those of female in shape, setation and ornamentation (Figs. 3D, E, 4B-D). Leg 1 (Fig. 3D) with inner spine on basis; rami not broadened; exopod distinctly 3-segmented. Leg 4 endopod 2-segmented. Distal endopodal segment of leg 4 $34 \times 15 \mu\text{m}$; its 3 terminal setae 15, 73, and $29 \mu\text{m}$ long, respectively, from outer to medial. Armature formula of legs 1-4 as follows:

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

Leg 2: coxa 0-0; basis 1-0; exp. 1-0; 1-1; 2, I, 5; enp. 0-1; 0-2; II, 3

Leg 3: coxa 0-0; basis 1-0; exp. 1-0; 1-1; 2, I, 5; enp. 0-1; 0-2; II, 2

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

Leg 5 represented by 1 dorsolateral seta on fifth pedigerous somite and 1-segmented exopod; exopod (Fig. 4D) slightly curved, $42 \times 12 \mu\text{m}$, 3.50 times as long as wide, with setules

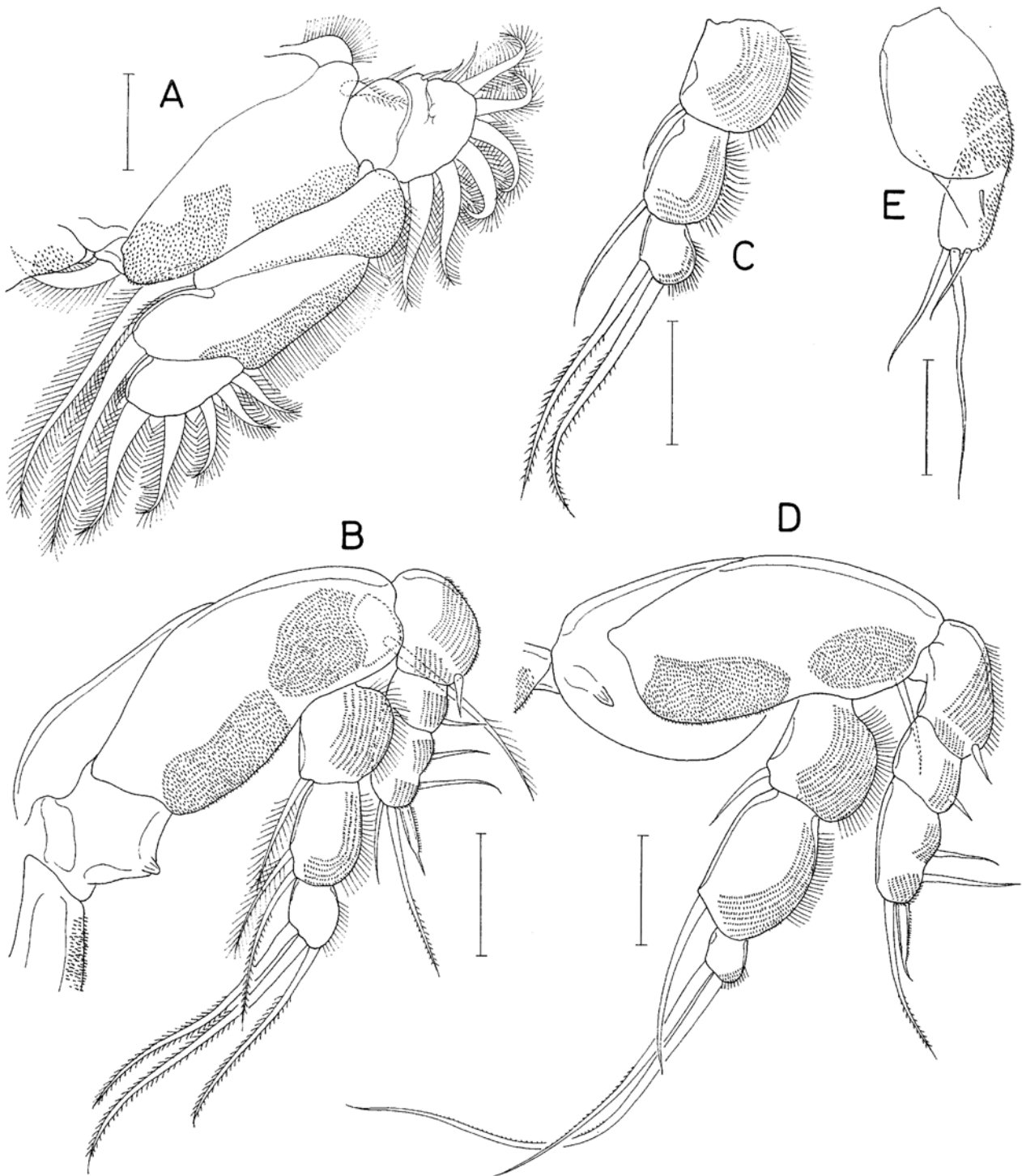


Fig. 2. *Orbitacolax pteragogi* n. sp., female. A, leg 1; B, leg 2; C, endopod of leg 3; D, leg 4; E, free segment of leg 5. Scales: 0.05 mm for all

and spinules on margins and 2 terminal setae (large outer seta 769 μ m long, and smaller inner seta spiniform and 248 μ m long). Leg 6 absent.

Etymology

The specific name is derived from the generic name of the host, *Pteragogus flagellifer*.

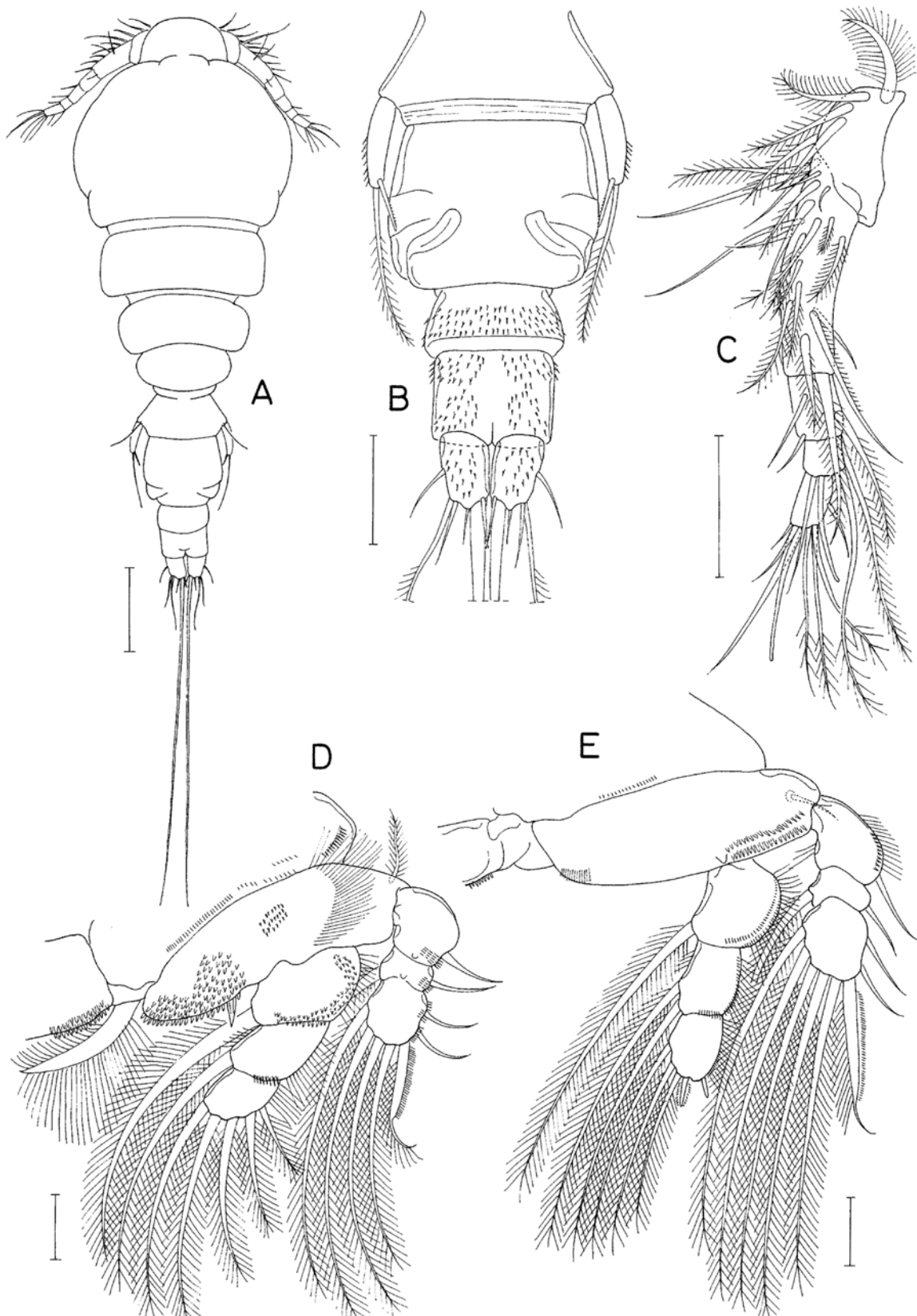


Fig. 3. *Orbitacolax pteragogi* n. sp., male. A, habitus, dorsal; B, urosome, ventral; C, antennule; D, leg 1; E, leg 2. Scales: A, 0.1 mm; B, C, 0.05 mm; D, E, 0.02 mm

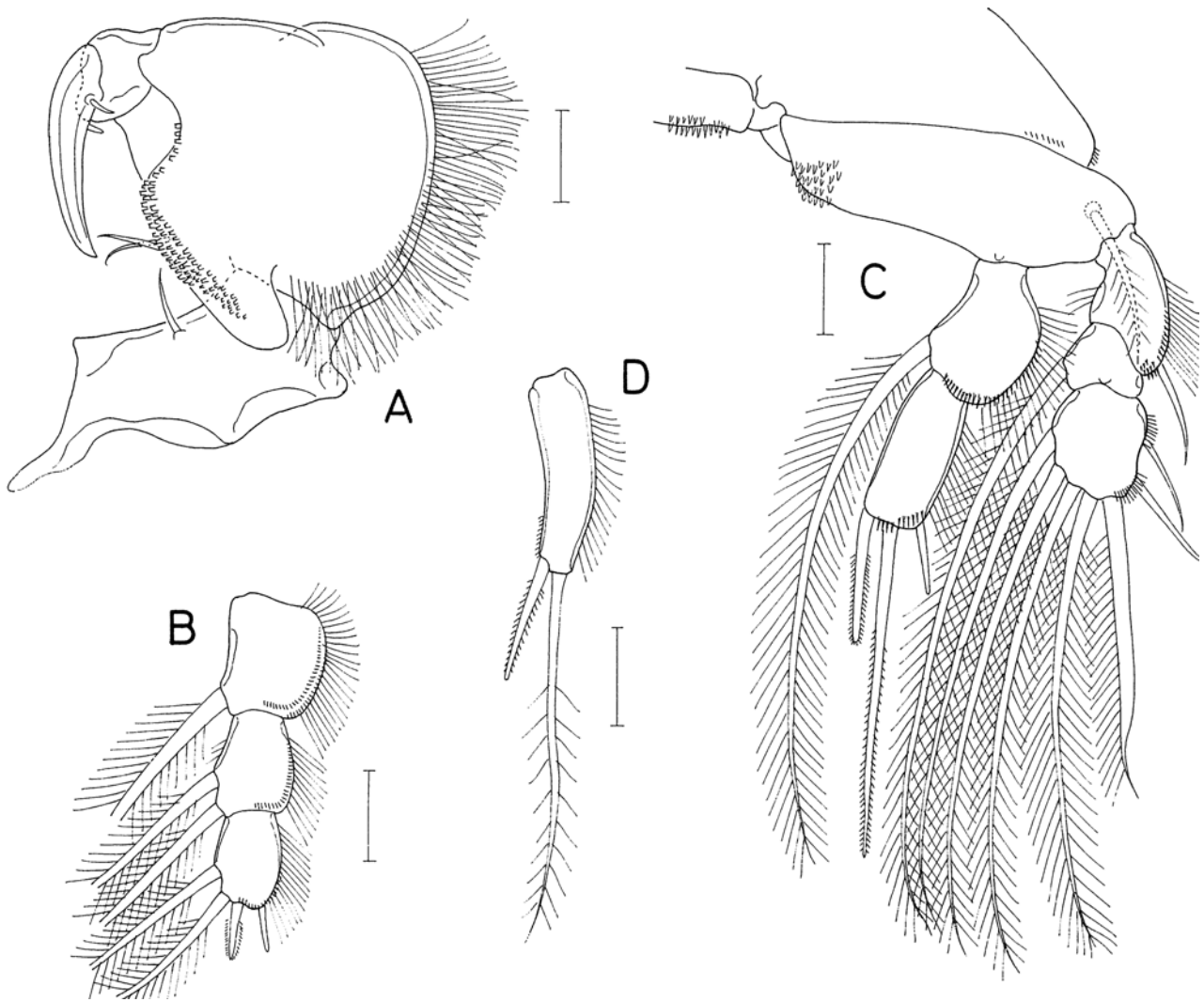


Fig. 4. *Orbitacolax pteragogi* n. sp., male. A, maxilliped; B, endopod of leg 3; C, leg 4; D, free segment of leg 5. Scales: 0.02 mm for all

Remarks

Eight species are known in the genus *Orbitacolax*, including *O. spinosus* (Byrnes, 1986) transferred from the genus *Pseudoeucanthus*. They are satisfactorily distinguishable from one another by the difference of leg setations. Only one of them, *O. hapalogenyos* (Yamaguti and Yamasu, 1959), carries two inner setae (instead of one seta) on the second endopodal segment of leg 2, as the new species. But *O. hapalogenyos* has four setae (instead of three setae) on the third endopodal segment of leg 2 and three setae (instead of two setae) on the third endopodal segment of leg 3 and, therefore, differs from the new species.

Only *O. uniunguis* Shen, 1959 is known to have, as *O. pteragogi* n. sp., three and two setae, respectively, on the third endopodal segments of legs 2 and 3. However, *O.*

uniunguis has a single inner seta on the second endopodal segment of leg 2, one spine plus two setae (armature formula 2, I) on the third exopodal segment of legs 2 and 3, and no inner seta on the second endopodal segment of leg 2 and 3 (Shen, 1957). These features are not observed in the new species.

Orbitacolax trichiuri n. sp. (Figs. 5, 6)

Material examined

One ♀ (holotype) from gill chambers of the cutlass fish *Trichurus lepturus* Linnaeus, purchased at Sorae Port near Incheon (caught off Jeju Island), collected by S. Y. Moon, 10 October 2009. Holotype (intact; NIBRIV0000216691; observed *in situ*) has been deposited in the National

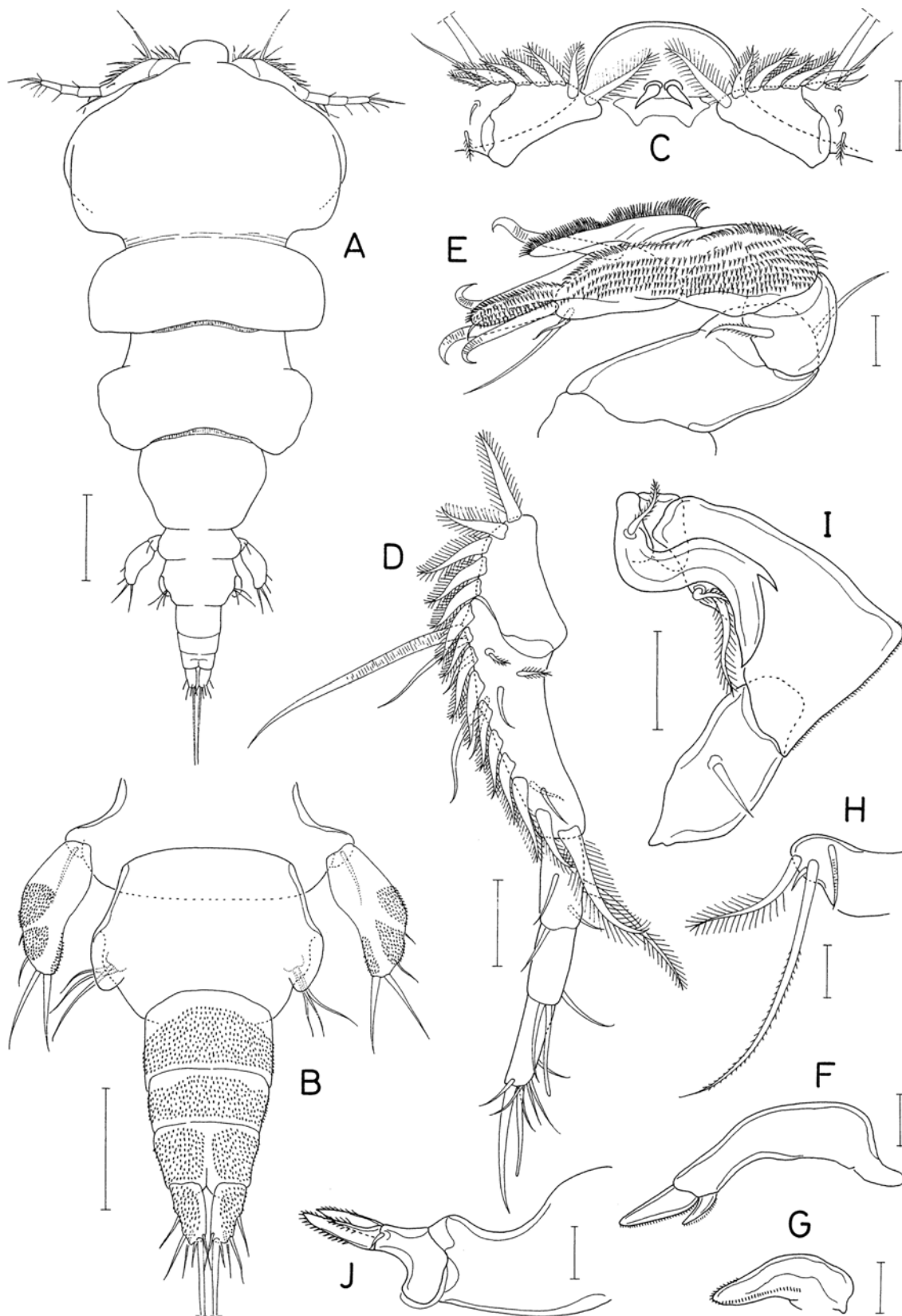


Fig. 5. *Orbitacolax trichiuri* n. sp., female. A, habitus, dorsal; B, urosome, ventral; C, rostral area, ventral; D, antennule; E, antenna; F, mandible; G, paragnath; H, maxillule; I, maxilliped; J, maxilla. Scales: A, 0.2 mm; B, 0.1 mm; C, D, I, 0.05 mm; E-H, J, 0.02 mm

Institute of Biological Resources (NIBR), Incheon.

Description

Female. Body (Fig. 5A) flat. Body length 1.53 mm. Cephalothorax $456 \times 655 \mu\text{m}$, bearing distinct rostral prominence. Three metasomal somites 550, 497, and $298 \mu\text{m}$ wide, respectively. First and second metasomites with narrow membrane along dorsal posterior border. Urosome (Fig. 5B) small, 5-segmented and occupying about 24% of body length. Fifth pedigerous somite distinctly wider than genital double-somite. Genital double-somite $136 \times 191 \mu\text{m}$; genital aperture located dorsolaterally slightly posterior to halfway of length of double-somite. Three abdominal somites covered with minute spinules on ventral surface and 64×105 , 43×99 , and $48 \times 88 \mu\text{m}$, respectively. Caudal ramus $50 \times 25 \mu\text{m}$, 2.0 times

as long as wide, with spinules on ventral surface, 1 large seta ($230 \mu\text{m}$ long) and 5 small setae; outer lateral seta located in midlength of ramus.

Rostrum with paired hooks on ventral surface (Fig. 5C). Antennule (Fig. 5D) $331 \mu\text{m}$ long and 5-segmented, with armature formula 5, 20, 4, 2+aesthetasc, and 7+aesthetasc; second seta on second segment distinctly larger than other setae. Antenna (Fig. 5E) 3-segmented; first and second segments each with 1 seta; third segment with rows of spinules on inner surface, 1 digitiform process tipped by 1 small seta, 1 lamellate spine bearing row of spinules, 4 claws and 2 spines.

Labrum not examined. Mandible (Fig. 5F) with 2 plate-like spines distally. Paragnath (Fig. 5G) tapering, with row of minute spinules. Maxillule (Fig. 5H) with 4 setae of unequal

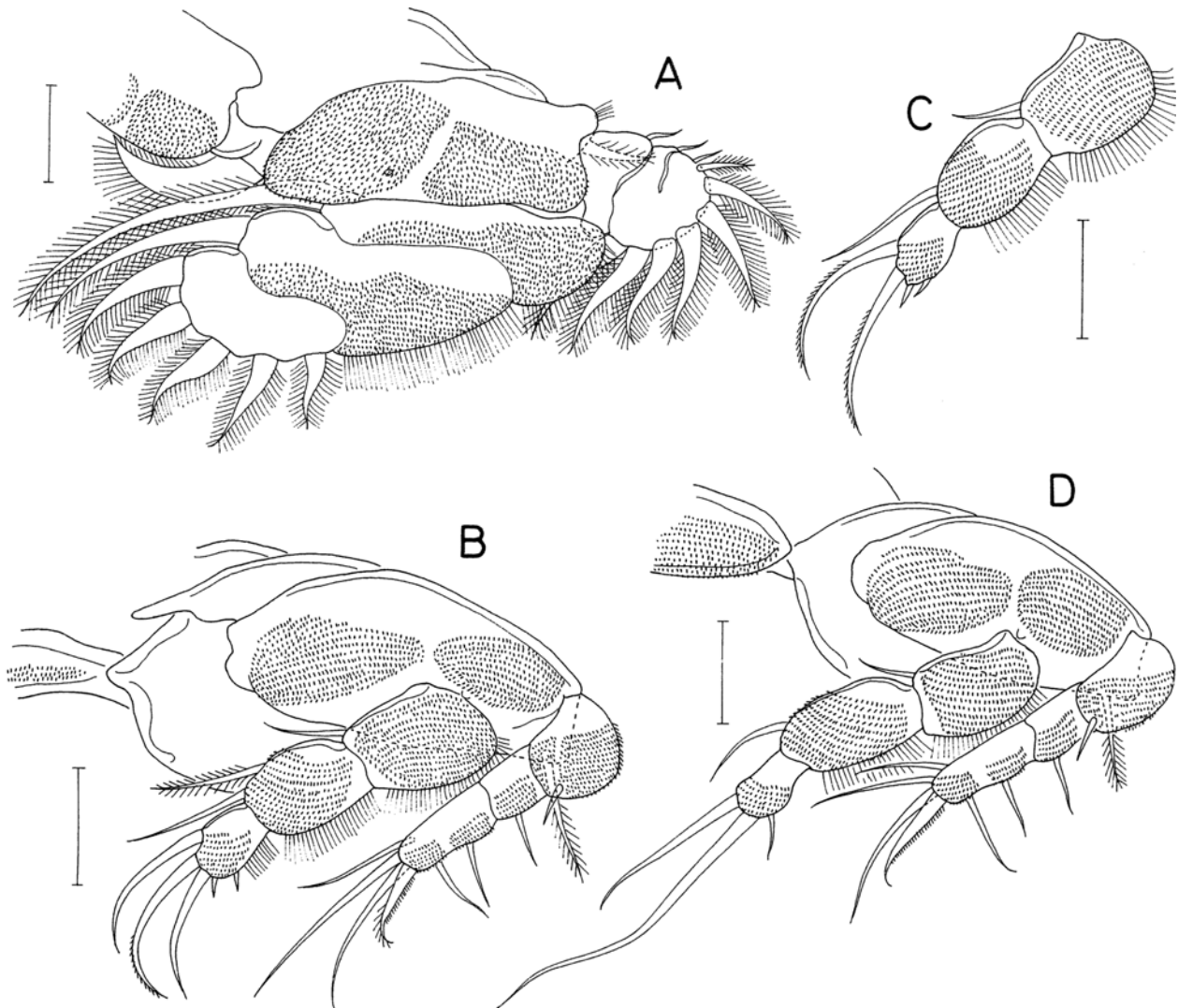


Fig. 6. *Orbitacolax trichiuri* n. sp., female. A, leg 1; B, leg 2; C, endopod of leg 3; D, leg 4. Scales: 0.05 mm for all

lengths. Maxilla (Fig. 5J) 2-segmented; first segment with 1 small distal seta (not drawn in Fig. 5J); distal segment with proximal protrusion on posterior side and distally 2 spinulose spines and 1 small seta. Maxilliped (Fig. 5I) 4-segmented; first segment with 1 naked seta near middle; second segment with angularly produced proximal outer margin and 2 pinnate medial setae; small third segment unarmed; terminal segment with 1 proximal seta and terminated by large, strongly curved claw bearing 1 clawlet.

Legs 1-4 with 3-segmented rami, except for 2-segmented exopod of leg 1, and patches of minute spinules on ventral surface (Fig. 6A-D). Distal segment of leg 1 exopod with rudiment suture on outer side. Endopod of leg 1 greatly expanded laterally. Third endopodal segment of leg 2 with 2 small outer and 3 larger inner setae. Third endopodal segment of leg 3 with 2 small outer and 2 large inner setae. Armature formula of legs 1-4 as follows:

Leg 1: coxa 0-1; basis 1-0; exp. 1-0; 3, 6; enp. 0-1; 0-1; 5

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

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

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

Leg 5 represented by 1 dorsolateral seta on fifth pedigerous somite and exopod; exopod weakly curved, with 3 patches of minute spinules and 2 larger distal and 2 small outer setae (Fig. 5B). Leg 6 represented by 3 naked setae in genital aperture (Fig. 5B).

Male. Unknown.

Etymology

The specific name is derived from the generic name of the host *Trichiurus lepturus*.

Remarks

In the genus *Orbitacolax*, only *O. hapalogenyos* is known to have two setae on the second endopodal segment of leg 2, as *O. trichiuri* n. sp. But by having five setae on the third endopodal segment of leg 2 and four setae on the third endopodal segment of leg 3, *O. trichiuri* can be differentiated from *O. hapalogenyos* and all other congeners.

***Orbitacolax unguifer* n. sp.** (Figs. 7, 8)

Material examined

One ♀ (holotype) from gill chamber of the porgy *Evynnis japonica* Tanaka, Yeosu fishery port (caught in the Strait of Korea), collected by S. Y. Moon, 14 April 2010. Holotype

(intact; NIBRIV0000216702; observed *in situ*) has been deposited in the National Institute of Biological Resources (NIBR), Incheon.

Description

Female. Body (Fig. 7A) flat and 1.96 mm long. Prosome occupying about 74% length of body. Cephalothorax 651×849 µm, with distinct rostral prominence and pair of anteriorly directed, horn-like hooks on dorsal surface just posterior to rostral prominence (Fig. 7C). Second pedigerous somite (first metasomite) 625 µm wide. Third pedigerous somite 559 µm wide, with posterolateral expansion on each side. Second and third pedigerous somites with narrow membrane along dorsal posterior margin. Fourth pedigerous somite 408 µm wide. Urosome (Fig. 7B) small and 5-segmented. Genital double-somite 146×237 µm, incompletely divided from first free abdominal somite. Three free abdominal somites 94×140, 64×137, 76×105 µm, respectively, from anterior to posterior, covered with minute spinules on ventral surface. Caudal ramus 82×40 µm, 2.05 times as long as wide, with minute spinules on ventral surface and 6 naked setae; largest one (seta V) of 2 median terminal setae 270 µm long, other 5 setae small, barely longer than width of ramus; one (seta IV) of 2 median terminal setae fused at base with nearby largest setae.

Rostrum prominent and anteriorly produced (Fig. 7A, C), with 2 hooks on ventral surface (Fig. 7D). Antennule (Fig. 7E) 470 µm long and 5-segmented, with armature formula 5, 20, 4, 2+aesthetasc, and 7+aesthetasc. Second seta on second segment distinctly larger than other setae. Antenna (Fig. 7F) 4-segmented; first and second segments each with 1 seta; third segment with rows of minute spinules on ventral surface, 1 claw, 1 large process bearing small subterminal seta, and 1 flat spine; terminal segment with 3 claws and 3 setae.

Labrum with spinules on ventral surface. Mandible (Fig. 7G) with 2 tapering, plate-like spines distally. Paragnath (Fig. 7H) tapering, with tuft of setules proximally and row of minute spinules distally. Maxillule (Fig. 7I) bearing 2 large and 2 small setae. Maxilla (Fig. 7J) 2-segmented; proximal segment with 1 small distal seta; distal segment with 2 distal spinulose spines and 1 small subdistal seta. Maxilliped (Fig. 8A) 4-segmented; first segment with naked seta in middle; second segment with 2 pinnate medial setae and strongly projected outer proximal region; small third segment unarmed; terminal segment with 1 naked proximal seta and terminated

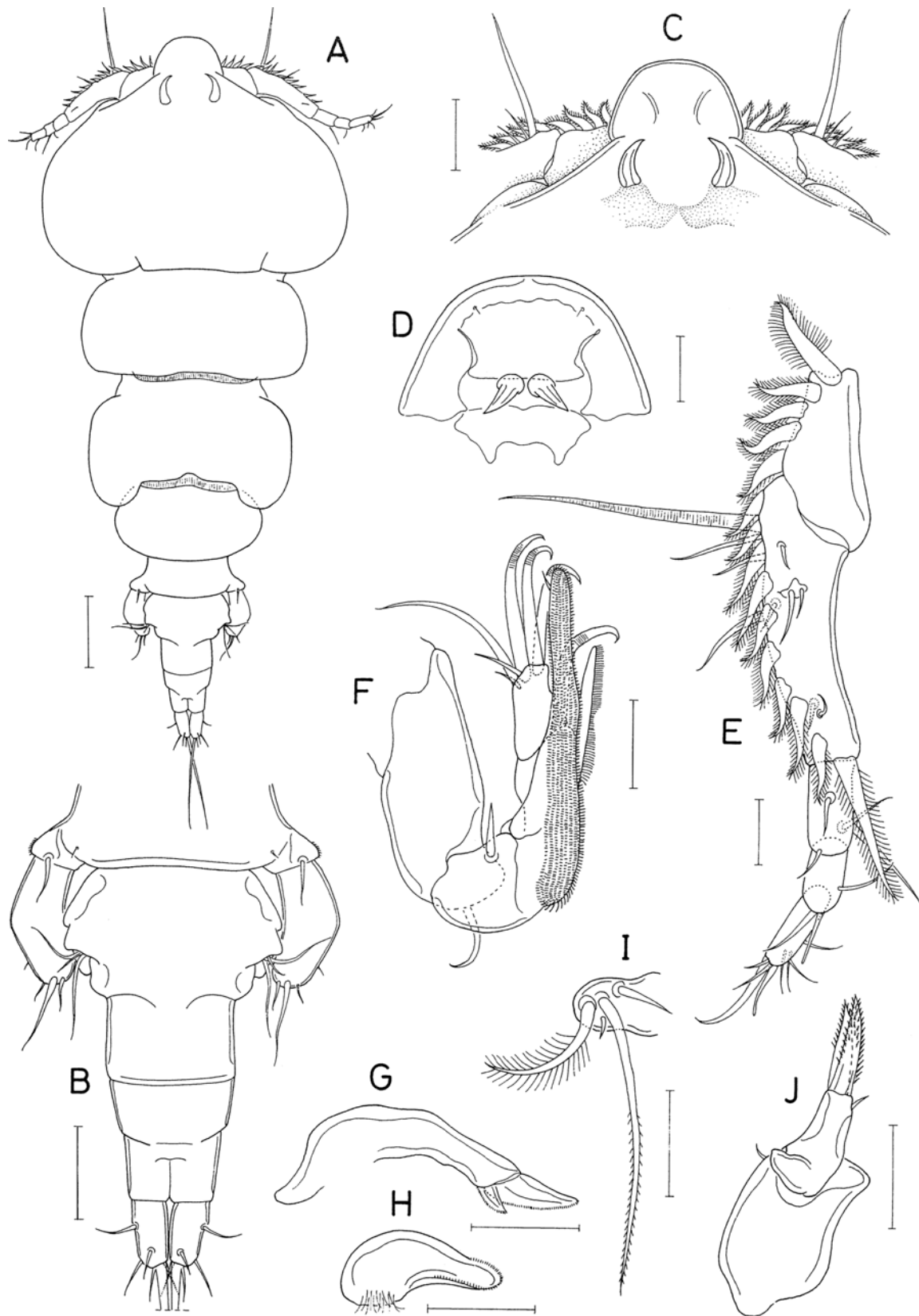


Fig. 7. *Orbitacolax unguifer* n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, rostral area, dorsal; D, rostrum, ventral; E, antennule; F, antenna; G, mandible; H, paragnath; I, maxillule; J, maxilla. Scales: A, 0.2 mm; B, C, 0.1 mm; D–J, 0.05 mm

by large, strongly curved claw bearing outer clawlet.

Legs 1-4 with 3-segmented rami, except for 2-segmented exopod of leg 1. Leg 1 (Fig. 8B) with greatly expanded endopod; distal segment of exopod with vestigial suture on outer side (Fig. 8B). Ventral surface of basis and rami of

legs 1-4 ornamented with patches of minute spinules (Fig. 8B-E). Armature formula of legs 1-4 as follows:

Leg 1: coxa 0-1; basis 1-0; exp. 1-0; 3, 6; enp. 0-1; 0-1; 5

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

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

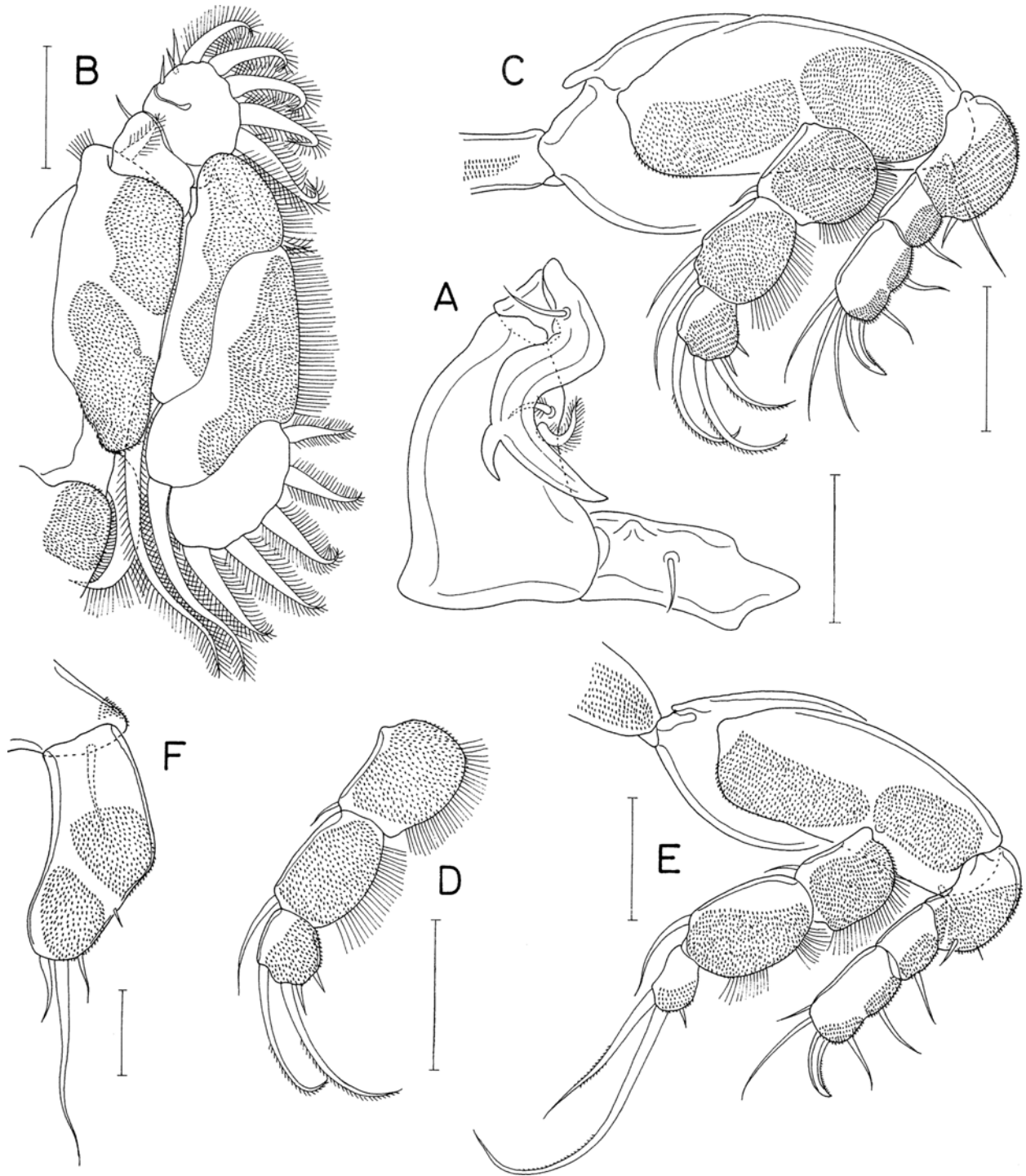


Fig. 8. *Orbitacolax unguifer* n. sp., female. A, maxilliped; B, leg 1; C, leg 2; D, endopod of leg 3; E, leg 4; F, leg 5. Scales: A-E, 0.1 mm; F, 0.05 mm

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

Leg 5 (Fig. 8F) 2-segmented; protopod not articulated at base from somite, with 1 dorsodistal seta; exopod curved, with 2 patches of minute spinules on ventral surface and 1 large and 3 small setae. Leg 6 represented by 3 naked setae in genital aperture (Fig. 7B).

Male. Unknown.

Etymology

The specific name *unguifer* is the combination of the Latin words *unguis* (claw) and *fero* (bearing), alluding to the presence of a pair of dorsal hooks on the cephalothorax.

Remarks

Orbitacolax unguifer n. sp. is most closely similar to *Orbitacolax trichuri*, described above, in sharing the same armature formula of legs 1-4. Nevertheless, *O. unguifer* n. sp. cannot be confused with that species and other congeners by having its outstanding feature, the possession of a pair of horn-like dorsal cephalic hooks located just posterior to the rostrum. Although the similar dorsal cephalic hooks are also present in species of *Pumiliopsis* Pillai, 1967 and in two species of *Pseudorbitacolax* Pillai, 1971, i.e., *P. fimbriatus* Cressey and Cressey, 1980 and *P. nudus* (Cressey and Boyle, 1973) (see Cressey and Cressey, 1980), these species are of different genera.

Family **Philichthyidae** Vogt, 1877

Genus ***Colobomatus*** Hesse, 1873

***Colobomatus unimanus* n. sp.** (Fig. 9)

Material examined

Two ♀♀ from cephalic canals of the red naped wrasse *Pseudolabrus eoethinus* (Richardson), off Sagye-ri (33°12'N, 128°19'E), Jeju Island, collected by M.-K. Choe, April 2010. Holotype (♀, NIBRIV0000282420) and paratype (♀, NIBRIV0000282421), both intact, have been deposited in the National Institute of Biological Resources (NIBR), Incheon.

Description

Female. Body (Fig. 9A) 3.42 mm long and unsegmented. In dorsal view, body divisible into cephalosome, expanded trunk, and cylindrical urosome. Cephalosome-trunk division recognizable by weak lateral constriction between them. Cephalosome about 600 µm long, with 2 pairs of processes in front of antennule: 1 anterodorsal and 1 ventral pairs (Fig.

9B, C); processes of each pair fused to each other at base. Trunk dorsoventrally flat, 540 µm wide (excluding lateral processes), with 2 pairs of lateral processes of similar lengths (about 210 µm long); anterior pair directed ventrolaterally and posterior pair directed dorsolaterally (Fig. 9B); anterior part of trunk in front of anterior processes tapering anteriorly and posterior part of trunk behind posterior processes tapering posteriorly. Urosome about 1.50 mm long, 240 µm wide across genital region, slightly directed to ventrally, with 3 weak lateral constrictions in dorsal view and 4 blunt ventral processes at regions each corresponding to genital double-somite and 3 abdominal somites (Fig. 9B); these ventral processes spinulose and becoming gradually prominent from anterior to posterior. Genital aperture small and positioned laterally. Region of anal somite directed posterodorsally. All processes on cephalosome, trunk and urosome blunt at tip and covered distally with numerous spinules (Fig. 9D) of about 5 µm long. Caudal rami divergent from each other, each ramus tapering, about 330 µm long and 170 µm wide at base, with blunt spinulose tip.

Antennule small, unsegmented, 56 µm long, slender, and setiferous (Fig. 9C). Antenna absent. Buccal capsule conical, containing 2 pairs of mouth organs; anterior mouth organ subdistally articulated, with 1 subdistal seta; posterior mouth organ lobate and unarmed (Fig. 9E).

Leg 1 (Fig. 9F) vestigial, consisting of 1 minute digitiform medial process, 1 larger digitiform outer process, and 1 small outer seta. Legs 2-5 absent.

Male. Unknown.

Etymology

The specific name *unimanus* is a Latin meaning “having only one hand” and alludes to the presence of only one pair of legs.

Remarks

Although *Colobomatus* is a very speciose genus, species of this genus are readily recognizable, because the forms and numbers of processes on the body in the female are various with species and can be utilized as good taxonomic traits. Among more than 65 known species of *Colobomatus*, only four species have, like *C. unimanus* n. sp., four processes on the cephalosome. They are *C. ornatus* West, 1992; *C. pterois* Madinabeitia, Tang and Nagasawa, 2012; *C. pupa* Izawa, 1974 which was redescribed by Madinabeitia et al. (2012); and *C. valle* Essafi, Cabral and Raibaut, 1984. *C. unimanus* n. sp. can easily be distinguished from these four

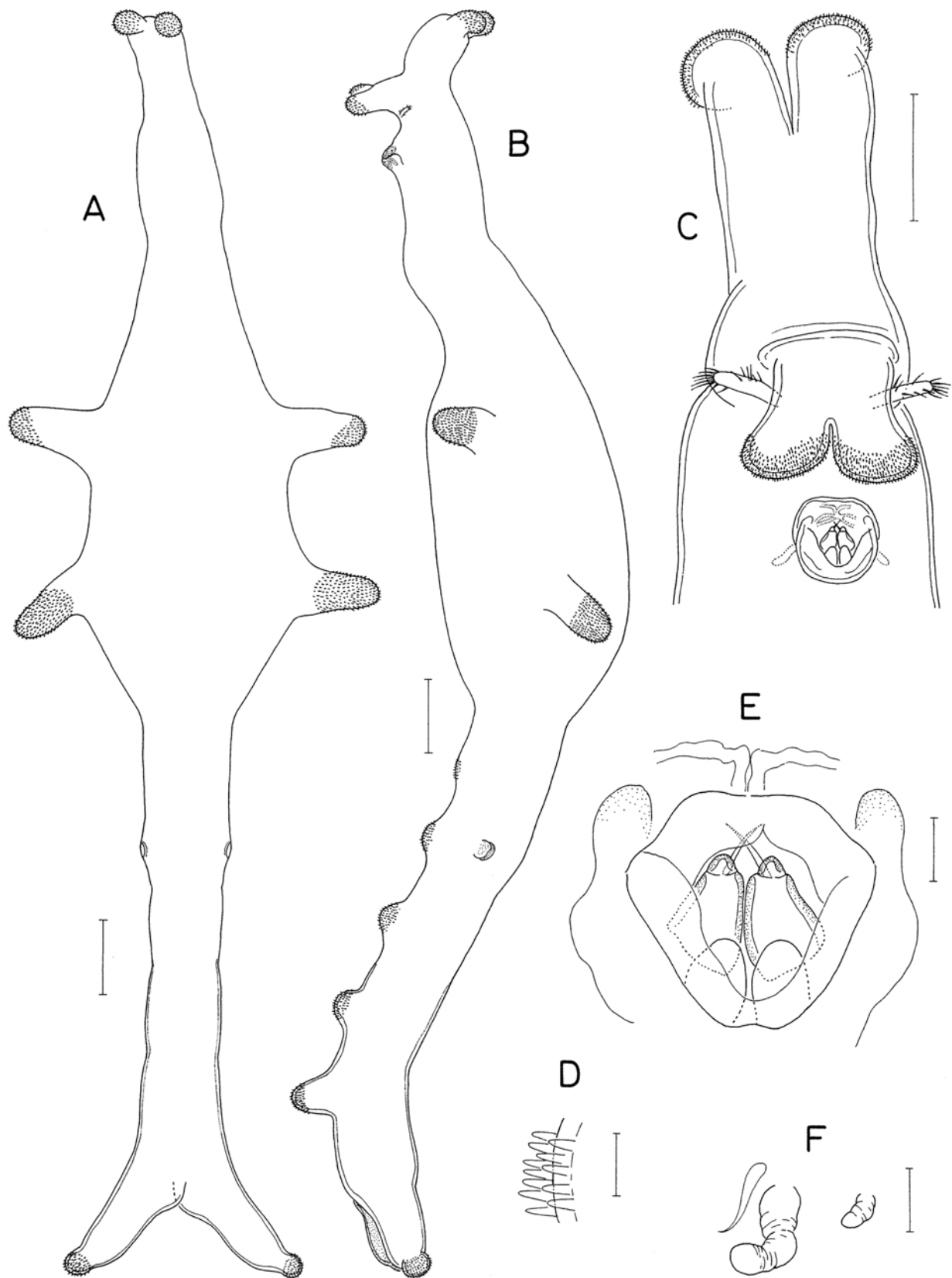


Fig. 9. *Colobomatus unimanus* n. sp., female. A, habitus, dorsal; B, habitus, left; D, cephalic region, ventral; E, spinules on tip of trunk process; E, mouth region, ventral; F, leg 1. Scale bars: A, B, 0.2 mm; C, 0.1 mm; D-F, 0.01 mm

congeners by having a smooth genital somite, without processes. Unlike *C. unimanus* n. sp., all of those four congeners were described and illustrated to have a pair of processes on the genital somite (see West, 1992, Madinabeitia et al., 2012, Essafi et al., 1984 for the four species).

***Colobomatus recticaudatus* n. sp.** (Fig. 10)

Material examined

One ♀ (holotype) from cephalic canals of the multicolorfin rainbowfish *Halichoeres poecilopterus* (Temminck and Schlegel) landed at Tongyeong Port (caught in the Strait of Korea), collected by I.-H. Kim, 14 November 2009. Holotype (intact, NIBRIV0000282422) has been deposited in the National Institute of Biological Resources (NIBR), Incheon.

Description

Female. Body (Fig. 10A, B) 3.02 mm long and clearly divisible into cephalosome, unsegmented trunk and segmented urosome. Cephalosome 505×307 µm, slightly narrowing anteriorly and clearly defined from trunk by constriction between them, with 2 pairs of processes in front of antennule: anterior processes fused to each other at base, 395 µm long, blunt at tip, and covered distally with numerous spinules (Fig. 10C) of about 6 µm long. Trunk dorsoventrally depressed, 1140×693 µm, slightly broadened distally, with 2 pairs of blunt dorsolateral processes; anterior processes about 200 µm long and posterior ones about 250 µm long; these trunk processes covered with numerous spinules on all surfaces. Urosome 5-segmented. First urosomal somite 198×317 µm, with slight ventral expansion covered with spinules. Genital double-somite 297×297 µm, formed by fusion of original genital somite and first abdominal somite, as long as wide, divisible into anterior and posterior parts by middle constriction in ventral and lateral views; anterior and posterior parts each with blunt ventral process covered with spinules (Fig. 10B); genital areas located dorsolaterally near anterior third of somite; genital aperture without armature element. Abdomen 3-segmented; first 2 free abdominal somites 129×228 and 119×197 µm, respectively, each with blunt ventral process covered with spinules. Anal somite smooth. Caudal rami fused with anal somite, without suture from anal somite, directed backwards, about 200×80 µm (ratio 2.5:1), and covered distally with spinules.

Rostrum absent. Antennule (Fig. 10D) slender, unsegmented, 65 µm long, armed with 20 smooth setae; some of these

setae blunt, aesthetasc-like. Antenna absent. Buccal capsule (Fig. 10E) not projected and containing 3 mouth organs; anteriormost organ tipped with 1 seta; second mouth organ with scattered spinules and tipped with 1 spiniform element, posteriormost mouth organ unarmed and distally curved medially and pointed.

Leg 1 (Fig. 10F) located at anterior region of trunk (Fig. 10B), consisting of weakly defined protopod and unsegmented rami; protopod with 1 outer seta; exopod with 5 setae; small endopod lobate and unarmed. Leg 2 (Fig. 10G) located at level of anterior processes of trunk and consisting of separated outer seta, exopod bearing 3 setae, and lobate, unarmed endopod. Leg 3 (Fig. 10H) represented by 1 seta. Legs 4–6 absent.

Male. Unknown.

Etymology

The specific name *recticaudatus* is a combination of the Latin words *rectus* (=straight) and *cauda* (=tail). It refers to the straight body and caudal rami.

Remarks

Like *Colobomatus unimanus* n. sp. and its four relatives, mentioned above, *C. recticaudatus* n. sp. also has four processes on the cephalosome. However, *C. recticaudatus* n. sp. can be comparable only with *C. unimanus*, because only these two species lack genital processes unlike other four species. *C. recticaudatus* is differentiated from *C. unimanus* by having the following features: (1) the urosome is well-segmented and shorter than the trunk (unsegmented and longer than the trunk in *C. unimanus*); (2) the caudal rami are parallel and blunt (divergent and tapering in *C. unimanus*); (3) the exopod of leg 1 is provided with five setae (unarmed in *C. unimanus*); (4) legs 2 and 3 are present (absent in *C. unimanus*); and (5) three pairs of mouth organs are present (two pairs in *C. unimanus*).

***Colobomatus floridus* n. sp.** (Fig. 11)

Material examined

One ♀ (holotype) from cephalic canals of the belted beard grunt *Hapalogenys mucronatus* (Eydoux and Souleyet), off Yeosu in the Strait of Korea, S. Y. Moon, 19 May 2012. Holotype (intact, NIBRIV0000282423) has been deposited in the National Institute of Biological Resources (NIBR), Incheon.

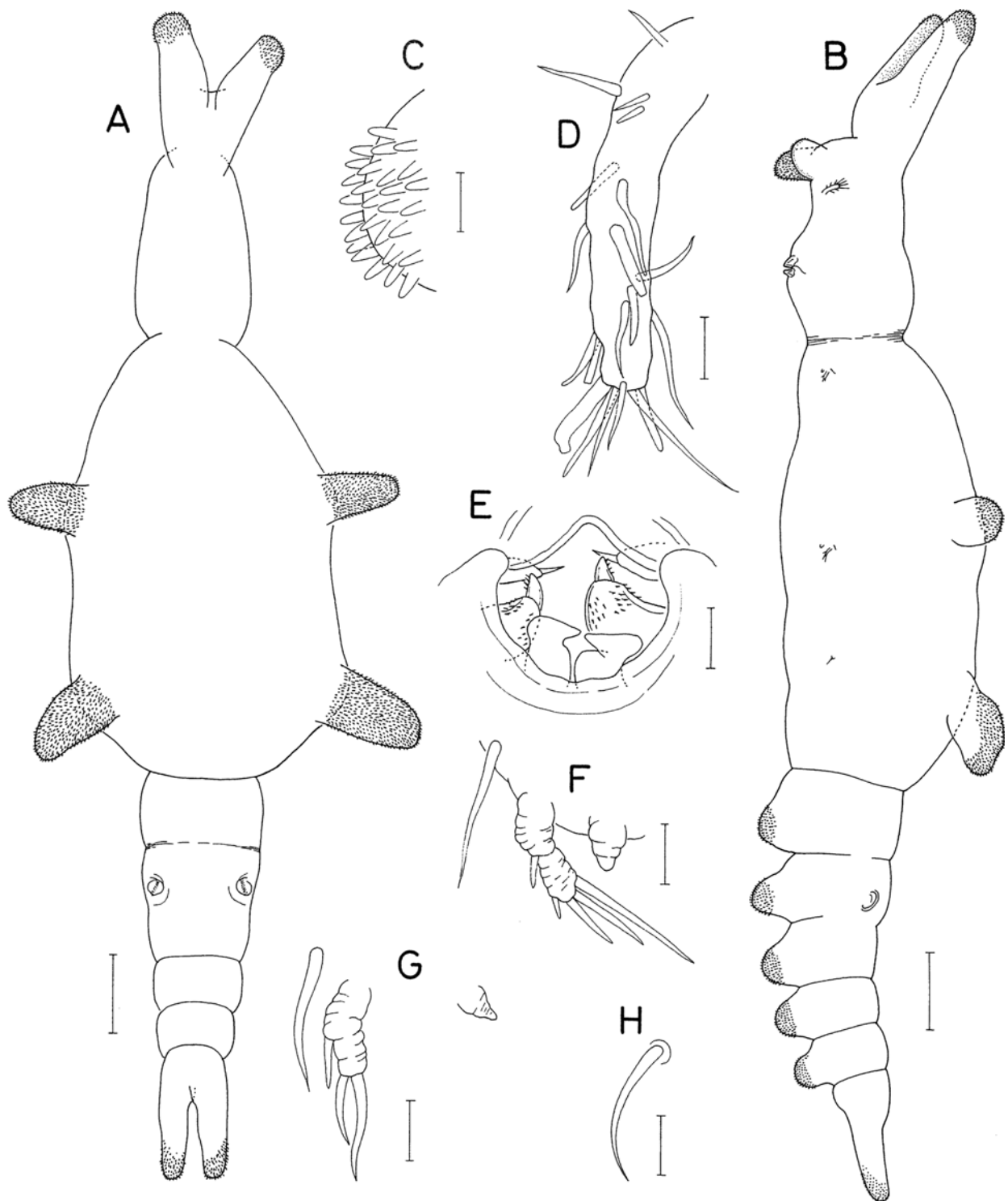


Fig. 10. *Colobomatus recticaudatus* n. sp., female. A, habitus, dorsal; B, habitus, left; C, spinules on trunk process; D, antennule; E, mouth region, ventral; F, leg 1; G, leg 2; H, leg 3. Scale bars: A, B, 0.2 mm; C-H, 0.01 mm

Description

Female. Body (Fig. 11A) 1.90 mm long and unsegmented, without divisions between Cephalosome and trunk and

between trunk and urosome. Maximum width of cephalic region 265 μ m measured at level of oral region. Cephalic region with 3 frontal processes: paired anterolateral processes

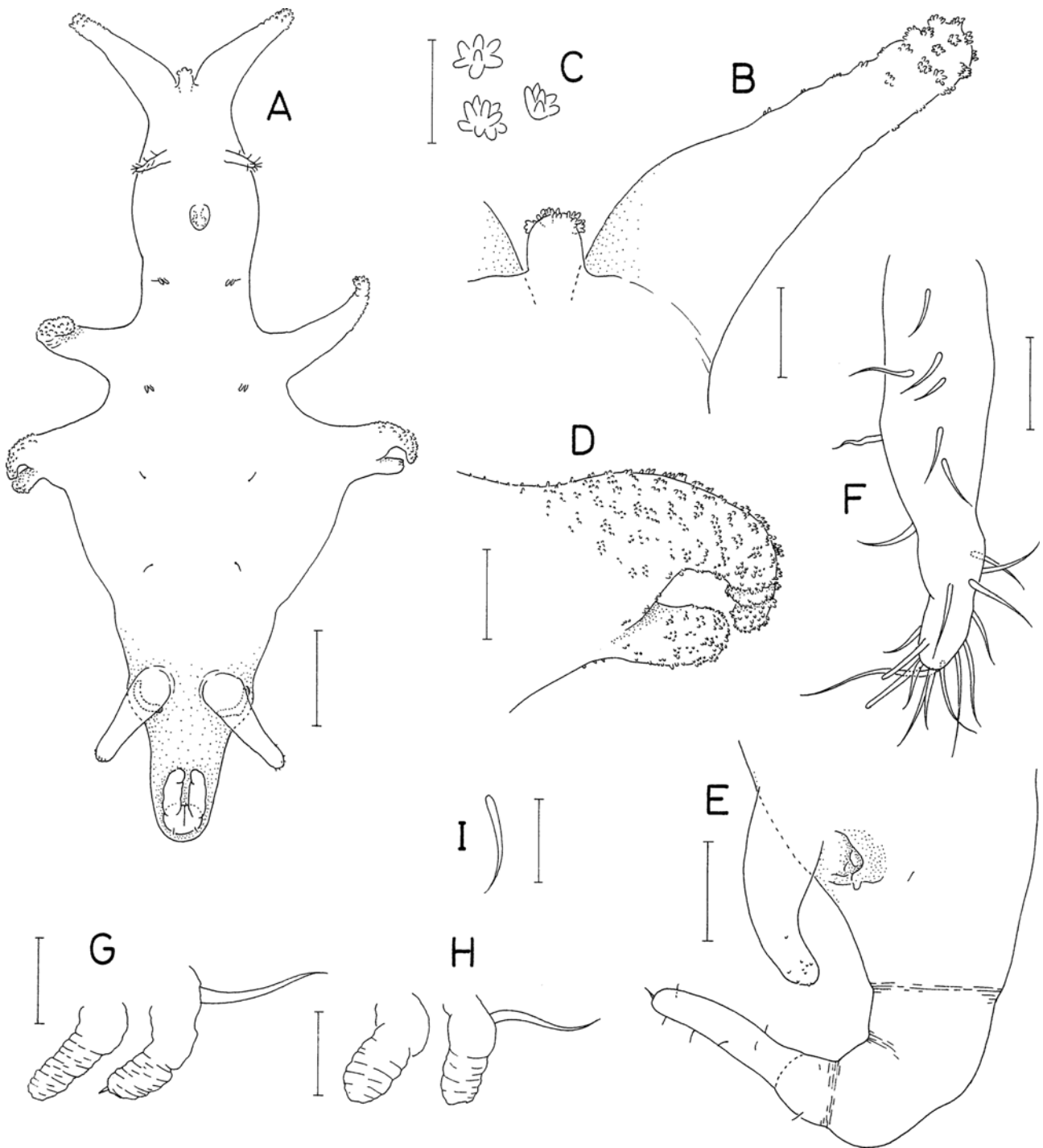


Fig. 11. *Colobomatus floridus* n. sp., female. A, habitus, ventral; B, antero-medial and antero-lateral processes, dorsal; C, ornamentation on antero-lateral process; D, second lateral process on trunk, dorsal; E, posterior part of body, right; F, antennule; G, leg 1; H, leg 2; I, leg 3. Scale bars: A, 0.2 mm; B, D, 0.05 mm; C, F, 0.02 mm; E, 0.1 mm; G-I, 0.01 mm

(Fig. 11B) tapering, 230 μ m long, directed anterolaterally, with blunt tip and rosette-like papillae (Fig. 11C) in distal region; small mid-frontal process about 30 μ m long, with rosetted papillae apically. Trunk with 2 pairs of lateral

processes: anterolateral processes located midway level between legs 1 and 2, about 265 μ m long, with tip covered with rosetted papillae; posterolateral process positioned at level of leg 3, broader than anterolateral one, confusing

with trunk at base, with distal end bifurcated and covered with rosetted papillae (Fig. 11D). Posterior part of body strongly tapering behind posterolateral processes. Urosome with paired ventrolateral processes at level of genital areas; these processes weakly tapering, 233 μm long, directed posterolaterally, with granule-like ornaments near tip. Genital aperture located dorsolaterally, without any armature element. Abdominal region recurved dorsally (Fig. 11E). Caudal ramus directed anterodorsally, 154 μm long, about 4 times as long as wide, with several scattered setules (Fig. 11E).

Rostrum probably represented by mid-frontal process (Fig. 11B). Antennule (Fig. 11F) unsegmented, about 90 μm long, with narrower distal two-fifths, and armed with 21 naked setae and 2 aesthetascs. Antenna absent. Buccal capsule as small ventral projection; mouth organs invisible.

Legs 1 and 2 (Fig. 11G, H) consisting of unsegmented, digitiform exopod and endopod, without protopod. Exopod of leg 1 with 1 outer proximal and 1 minute distal setae; endopod unarmed. Leg 2 similar to leg 1 but exopod with only 1 outer proximal seta. Legs 3 and 4 each represented by 1 small seta (Fig. 11I). Legs 5 and 6 absent.

Male. Unknown.

Etymology

The specific name *floridus* is a Latin meaning “flowery”. It alludes to the presence of the numerous flower-like ornamentations on the body processes.

Remarks

The majority of species of *Colobomatus* possess two pairs (anterior and posterior pairs) of processes on the trunk. Of these, five species have been known to have a simple anterior pair of processes and distally bifurcate posterior pair of processes on the trunk, as *C. recticaudatus* n. sp., as follows: *C. baraldii* (Richiardi, 1877), *C. benazzii* Delamare-Deboutville and Nunes-Ruivo, 1952, *C. denticis* (Richiardi, 1877), *C. sciaenae* (Richiardi, 1876), and *C. tenuis* Castro Romero and Munoz, 2011. *C. recticaudatus* n. sp. can be distinguished from those five species by the following different features possessed by the latter: *C. baraldii* has distally bifurcated caudal rami; *C. benazzii* has strongly tapering caudal rami each armed with 2 setiform elements; *C. denticis* has bifurcated anterolateral processes on the cephalosome and a pair of processes on the anal somite; *C. sciaenae* has a circular trunk and very slender caudal rami; and *C. tenuis* has three similarly elongate cephalic processes.

Colobomatus orientalis n. sp. (Figs. 12-14)

Material examined

One ♀ (holotype), 1♂ (paratype) from cephalic canals of a croaker *Johnius grypotus* (Richardson), Suncheon Bay (34°45'N, 127°34'E), collected by S. Y. Moon, 14 June 2012. Holotype ♀ (NIBRIV0000282424; left antennule and right legs 1 and 2 dissected out) has been deposited in the National Institute of Biological Resources (NIBR), Incheon. Dissected paratype (♂: mounted on a glass slide) is kept in the collection of the senior author.

Description

Female. Body (Fig. 12A, B) well-segmented. Body length 3.78 mm, measured from anterior apex of cephalosome to distal end of caudal rami. Cephalosome 500×410 μm , nearly circular, and clearly defined from first pedigerous somite, with pair of elongate anterolateral processes; each process about 900 μm long, gradually attenuated distally, 7.8 times as long as basal width, and ornamented with numerous thick setules in distal third (Fig. 12B). First to fourth pedigerous somites fused. First pedigerous somite small, defined from second pedigerous somite by lateral constriction, and 180×308 μm . Second pedigerous somite broadening posteriorly. Third pedigerous somite not defined ventrally but with dorsal, roof-like, large expansion carrying paired anterolateral and posterolateral processes; anterolateral processes strongly tapering, directed laterally, with setules-covered distal region; posterolateral processes much longer and broader than anterolateral processes and directed posterolaterally, with tapering distal fourth and setules on distal region. Distance between tips of posterolateral processes 1.99 mm. Urosome clearly segmented. Fifth pedigerous somite 238×408 μm . Genital somite slightly expanded laterally and 246×538 μm . First to third abdominal somites smooth, 208×338, 208×331, and 169×308 μm , respectively. Anal somite 170 μm long, with anus posteromedially. Caudal ramus (Fig. 12C) fused with anal somite, 846×163 μm , 5.19 times as long as wide, evenly tapering, covered with thick setules, and armed with 1 seta on medial margin. Egg sac 990×460 μm ; eggs irregularly arranged.

Rostrum absent (Fig. 12D). Antennule (Fig. 12E) unsegmented, constricted in middle, and armed with 19 naked setae. Antenna absent. Buccal capsule located at anterior region of cephalosome and hemicircularly projected; mouth organs not observed.

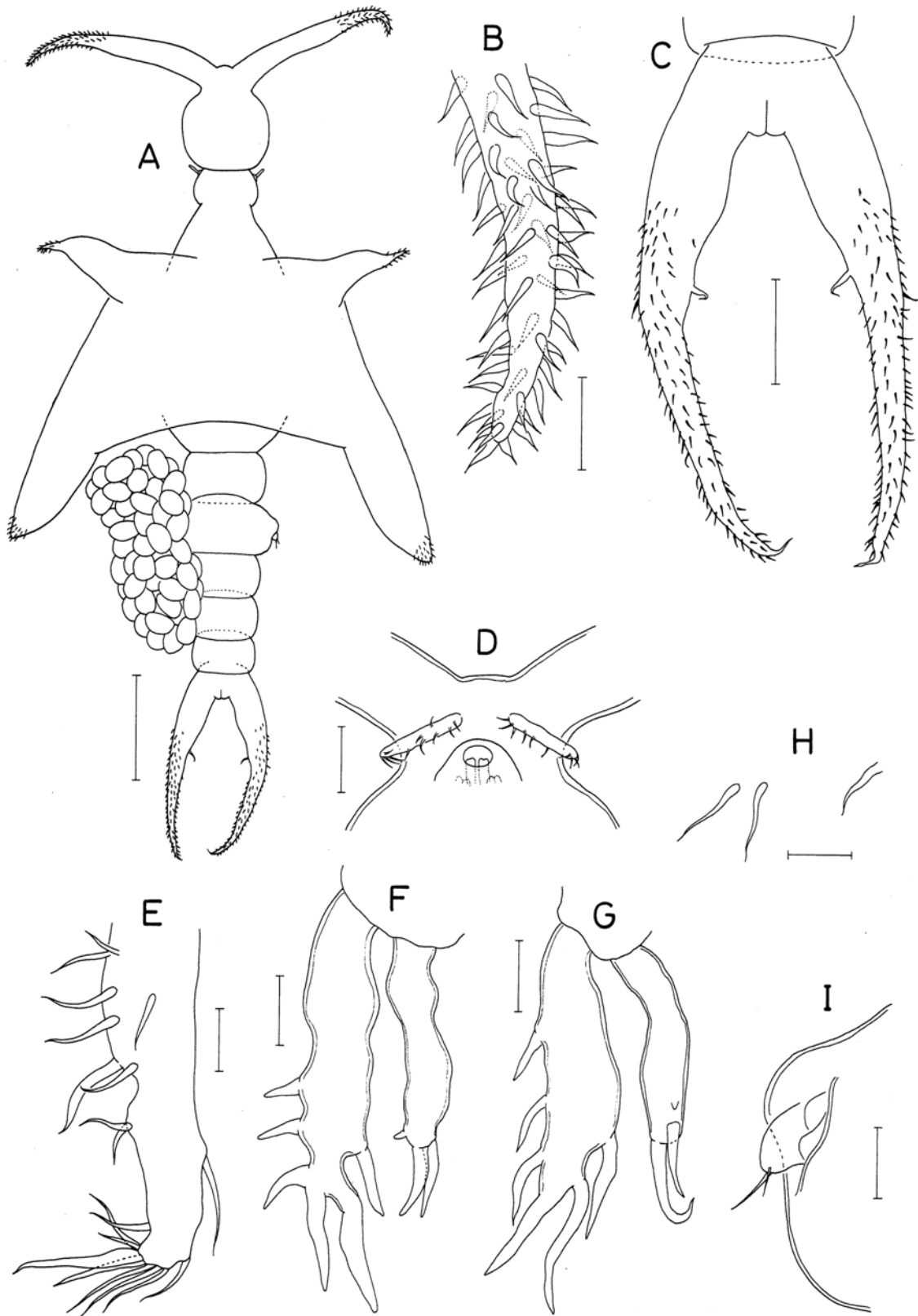


Fig. 12. *Colobomatus orientalis* n. sp., female. A, habitus, dorsal; B, distal part of cephalic process; C, anal somite and caudal rami, ventral; D, rostral region, ventral; E, antennule; F, leg 1; G, leg 2; H, leg 3; I, genital aperture, dorsal. Scale bars: A, 0.5 mm; B, I, 0.05 mm; C, 0.2 mm; D, 0.1 mm; E-H, 0.02 mm

Legs 1 and 2 (Fig. 12F, G) unsegmented, elongated and armed with broad and blunt setae, with obscure protopod; each leg with 6 setae on exopod and 3 setae on endopod; setae generally not articulated at base. Leg 3 (Fig. 12H) consisting of 3 small setae located on posterior region of third pedigerous somite, medial 2 of them neighboring and separated from outer one. Legs 4 and 5 absent. Leg 6 probably represented by 2 small setae in genital operculum (Fig. 12I).

Male. Body (Fig. 13A) narrow, cylindrical and not transformed. Body length 1.46 mm. Cephalosome $246 \times 302 \mu\text{m}$, with transverse sclerotization band posterodorsally and rounded posterolateral corners. Second pedigerous somite with paired large dorsolateral processes; these processes directed backwards, but distal part recurved dorsally and hook-like. Third pedigerous somite fused with second pedigerous somite, without articulation between them on ventral surface, with leg 3 pair on posterior region of ventral surface (Fig. 13B). Genital somite $117 \times 154 \mu\text{m}$, not expanded, with 2 setae on posterolateral corner of genital operculum (Fig. 13A, B). Four abdominal somites 123×136 , 117×123 , 98×105 , and $126 \times 98 \mu\text{m}$, respectively. Anus exposed, without anal operculum. Caudal ramus $157 \times 35 \mu\text{m}$, 4.49 times as long as wide and armed with 6 naked setae; seta on medial margin recurved toward base of ramus.

Rostrum absent. Antennule (Fig. 13C) $169 \mu\text{m}$ long, 3-segmented, but with 3 rudiments of articulation: 1 on second and 2 on third segments; armatures on segments: 1 seta on first segment, 4+4 setae on second, 12 setae+ 3 aesthetascs on third; all setae naked. Antenna (Fig. 13D) 6-segmented and consisting of precoxa, coxa, basis, and 3-segmented endopod; short precoxa unarmed; coxa and basis each with 1 small medial seta; first endopodal segment with 1 large claw and 2 small setae; second endopodal segment with 1 medial and 1 small ventral spines; third endopodal segment with 1 small medial and 1 large terminal claws.

Labrum (Fig. 13E) much reduced and armed with 4 stout teeth of identical size on ventral surface. Lateral regions of labrum sclerotized, with 2 blunt humps (Fig. 13E). Mandible (Fig. 13F) large, hook-like, with transparent region in proximal third and 1 naked seta on concave medial margin. Maxillule (Fig. 13G) with large, tapering, transparent extension on outer side, 2 thick spinulose setae distally, and 1 small naked seta on medial margin. Maxilla (Fig. 13H) 2-segmented; first segment unarmed; second segment terminating in 2 subequal, spinulose spines. Maxilliped (Fig. 13I) 3-segmented; all segments unarmed; terminal segment as narrow, elongate

claw.

Legs 1 and 2 (Fig. 14A, B) consisting of coxa, basis, and 2-segmented rami. Outer proximal seta spiniform on second exopodal segment of leg 2. Armature formula of these 2 legs as follows:

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

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

Leg 3 (Fig. 14C) 1-segmented, much wider than long, and armed with 1 naked outer seta and 3 spinulose distal setae. Leg 4 represented by 1 naked ventrolateal seta on fourth pedigerous somite (Fig. 13B). Leg 5 absent. Leg 6 represented by 2 unequal setae on genital operculum of genital somite (Fig. 13B).

Etymology

The specific name *orientalis* is taken from the name of a geographical region in consideration that the fish host, *Johnius grypotus*, is limited to the Oriental region in its distribution.

Remarks

The new species has the following four diagnostic characters in the female: (1) the cephalosome has a pair of processes; (2) the trunk has two pairs of processes; (3) the genital somite has no process; and (4) the anal somite has no process, either.

The above four characteristics of the new species are shared by eight congeners: *C. arabicus* Hayward, 1996; *C. asiaticus* Hayward, 1996; *C. cribbi* West, 1992; *C. hispidus* West, 1992; *C. labracis* Delamare Devbouteville and Nunes-Ruivo, 1952; *C. quadrifarius* Cressey and Schotte, 1983; *C. sieboldi* (Richiardi, 1877); and *C. sillaginis* West, 1983. The new species can be distinguished from the above eight congeners by the following features possessed by females of these congeners, as follows:

In *C. arabicus* the cephalic processes are small, not longer than the cephalosome, the anterior trunk processes are extended anteriorly over the cephalosome, and the caudal ramus terminates in a blunt tip (Hayward, 1996).

In *C. asiaticus* the cephalic processes are blunt and as long as the cephalosome, the trunk processes also are blunt at tip; and leg 3 is represented by a single seta.

In *C. cribbi* the trunk processes are very small, the urosome is unsegmented, the rami of legs 1 and 2 are armed with fewer setae, with at most four setae on the exopod; and leg 3 comprises two setae (West, 1992).

In *C. hispidus* which is very similar to the new species,

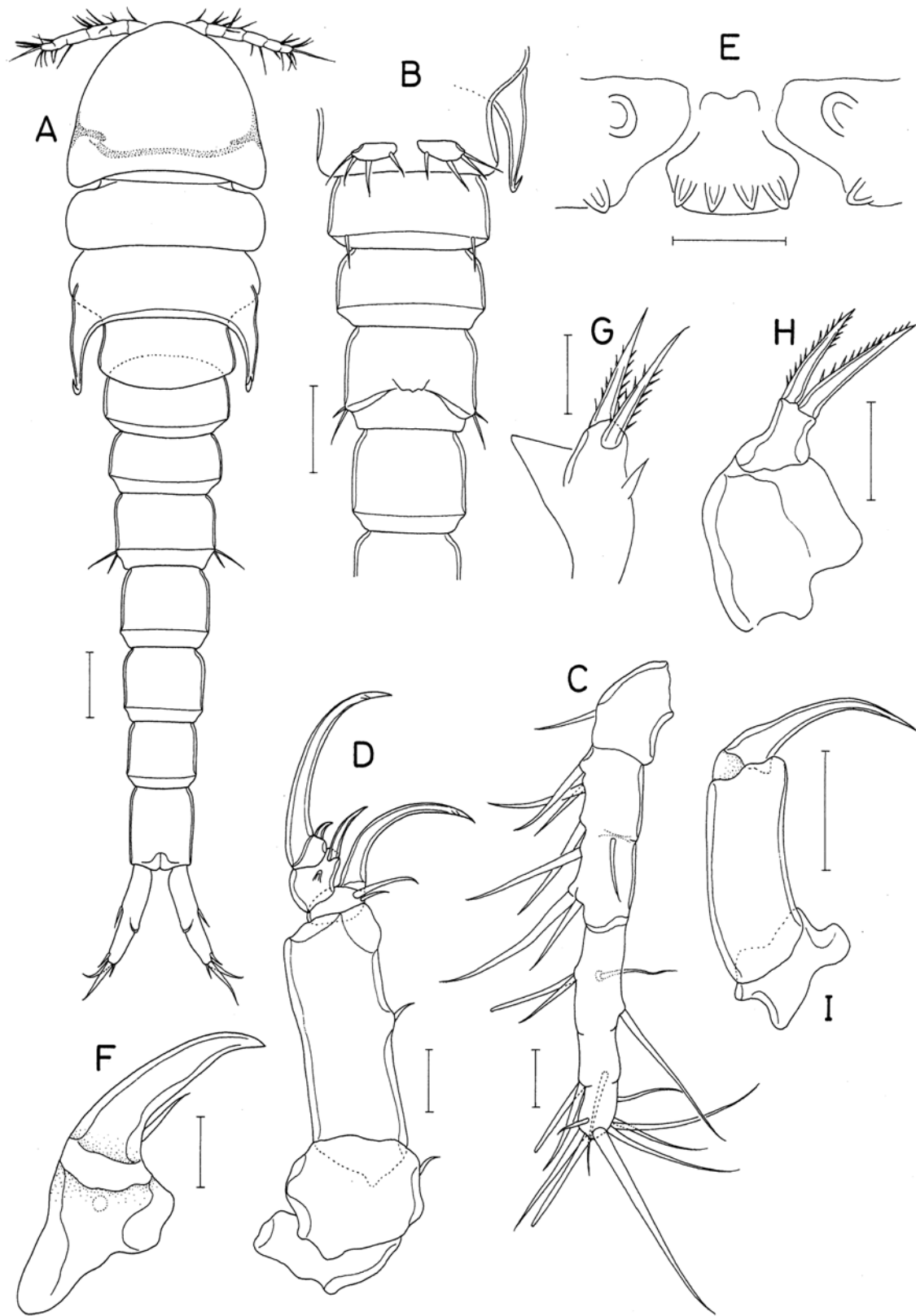


Fig. 13. *Colobomatus orientalis* n. sp., male. A, habitus, dorsal; B, third pedigerous somite to first abdominal somite, ventral; C, antennule; D, antenna; E, labrum and its lateral processes; F, mandible; G, maxillule; H, maxilla; I, maxilliped. Scale bars: A, B, 0.1 mm; C-F, H, I, 0.02 mm; G, 0.01 mm

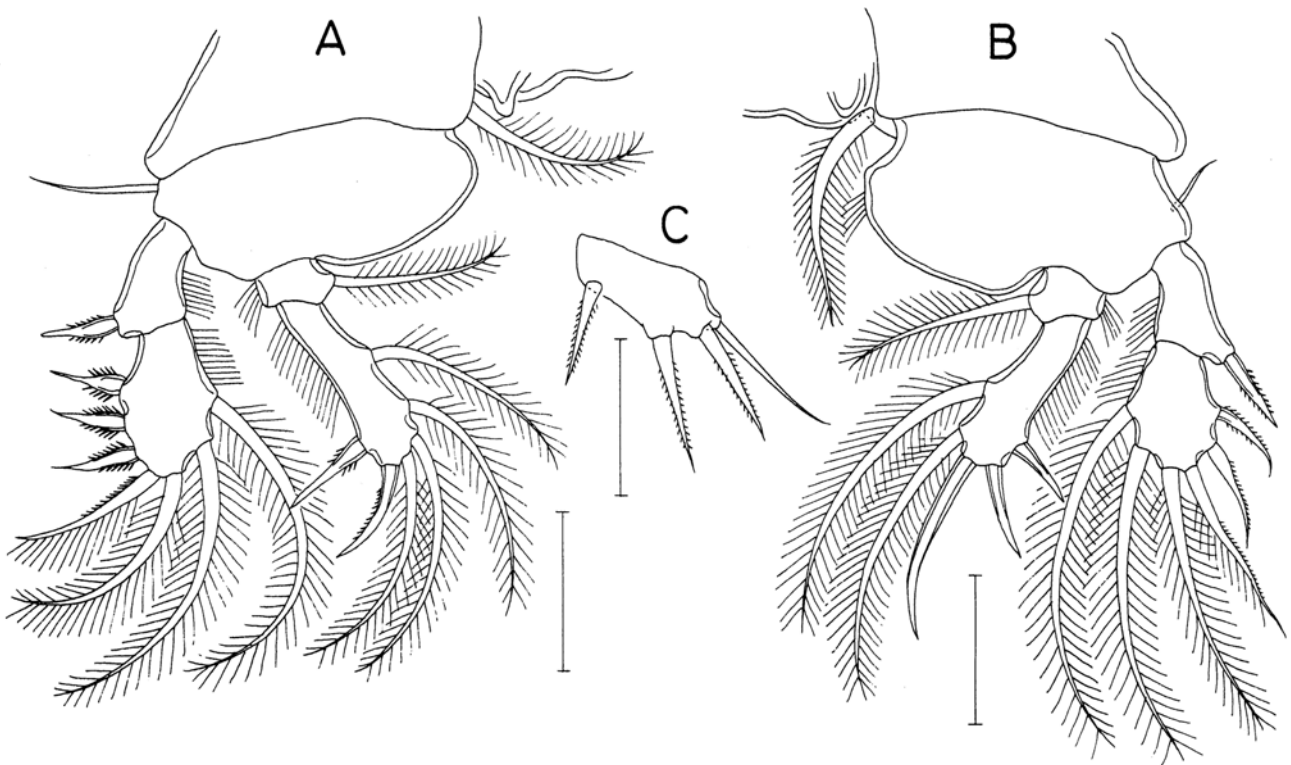


Fig. 14. *Colobomatus orientalis* n. sp., male. A, leg 1; B, leg 2; C, leg 3. Scale bars: 0.05 mm for all

leg 1 is armed with eight setae on the exopod and five setae on the endopod, leg 2 is armed with seven setae on the exopod and four setae on the endopod, and leg 3 comprises two setae (West, 1992).

In *C. labracis* the cephalic and trunk processes are expanded distally and pad-like, the antennule of both sexes are segmented, and leg 5 of the male is armed with five setae (Raibaut et al., 1979).

In *C. quadrifarius* the pre-anal somite bears a pair of large processes, and the cephalic processes are very small, not longer than the width of the cephalosome (Cressey and Schotte, 1983).

In *C. sieboldi* the cephalic processes expanded distally and pad-like, the trunk processes are small, and the caudal ramus is bluntly tipped.

In *C. sillaginis* the caudal ramus and all the processes on the body are smooth, without setules or spinules, the antennule and the rami of legs 1 and 2 are segmented, and leg 3 consists of only a single seta (West, 1983).

Family **Taeniacanthidae** Wilson, 1911

Genus **Taeniacanthus** Sumpf, 1871

***Taeniacanthus singularis* n. sp. (Figs. 15, 16)**

Material examined

One ♀ (holotype) from gills of the smoky batfish *Halieutaea fumosa* Alcock, off Yangpo Port (35°53'N, 129°33'E), Pohang-shi, collected by I.-H. Kim, 30 July 2010. Holotype (NIBRIV0000209142; dissected and mounted on 2 glass slides) has been deposited in the National Institute of Biological Resources (NIBR), Incheon.

Description

Female. Body (Fig. 15A) 3.47 mm long and slender. Cephalothorax semicircular, forming sucking cup, 950×1090 μm, much wider than succeeding somites. Second to fourth pedigerous somites 320×650, 310×540, and 270×450 μm, respectively. Urosome 6-segmented. Fifth pedigerous somite 180×420 μm. Genital somite 250×430 μm; genital apertures positioned dorsolaterally near midway of somite. Four abdominal somites 280×320, 280×290, 200×260, and 270×220 μm, respectively. Anal somite proximally with 2 transverse rows of minute spinules on both sides of ventral surface (Fig. 15B). Caudal ramus weakly tapering, 180×78 μm (ratio 2.31:1), and armed with 6 setae; outer lateral seta

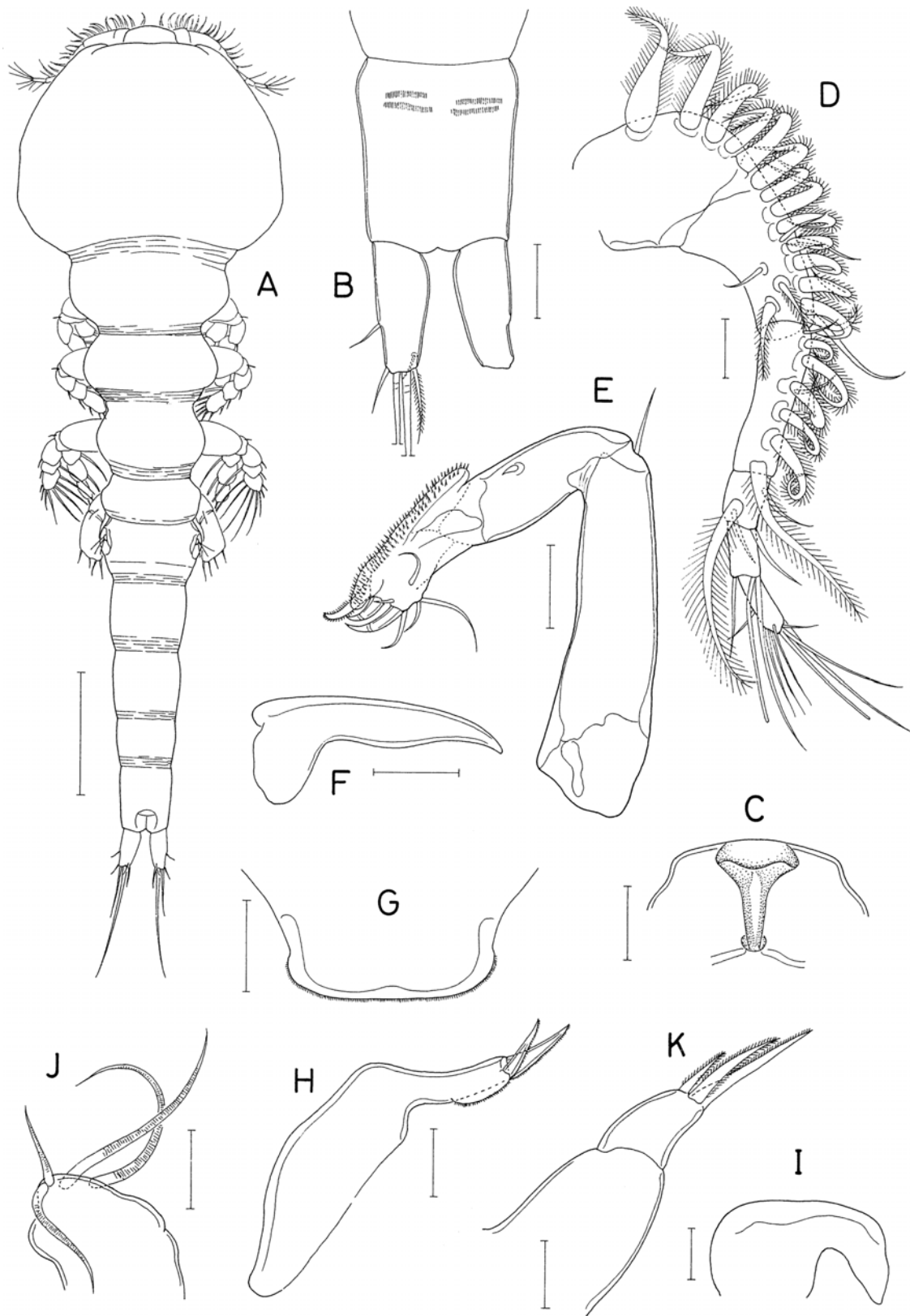


Fig. 15. *Taeniacanthus singularis* n. sp., female. A, habitus, dorsal; B, anal somite and caudal rami, ventral; C, rostrum, ventral; D, antennule; E, antenna; F, postantennary process; G, labrum; H, mandible; I, paragnath; J, maxillule; K, maxilla. Scales: A, 0.5 mm; B, C, F, G, 0.1 mm; D, E, H, J, K, 0.05 mm; I, 0.02 mm

located in distal third of outer margin; largest one of distal setae 500 μm long, other setae much shorter, not exceeding half length of largest seta.

Rostrum wider than long, nearly trapezoid, with sclerotized longitudinal ridge on ventral surface as in Fig. 15C. Antennule (Fig. 15D) 475 μm long and 6-segmented, with armature formula 5, 15, 8, 4, 2+aesthetasc, and 7+aesthetasc; setae on first to third segments usually broad and pinnate, except 4 naked ones on second segment and 2 naked ones on third segment. Antenna (Fig. 15E) 3-segmented. First segment longest, with 1 inner distal seta. Second segment with 1 small seta on inner side. Terminal segment obscurely delimited from the second and armed with 4 setae, 2 distal claws, 1 spiniform, spinulose distal element and medially 1 elongated, spinules-covered linguiform element.

Labrum (Fig. 15G) with straight posterior margin bearing minute spinules. Mandible (Fig. 15H) with 2 spiniform elements distally. Paragnath (Fig. 15I) is strongly curved, unornamented lobe. Maxillule (Fig. 15J) lobate, bearing 4 naked setae apically. Maxilla (Fig. 15K) 2-segmented; proximal segment unarmed; distal segment armed with 3 spiniform elements distally. Maxilliped (Fig. 16A) 4-segmented, but proximal 2 segments almost fused; broad first segment unarmed; second segment obscurely demarcated from first segment, with 3 proximal setae on medial margin (one of them minute); third segment very short and unarmed; terminal segment characteristically short, tapering, almost straight, and about half as long as second segment, with 2 minute setae proximally (Fig. 16B).

Leg 1 (Fig. 16C) leaf-like, with 2-segmented rami; most of setae, except 3 outer setae on second exopodal segment, expanded and pinnate; second endopodal segment with 5 expanded pinnate setae on distal and medial margins and 1 or 2 small naked setae on outer distal corner. Legs 2-4 with 3-segmented rami. Legs 2 and 3 sharing same armature formula but second outer setae on third endopodal segment different between 2 legs (Fig. 16D and E). Armature formulae of legs 1-4 as follows:

Leg 1: coxa 0-1; basis 1-1; exp. 1-0; 3, 1, 5; enp. 0-1; 7 (or 6)

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

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

Leg 5 (Fig. 16G) consisting of protopod and exopod; protopod with 1 outer distal seta; exopod $187 \times 104 \mu\text{m}$ (ratio 1.80:1), curved in middle, strongly tapering in distal

half, armed with 4 naked setae and ornamented with several rows of minute spinules near distal margin and minute pits scattered on surfaces. Leg 6 represented by 3 small setae in genital aperture.

Male. Unknown.

Etymology

The specific name *singularis* refers to the finding of only a single specimen available for the study of this species.

Remarks

According to two keys to genera of the Taeniacanthidae each provided by Dojiri and Cressey (1987) and Boxshall and Halsey (2004), the generic position of the new species is keyed out to the genus *Taeniacanthus* Sumpf, 1871. But based on a revised key to genera of the family given by Tang and Johnston (2005) it may be placed in the genus *Caudacanthus* Tang and Johnston, 2005. While Tang and Johnston (2005) proposed a new genus *Caudacanthus*, they characterized this genus by four diagnostic characteristics: (1) abdominal somites each is ornamented with spinules along the posteroventral margin; (2) the maxilliped has a short terminal claw pressed close the base; (3) legs 2 and 3 have an inner coxal seta; and (4) the inner distal seta (seta VI) on the caudal ramus is transformed to a stout spine. Our new species shares with *Caudacanthus* two (characters 2 and 3) of the above four characters. Nevertheless, the new species cannot be placed in that genus, because of the lack of the characteristics 1 and 4 and the sharing the characteristics 1 and 4 with several other genera in the Taeniacanthidae. We would like to place the new species within *Taeniacanthus*, the most inclusive genus in the family, containing more than 45 species.

Within the genus *Taeniacanthus*, *T. singularis* n. sp. is characterized by having an inner coxal seta on legs 2 and 3 and a short terminal claw on the maxilliped. The inner coxal seta on legs 2 and 3 is present in species of some genera, such as *Anchistrotos* Brian, 1906, *Biacanthus* Tang and Izawa, 2005, *Irodes* Wilson, 1911, and the above *Caudacanthus*, but none of these cases has been known with regard to *Taeniacanthus*. On the other hand, four species of *Taeniacanthus*, *T. longicervis* (Pillai, 1963), *T. petilus* Dojiri and Cressey, 1987, *T. pterosi* Shen, 1957, and *T. sauridae* Yamaguti and Yamasu, 1959 are known to have the short terminal claw on the maxilliped, like *T. singularis* n. sp. In these species the terminal claw of the maxilliped is half or less than half as

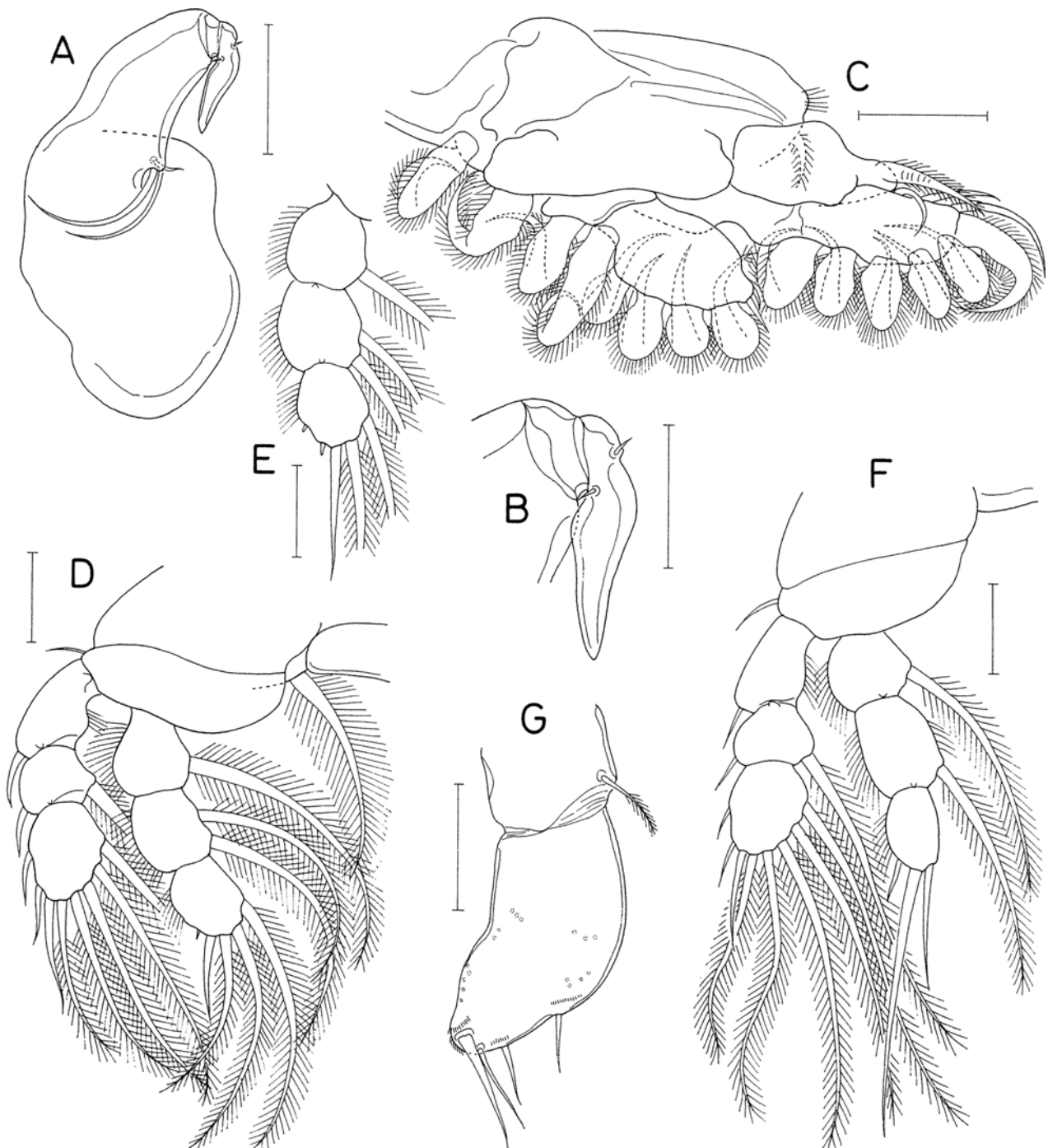


Fig. 16. *Taeniacanthus singularis* n. sp., female. A, maxilliped; B, apical part of maxilliped; C, leg 1; D, leg 2; E, endopod of leg 3; F, leg 4; G, leg 5. Scales: A, C-G, 0.1 mm; B, 0.05 mm

long as the second segment (basis). *Taeniacanthus singularis* n. sp. can easily be differentiated from these four species by having no inner coxal seta on legs 2 and 3. It can be distinguished further from those 4 congeners by having two transverse rows of minute spinules on both sides of the ventral surface of the anal somite, in contrast that there is a single row of spinules in

T. longicervis or none in the other three species, as illustrated by Dojiri and Cressey (1987) for *T. longicervis*, *T. petilus*, and *T. pterois* and by Yamaguti and Yamasu (1959) for *T. sauridae*. These four species show further differences from *T. singularis* n. sp. as follows: *T. longicervis* has a 7-segmented antennule and denticles on the claw of the maxilliped; *T.*

petilus has a mandible bearing two blades and one seta distally and the exopod of leg 5 is 2.67 times as long as wide; *T. pterois* has a corrugated terminal claw of the maxilliped and the innermost terminal claw of the antenna is much larger than other nearby claws (Ho and Lin, 2007); and *T. sauridae* typically has a bifid terminal claw on the maxilliped as confirmed by Cressey and Cressey (1979).

T. carchariae, *T. coleus* and *T. tetradonis*, all of which are not or imperfectly known of their maxilliped, can be compared with *T. singularis* n. sp. as follows: in *T. carchariae*, the type species, the cephalothorax is not much broader than the remaining part of body, unlike *T. singularis* n. sp. and most of other congeners (Dojiri and Cressey, 1987). *T. coelus* and *T. tetradonis* are impossible to compare exactly with *T. singularis* n. sp., because they were incompletely described originally and have not been redescribed since. However, Wilson (1922) described a two-segmented condition of the endopod of leg 3 in *T. coleus* and Bassett-Smith (1898) illustrated a single inner seta on the second segment of legs 2 and 3 in *T. tetradonis*. These features are not observable in *T. singularis* n. sp.

***Triacanthus* n. gen.**

Diagnosis

Body tapering posteriorly with expanded cephalothorax. Urosome 6-segmented in female and 5-segmented in male. Antennule 7-segmented, with armature formula 5+claw, 15, 5, 3, 4, 2+aesthetasc, and 7+aesthetasc. Rostrum ventrally with 1 large claw in middle and 2 small anterior claws. Antenna of female 4-segmented. Proximal 2 segments each with 1 seta; third segment with 1 strong claw and 2 pectinate process, and several spinules; fourth segment with 2 claws, 4 setae, and 1 large outer distal process. Antenna of male as in female but last segment lacking outer distal process. Postantennal process present. Labrum tapering posteriorly. Mandible with 2 distal blades. Maxillule weakly bilobed, with 2 setae on outer lobe and 4 setae on inner lobe. Maxilla 2-segmented; proximal segment unarmed; distal segment with 2 broad, serrate spines and 1 small seta. Maxilliped of female 3-segmented; first segment (syncoxa) unarmed; second segment (basis) with 2 inner setae; terminal segment forming elongate, spiniform claw, with 2 proximal setae. Maxilliped of male 4-segmented; first segment with 1 inner seta; second segment with 2 setae and numerous spinules on inner side; third segment unarmed; terminal segment forming claw, with 4

proximal setae. Legs 1-4 with 3-segmented rami. Legs 1-3 with inner seta on coxa. Leg 1 of female lamellate, with flattened rami. Leg 1 of male less flattened. Leg 4 without inner seta on coxa; terminal segment of endopod with 4 setal elements. Leg 5 2-segmented; distal free segment with 3 spines and 1 seta.

Type species

Triacanthus luteus n. sp.

Etymology

The generic name *Triacanthus* is derived from the Greek *treis* (three) and *acanthus* (a thorn) and alludes to the presence of the three claws on the rostrum in the new genus. Gender is masculine.

Remarks

Triacanthus n. gen. is distinguishable from all known genera of the family Taeniacanthidae by a combination of the following four significant characteristics: (1) the rostrum is armed with three claws; (2) the antennule has a claw on the first segment; (3) the antenna has a powerful claw and two pectinate processes on the third segment; and (4) the maxilliped terminates in an elongated spiniform claw. Based on these four characteristics, *Triacanthus* n. gen. is compared with other genera of the family as follows:

(1) Within the Taeniacanthidae, only two genera *Scolecicara* Ho, 1969 and *Taeniacanthodes* Wilson, 1936 are known to have claw(s) or claw-like process (es) on the rostrum. In the monotypic genus *Scolecicara*, these elements are located at the apex of the rostrum, consisting of two lateral processes and one smaller middle process. *Scolecicara* is, however, not related to *Triacanthus*, because it has various morphological differences from *Triacanthus*. For examples, it has an unusual form of body with its second pedigerous somite forming an elongated neck region, a leg 1 bearing 2-segmented rami, and a 2-segmented maxilliped (Ho, 1969). The genus *Taeniacanthodes*, which is represented by two known species, appears to be close to *Triacanthus* n. gen. in having a claw-like process on the rostrum and a claw on the antennule. Interestingly, the claw on the antennule of *Taeniacanthodes* is confined to the male antennule, but absent in the female (Dojiri and Cressey, 1987). *Taeniacanthodes* has, unlike *Triacanthus* n. gen., a slender body, a robust terminal claw on the maxilliped, and the antenna of general form of the Taeniacanthidae.

(2) The claw (or tooth) on the antennule is observable in

three species of *Pseudotaeniacanthus* Yamaguti and Yamasu, 1959, a genus parasitic on anguilliform fishes: *P. coniferus* Dojiri and Cressey, 1987, *P. dentiferus* Lin and Ho, 2008 and *P. similis* Lin and Ho, 2008 (Dojiri and Cressey, 1987; Lin and Ho, 2008). However, *Triacanthus* n. gen. is not related to *Pseudotaeniacanthus*, because the latter genus characteristically has a Y-shaped rostral bar armed with hooklets.

(3) *Triacanthus* has a very unusual form of antenna. In four-segmented antenna of the Taeniacanthidae, the third segment generally has two large pectinate processes and one claw. One or two pectinate processes on the third segment of the antenna appears first in the early copepodid stages during development and retains in adults, as shown in copepodids of *Taeniacanthus lagocephali* Pearse, 1952 and *Biacanthus pleurichthydis* (Yamaguti, 1939) both of which were studied for their copepodids by Izawa (1986a, b). In *Triacanthus* n. gen. there are one large claw and two pectinate processes on the same segment of the antenna.

(4) The basic form of maxilliped in the family Taeniacanthidae is a three-segmented appendage bearing a robust claw on the terminal segment, as shown in *Taeniacanthus*, the type genus of the family. This form of the maxilliped is also observable in late copepodid larval stages of *Taeniacanthus lagocephali* and *Biacanthus pleurichthydis* (see Izawa, 1986a, b). Deviations from this prehensile maxilliped of fish-parasitic taeniacanthids are revealed in the following nine genera: *Anchistrotos* Brian, 1906, *Biacanthus* Tang and Izawa, 2005, *Caudacanthus* Tang and Johnston, 2005, *Irodes* Wilson, 1911, *Metataeniacanthus* Pillai, 1965, *Nudisodalis* Dojiri and Cressey, 1987, *Phagus* Wison, 1911, *Pseudotaeniacanthus* Yamaguti and Yamasu, 1959, and *Scolecicara* Ho, 1969. Of these nine genera, *Irodes*, *Nudisodalis*, *Phagus*, *Pseudotaeniacanthus*, and *Scolecicara* carry no claw on the third maxillipedal segment or no third segment at all. In *Anchistrotos* the third maxillipedal segment has a whip-like claw or a claw accompanied with two large, whip-like setae which extend to or beyond distal limit of the claw (Dojiri and Cressey, 1987). In other three genera the terminal claw of maxilliped resembles a small tapering claw as in *Caudacanthus* (see Tang and Johnston, 2005), or is reduced to a small process and closely appressed to the second segment (basis) as in *Metataeniacanthus* (see Dojiri and Cressey, 1987), or is distally bifurcate as in *Biacanthus*. All the above forms of maxillipeds in the nine genera are not similar to that of *Triacanthus* n. gen. Therefore, the characteristic form of the terminal claw of the maxilliped is unique to *Triacanthus* n. gen.

Triacanthus luteus n. sp. (Figs. 17–20)

Material examined

Thirteen ♀♀, 5 ♂♂ from the gill chambers of the green eel goby *Odontamblyopus lacepedii* (Temminck and Schlegel), Suncheon Bay (approximately 34°51'N, 127°31'E), collected by S. Y. Moon, 6 June 2012. Holotype (♀, NIBRIV0000282425), allotype (♂, NIBRIV0000282426) and paratypes (10 ♀♀, 2 ♂♂, NIBRIV0000282427) have been deposited in the National Institute of Biological Resources, Incheon, Korea. Dissected paratypes (3 ♀♀, 2 ♂♂) are kept in the collection of the senior author.

Description

Female. Body (Fig. 17A) tapering posteriorly. Body length of figured paratype 1.25 mm, excluding caudal setae (other 4 measured specimens 1.11, 1.15, 1.18, and 1.45 mm). Prosome consisting of cephalothorax and 3 pedigerous somites. Cephalothorax expanded 514×573 µm; rostral area well-defined by dorsal suture line. Urosome (Fig. 17B) 6-segmented. Fifth pedigerous somite 142 µm wide. Genital somite 87×142 µm, much wider than long, with convex lateral margins; genital areas located dorsolaterally. Four abdominal somites 44×87, 33×77, 18×69, and 57×65 µm, respectively. Articulation between two distal abdominal somites dorsally incomplete and indistinct, but ventrally complete and distinct. Caudal rami touching each other; each ramus (Fig. 17C) 60×25 µm, 2.40 times as long as wide, with 7 setae, including setule-like outer proximal seta (seta I); outer lateral seta (seta II) naked and located at midlength of outer margin; 2 mid-terminal setae naked and other 3 setae pinnate; inner one of 2 mid-terminal setae largest among caudal setae, 436 µm long, about 3 times as long as next largest nearby seta (145 µm long); other setae not longer than caudal ramus. Egg sac 880×196 µm; eggs arranged in 4 rows.

Rostrum with 1 large claw in middle and 2 small claws anteriorly (Fig. 17E). Antennule (Fig. 17F) 272 µm long and 7-segmented; armature formula: 5+claw, 15, 5, 3, 4, 2+ aesthetasc, and 7+aesthetasc; claw on first segment strongly recurved (Fig. 17E, F); setae pinnate except for following smooth ones: one on second segment, 2 on fourth, and all on distal 3 segments. Antenna (Fig. 17G) 4-segmented; first segment (coxobasis) armed with 1 inner distal seta; second segment (first endopodal segment) with 1 small seta; third segment with 7–9 small, hooklet-like spinules on inner surface and on inner distal corner 1 large, powerful claw and 2

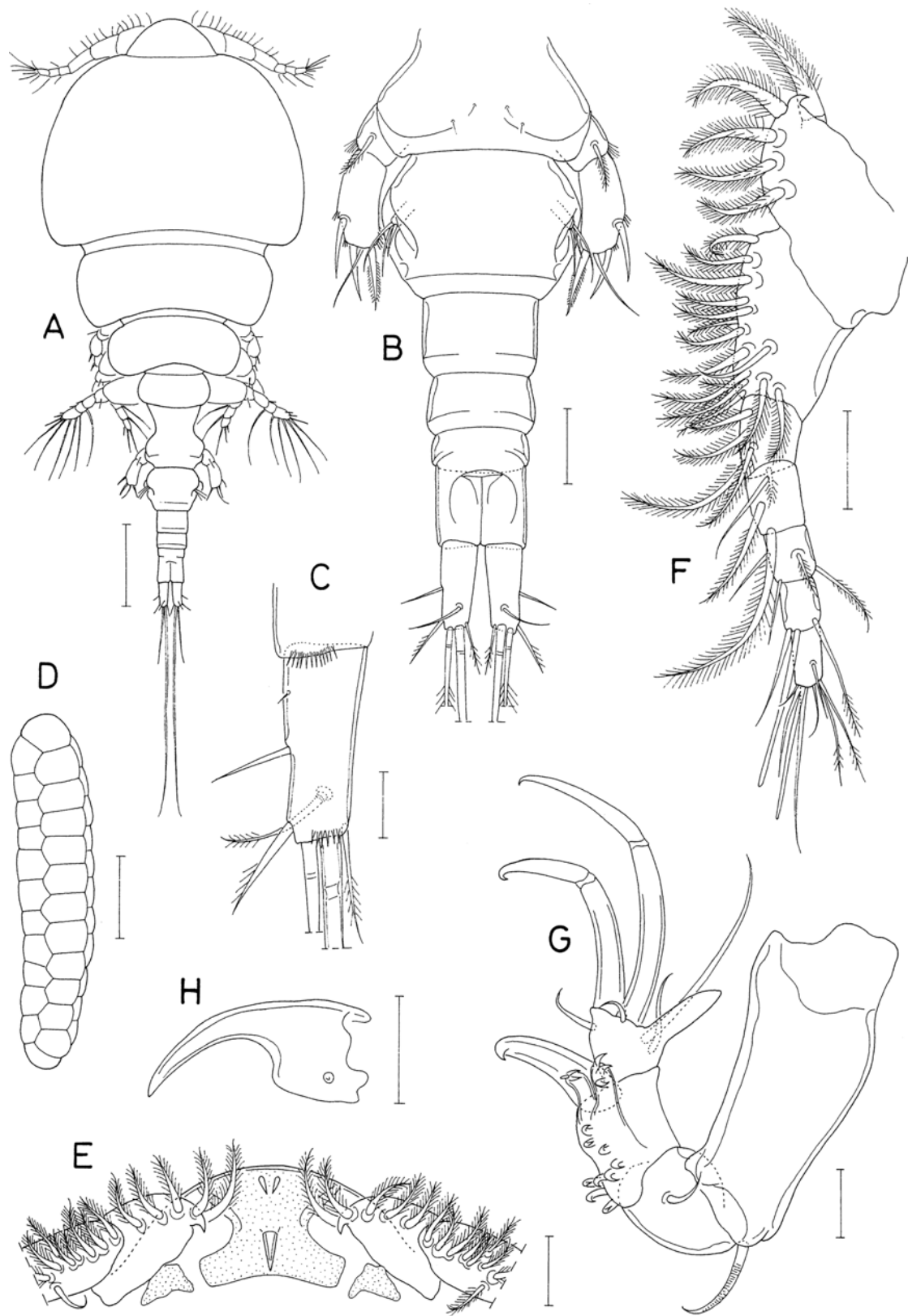


Fig. 17. *Triacanthus luteus* n. gen. n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, right caudal ramus, ventral; D, egg sac; E, rostral region, ventral; F, antennule; G, antenna; H, postantennary process. Scale bars: A, D, 0.2 mm; B, E, F, H, 0.05 mm; C, G, 0.02 mm

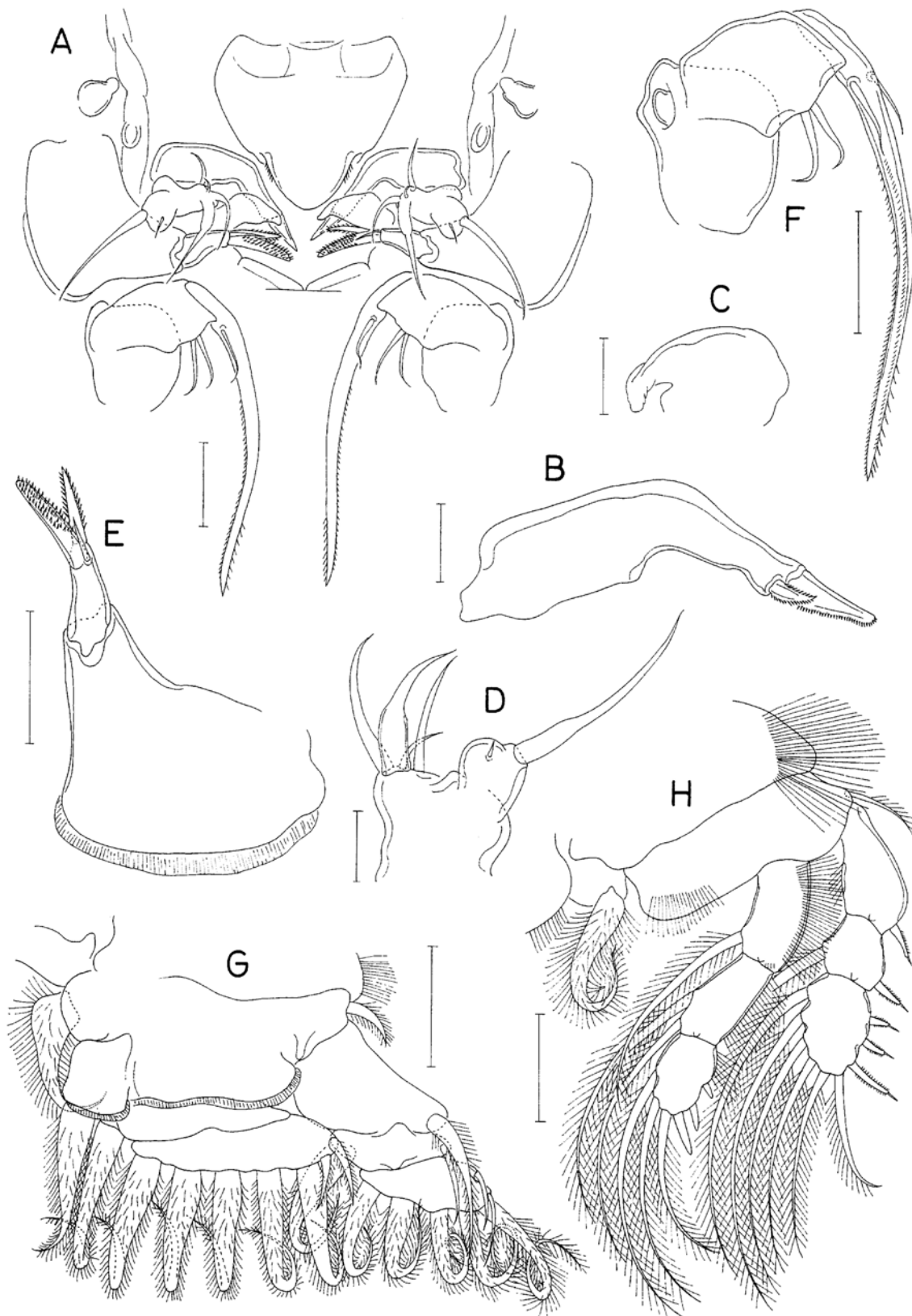


Fig. 18. *Triacanthus luteus* n. gen. n. sp., female. A, mouthparts; B, mandible; C, paragnath; D, maxillule; E, maxilla; F, maxilliped; G, leg 1; H, leg 2. Scale bars: A, E-H, 0.05 mm; B-D, 0.02 mm

pectinate processes, one of latter tipped distally by 1 setule and 1 or 2 spinules, the other with 2-4 spinules distally. Fourth segment wider than long with 1 large outer distal process, 2 large geniculate claws, and 4 setae of unequal lengths. Postantennal process (Fig. 17H) with sharp and gently curved tine.

Labrum tapering, with strongly convex posterior apex and minute spinules on lateral margins (Fig. 18A). Mandible (Fig. 18B) with 2 unequal blades apically; these blades with fine spinules along posterior margin. Paragnath (Fig. 18C) a weak lobe bearing narrow distal part. Maxillule (Fig. 18D) weakly bilobed; outer lobe with 1 minute and 1 large setae; inner lobe with 4 very unequal setae, one of which expanded in proximal half. Maxilla (Fig. 18E) 2-segmented; proximal segment unarmed but with membranous flange along proximal part of posterior margin; distal segment with 2 spiniform

elements bearing spinules and 1 small seta. Maxilliped (Fig. 18F) 4-segmented; first segment with smooth knob on expanded outer distal region and 1 subdistal seta; second segment with 2 subequal setae on inner margin; small third segment unarmed; terminal segment forming an elongated, weakly curved spiniform claw, 186 μm long, about twice as long as 2 proximal segments combined, with 2 setae proximally and rows of minute setules (or spinules) along margins.

Leg 1 (Fig. 18G) with 3-segmented exopod and 2-segmented endopod. Legs 2-4 (Figs. 18H and 19A, B) with 3-segmented rami. Leg 1 flat and laterally expanded. Leg 2 with long setules on outer side of coxa. Spines on legs 2-4 setiform. Outer spines on exopod of legs 2 and 3 tipped by setule. Leg 4 without inner seta on coxa. Armature formula of legs 1-4 as follows:

Leg 1: coxa 0-1; basis 1-1; exp. 1-0; 1-1; 2, 5; enp. 0-1; 7

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

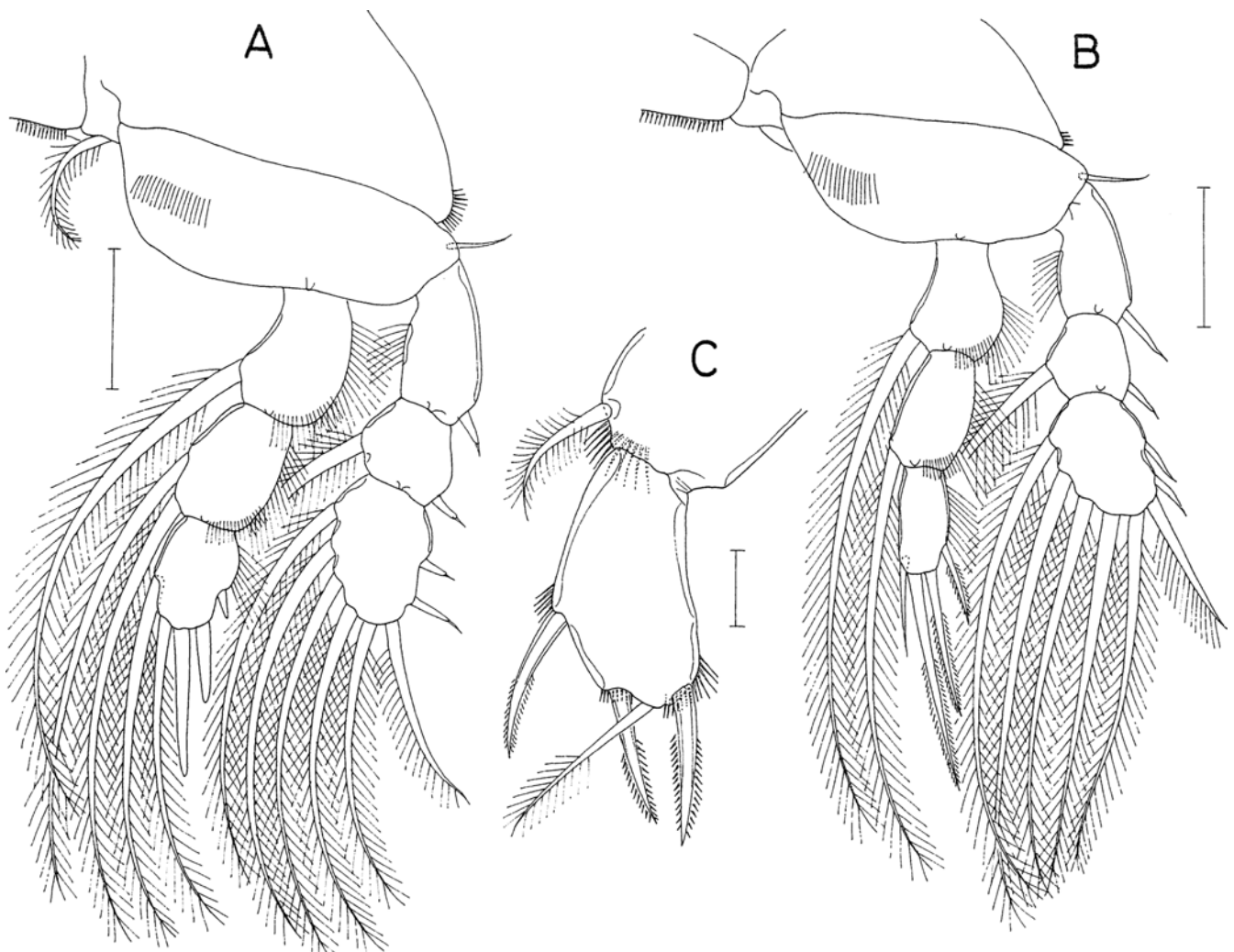


Fig. 19. *Triacanthus luteus* n. gen. n. sp., female. A, leg 3; B, leg 4; C, leg 5. Scale bars: A, B, 0.05; C, 0.02 mm

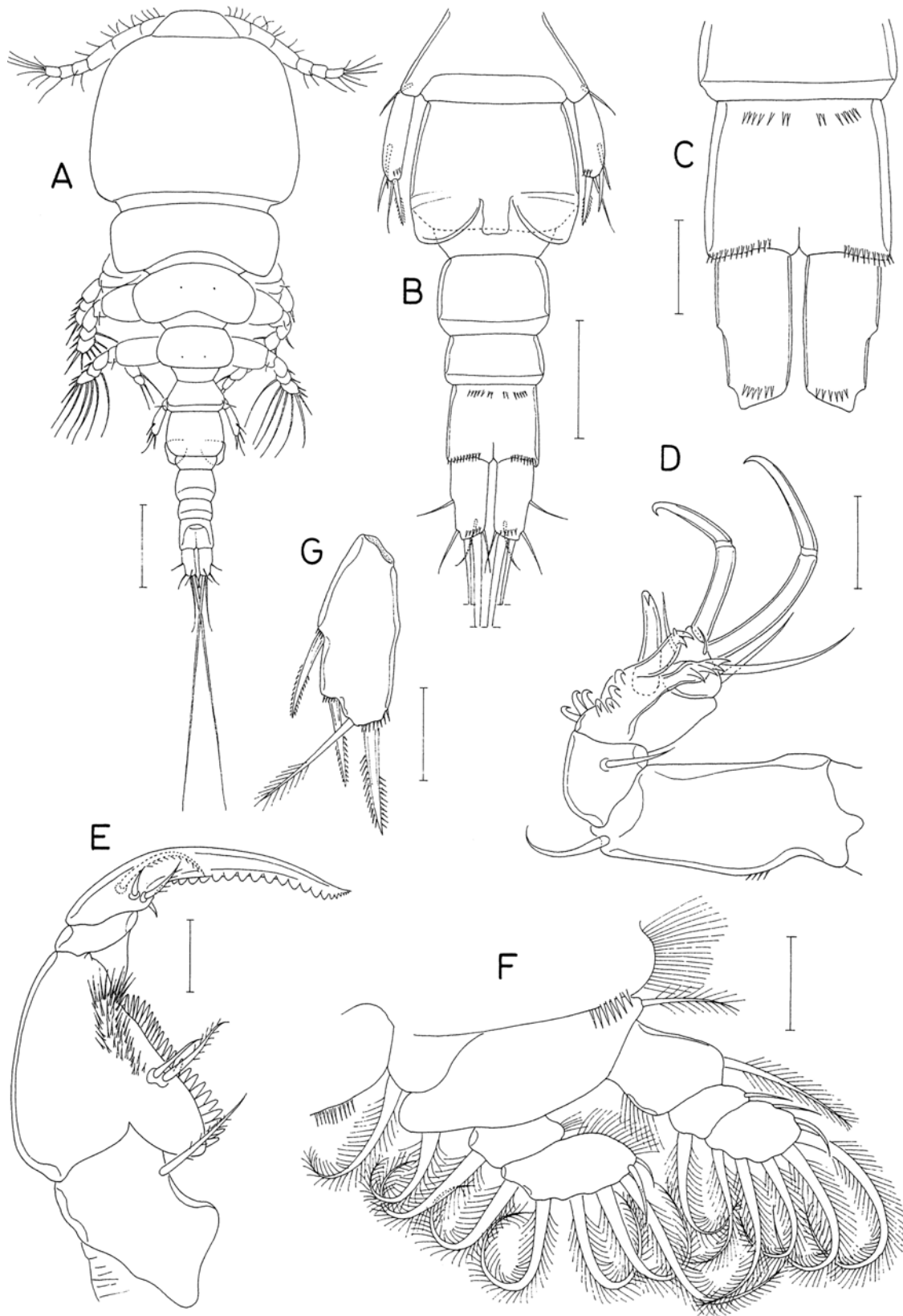


Fig. 20. *Triacanthus luteus* n. gen. n. sp., male. A, habitus, dorsal; B, urosome, ventral; C, anal somite and caudal rami, ventral; D, antenna; E, maxilliped; F, leg I. Scale bars: A, 0.1 mm; B, 0.05 mm; C-G, 0.02 mm

0-2; I, II, 3

Leg 3: coxa 0-1; basis 1-0; exp. I-0; I-1; II, 1, 5; enp. 0-1; 0-2; I, II, 2

Leg 4: coxa 0-0; basis 1-0; exp. I-0; I-1; II, 1, 5; enp. 0-1; 0-1; I, II, 1

Leg 5 (Fig. 19C) 2-segmented; proximal segment fused with somite, with 1 pinnate seta and row of setules near outer distal corner; distal free segment $69 \times 35 \mu\text{m}$ (ratio 1.97:1), armed with 3 spines (41, 36, and $41 \mu\text{m}$ long, from outer to inner) and 1 pinnate seta ($51 \mu\text{m}$ long); each spine accompanied with row of spinules near base. Leg 6 represented by a lobe bearing 3 naked setae in genital area (Fig. 17B).

Male. Body (Fig. 20A) similar to that of female but more slender. Body length $692 \mu\text{m}$. Cephalothorax $221 \times 257 \mu\text{m}$. Urosome (Fig. 20B) 5-segmented. Fifth pedigerous somite $79 \mu\text{m}$ wide. Genital somite $64 \times 72 \mu\text{m}$, with well-defined genital flap ventrally. Three abdominal somites 32×47 , 22×42 , and $32 \times 40 \mu\text{m}$, respectively. Anal somite ornamented with row of spinules on ventral surface and along posteroventral margin near base of caudal rami (Fig. 20C). Caudal ramus $34 \times 17 \mu\text{m}$ (ratio 2.0:1) and armed with 6 naked setae; seta I absent.

Rostrum and antennule as in female. Antenna (Fig. 20D) different from that of female in lacking of outer distal process on terminal segment.

Labrum, mandible, paragnath, maxillule, and maxilla as in female. Maxilliped (Fig. 20E) 4-segmented; first segment with 1 inner distal seta; second segment tapering, greatly expanded proximally, with 2 unequal inner setae, patch of spinules and longitudinal row of spines; small third segment unarmed; terminal segment forming claw bearing serrate inner margin and pointed distal end, with 4 proximal setae of different lengths.

Leg 1 (Fig. 20F) less expanded, with spinules on coxa along outer side of posteroventral margin. Legs 2-4 as in female. Leg 5 more slender than that of female; distal free segment (Fig. 20G) $41 \times 17 \mu\text{m}$ (ratio 2.41:1). Leg 6 absent.

Etymology

The specific name *luteus* is a Latin meaning “of mud”. It alludes to the benthic dwelling on the tidal flat of the fish host.

Remarks

The host of the new species, the green eel goby *Odontamblyopus lacepedii* (Temminck and Schlegel) is found in muddy-bottomed coastal waters in China, Korea and Japan. This species excavates elaborate vertical burrows

up to 90 cm long in the sea bed (Wikipedia). It does not emerge from water but stays inside the burrows during low tide (Gonzales et al., 2006).

Genus *Umazuracola* Ho, Ohtsuka and Nakadachi, 2006
Umazuracola geminus n. sp. (Figs. 21-24)

Material examined

Two ♀♀, 1 ♂ collected from gill filaments of the filefish *Stephonolepis cirrifer* (Temminck and Schlegel) purchased at a fish market in Yeosu (caught in the Strait of Korea), collected by S. Y. Moon, 23 November 2011, Holotype (♀, NIBRIV0000282428) has been deposited in the National Institute of Biological Resources (NIBR), Incheon. Dissected paratypes (1 ♀, 1 ♂) are kept in the collection of the senior author.

Description

Female. Body (Fig. 21A, B) elongated and almost cylindrical. Body length 1.38 mm (1.41 mm in holotype), excluding caudal setae. Body segmentations incomplete but each somite well defined by lateral constrictions between somites. Prosome 4-segmented, $877 \mu\text{m}$ long, and consisting of cephalothorax and second to fourth pedigerous somites. Cephalothorax (Fig. 21C) about $340 \mu\text{m}$ long; its posterior third widest ($197 \mu\text{m}$ wide), forming blunt angle on lateral margins. Three metasomites gradually shortened from anterior to posterior. Posterodorsal margin of fourth pedigerous somite projected posteriorly. Urosome (Fig. 21D) directed posteroventrally and indistinctly 5-segmented. Fifth pedigerous somite longer than preceeding somite and genital double-somite. Genital area positioned dorsally on posterior region of genital double-somite. Three free abdominal somites gradually shortened and narrowed from anterior to posterior. Caudal ramus (Fig. 21E) slightly tapering, $28 \times 18 \mu\text{m}$ (ratio 1.56:1), with 7 setae including minute outer proximal seta (seta I); all of caudal setae smooth and mid-terminal one of them much larger than other ones.

Rostrum nearly trapezoid and articulated at base from cephalothorax (Fig. 21C). Antennule (Fig. 22A) 6-segmented; first 3 segments much wider than distal 3 and obscurely segmented; armature formula: 5, 11(?), 7, 4, 2+aesthetasc, and 7+aesthetasc. Antenna (Fig. 22B) 4-segmented. First segment (coxobasis) broadest and longest among segments, with 1 small mediobasal seta. Second segment (first endopodal segment) with 1 small medial seta in distal third and

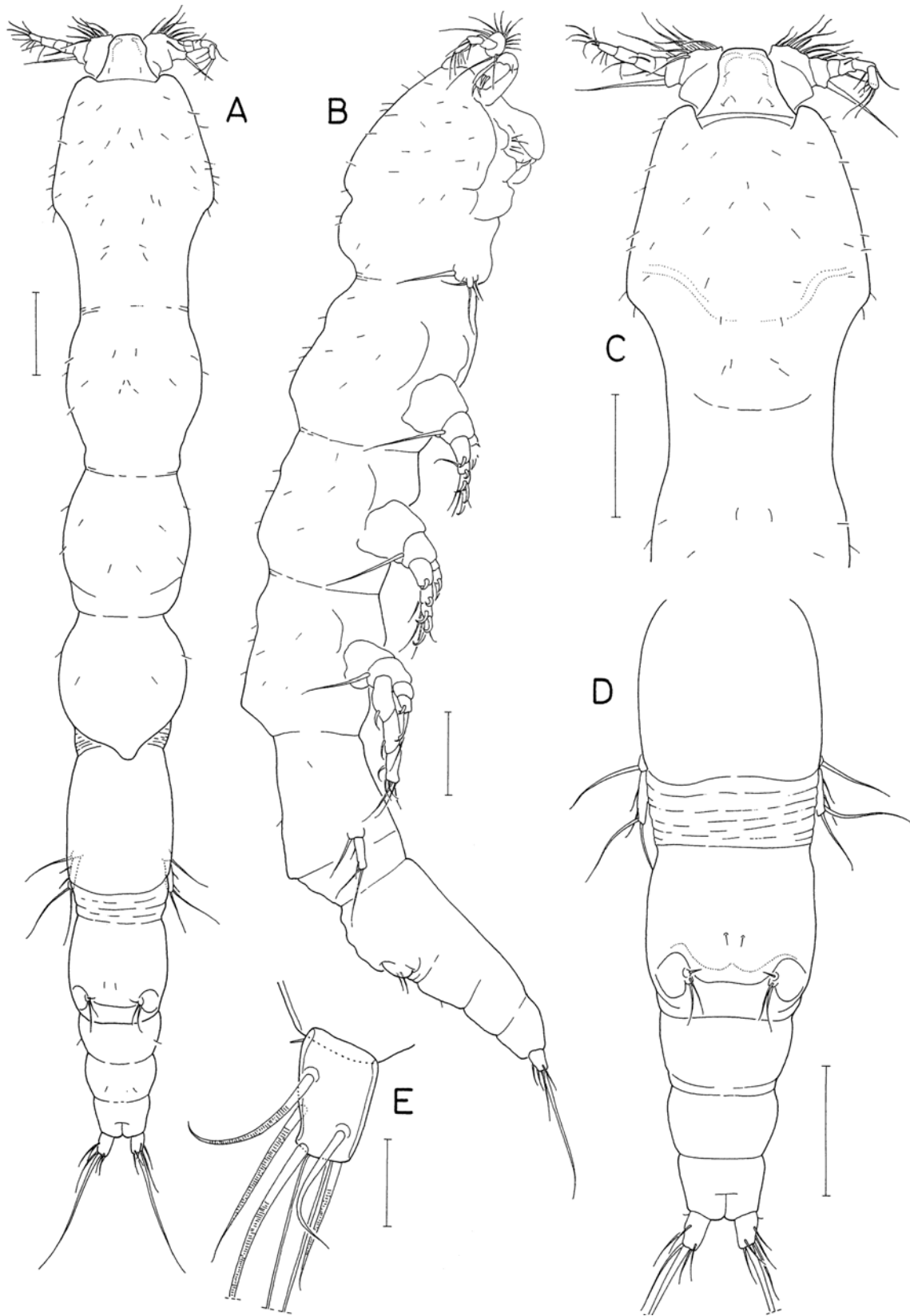


Fig. 21. *Umazuracola geminus* n. sp., female. A, habitus, dorsal; B, habitus, right; C, cephalothorax, dorsal; D, urosome, dorsal; E, left caudal ramus, dorsal. Scale bars: A-D, 0.1 mm; E, 0.02 mm

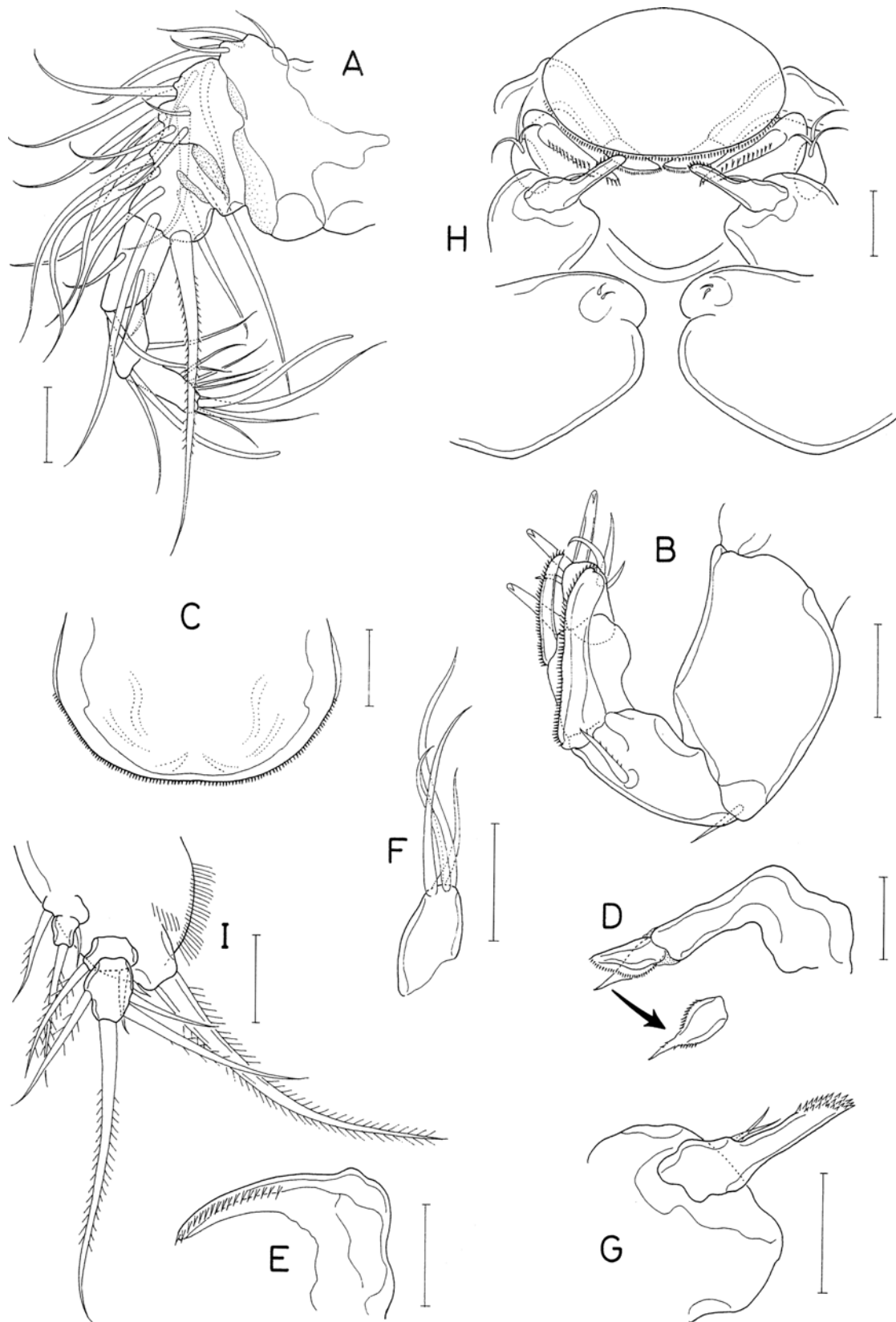


Fig. 22. *Umazuracola geminus* n. sp., female. A, antennule; B, antenna; C, labrum; D, mandible; E, paragnath; F, maxillule; G, maxilla; H, mouthparts; I, leg 1. Scale bars: 0.02 mm for all

mediodistally 1 large lamella-like spinulose element. Third segment with 1 spinulose spine and 1 claw. Fourth segment armed with 2 claws and 4 simple setae.

Labrum (Fig. 22C) nearly hemicircular; posterior margin rimmed with minute spinules. Mandible (Fig. 22D) apically with 2 spinulose blades, one of which pointed apically. Paragnath (Fig. 22E) curved in right angle, with broad proximal half and narrow distal half bearing row of spinules. Maxillule (Fig. 22F) as a lobe armed distally with 4 naked setae. Maxilla (Fig. 22G) 2-segmented. Proximal segment broad and unarmed. Distal segment elongate, straight, with 2 small setae in midlength and spinulose pad distally. Maxilliped a large, unsegmented lobe (Fig. 22H), weakly bilobed distally, with 2 minute setae subdistally.

Leg 1 (Fig. 22I) rudimentary and consisting of protopod and 2-segmented exopod and endopod. Outer seta on protopod enlarged. Proximal segment of endopod fused with protopod. Legs 2-4 (Fig. 23A-C) with well-delimited coxa and basis, and 3-segmented exopod and 2-segmented endopod. Outer seta on basis of legs 2-4 large and unilaterally pinnate along outer margin. Exopod of legs 2-4 much longer than endopod. Outer spines on exopod of legs 2 and 3 serrate along outer margin and with subdistal setule. Distal spines on endopod of leg 4 serrate along outer margin. Distal margin of basis of legs 2-3 with membranous flange. Endopodal segments and proximal segment(s) of exopod in legs 2-4 with following numbers of membranous flanges: exp. 2; 0; 0; enp. 1; 2 in leg 2; exp. 3; 0; 0; enp. 2; 2 in leg 3; and exp. 2; 2; 0; enp. 1; 2 in leg 4. Exopod of leg 4 elongated; its terminal segment with spinulose knob distally. Armature formulae of legs 1-4 as follows:

Leg 1: protopod 1-0; exp. 1-1; 3, 1, 1; enp. 0-1; 1, 1, 0

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

Leg 3: coxa 0-0; basis 1-0; exp. I-0; I-1; III, I, 3; enp. 0-1; I, II, 0

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

Leg 5 (Fig. 23D) 2-segmented. Proximal segment fused with somite, with 1 outer seta. Distal segment (exopod) $42 \times 13 \mu\text{m}$ (ratio 3.23:1) and armed with 2 outer lateral and 2 large distal setae; all of these 4 setae naked. Leg 6 represented by 1 spiniform seta and 2 naked setae on a lobe accompanied by a shield-like outer plate in genital area (Fig. 23E).

Male. Body (Fig. 24A) similar in form to that of female. Body length 1.01 mm. Urosome (Fig. 24B) clearly 6-segmented. Length of third abdominal somite much shorter ventrally than dorsally and its posterodorsal margin obscure (Fig. 24C). Anal somite with several spinules mid-distally near base of caudal rami. Caudal ramus $29 \times 16 \mu\text{m}$ (ratio 1.81:1).

Rostrum as in female. Antennule 7-segmented, with armature formula 5, 14, 7, 4, 2+aesthetasc, and 7+aesthetasc. Antenna as in female.

Labrum (Fig. 24D) with strongly convex, smooth posterior margin and large spinulose papilla on ventral surface. Mandible, maxillule and maxilla as in female. Maxilliped (Fig. 24E) 4-segmented; first segment unarmed; second segment with 2 small setae and longitudinal rows of spinules on inner surface; short third segment unarmed; terminal segment forming a long, strongly curved claw bearing 1 subterminal setule and 4 proximal setae.

Legs 1-3 showing same armature formulae as those of female, but ornamentations of rami of legs 2 and 3 different from those of female. Membranous flanges absent on exopod and endopod of legs 2-4. Distal segment of endopod of leg 1 with patch of spinules on mid-distal region and near base of outer spine (Fig. 24F). Leg 4 with armature formula: I-0; I-1; II, I, 3 on exopod (Fig. 24G); endopod as in female.

Leg 5 (Fig. 23F) with exopod shorter than that of female, $37 \times 13 \mu\text{m}$ (ratio 2.85:1), with setules on proximal and distal segments. Leg 6 absent.

Etymology

The specific name *geminus* is a Latin meaning “twin” and alludes to a close similarity between the new species and the type species, *U. elongatus*.

Remarks

Umazuracola elongatus Ho, Ohtsuka and Nakadachi, 2006, the type species of the genus, was described as a new genus and species, based on the specimens discovered from the body surface of the black scraper, *Thamnaconus modestus* (Günther). They proposed a new family Umazuracolidae to accommodate that new genus, but Huys et al. (2012) transferred *Umazuracola* to the Taeniacanthidae after an analysis of rDNA of *U. elongatus* and a comparing it with related species.

U. geminus n. sp. is very similar to *U. elongatus* in the body form and major morphological characters. However, they are not the same species, because they show different morphological details as follows: (1) The lateral margins of the cephalothorax are pronounced in the new species but linear in *U. elongatus*; (2) the urosome is segmented (although segmentation is incomplete in the female) in the new species but unsegmented in both sexes of *U. elongatus*; (3) the antennule is 6-segmented in the new species but 7-segmented in *U. elongatus*; (4) the proximal segment of the

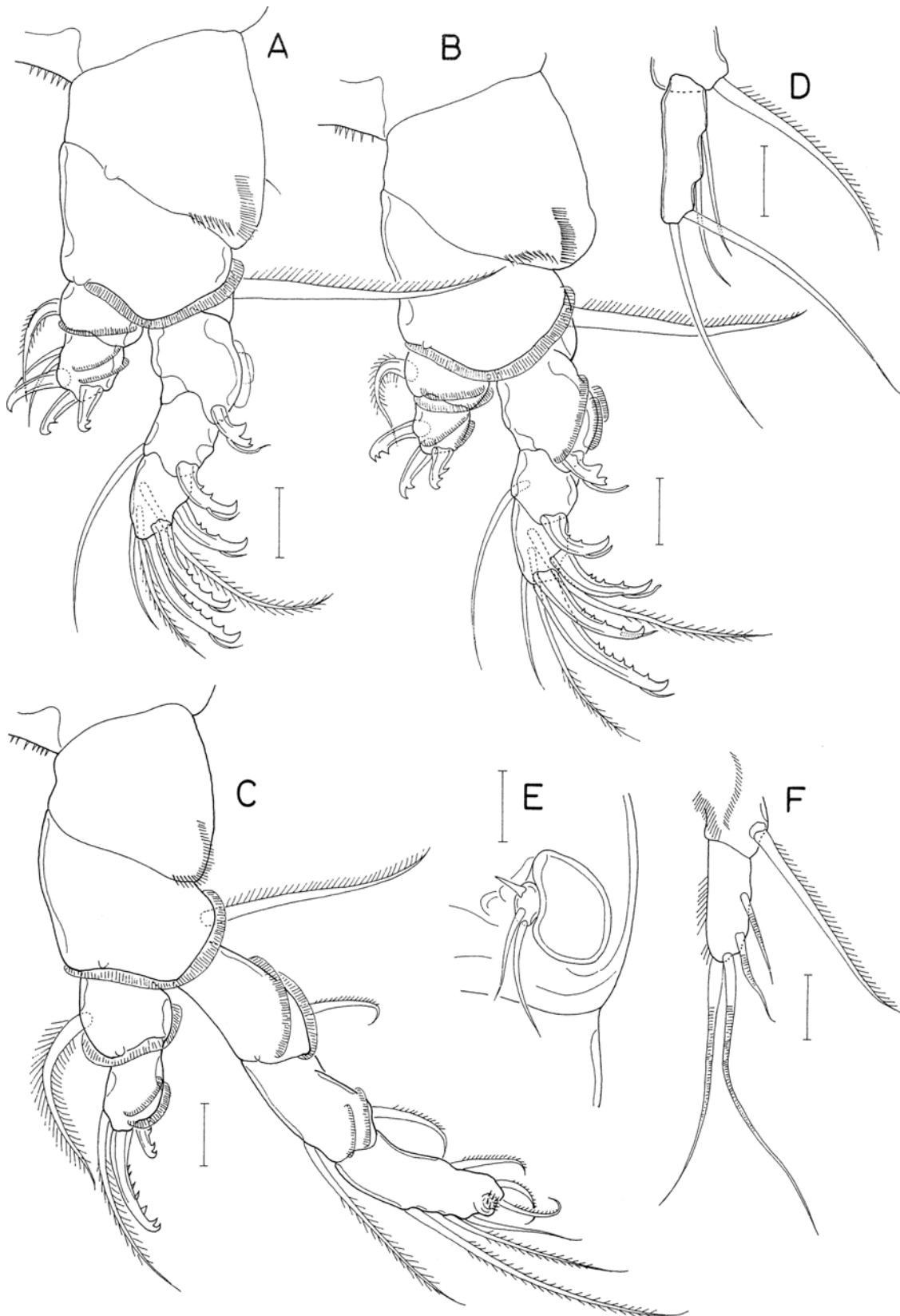


Fig. 23. *Umazuracola geminus* n. sp. Female: A, leg 2; B, leg 3; C, leg 4; D, leg 5; E, right genital area. Male: F, leg 5. Scale bars: 0.02 mm for all

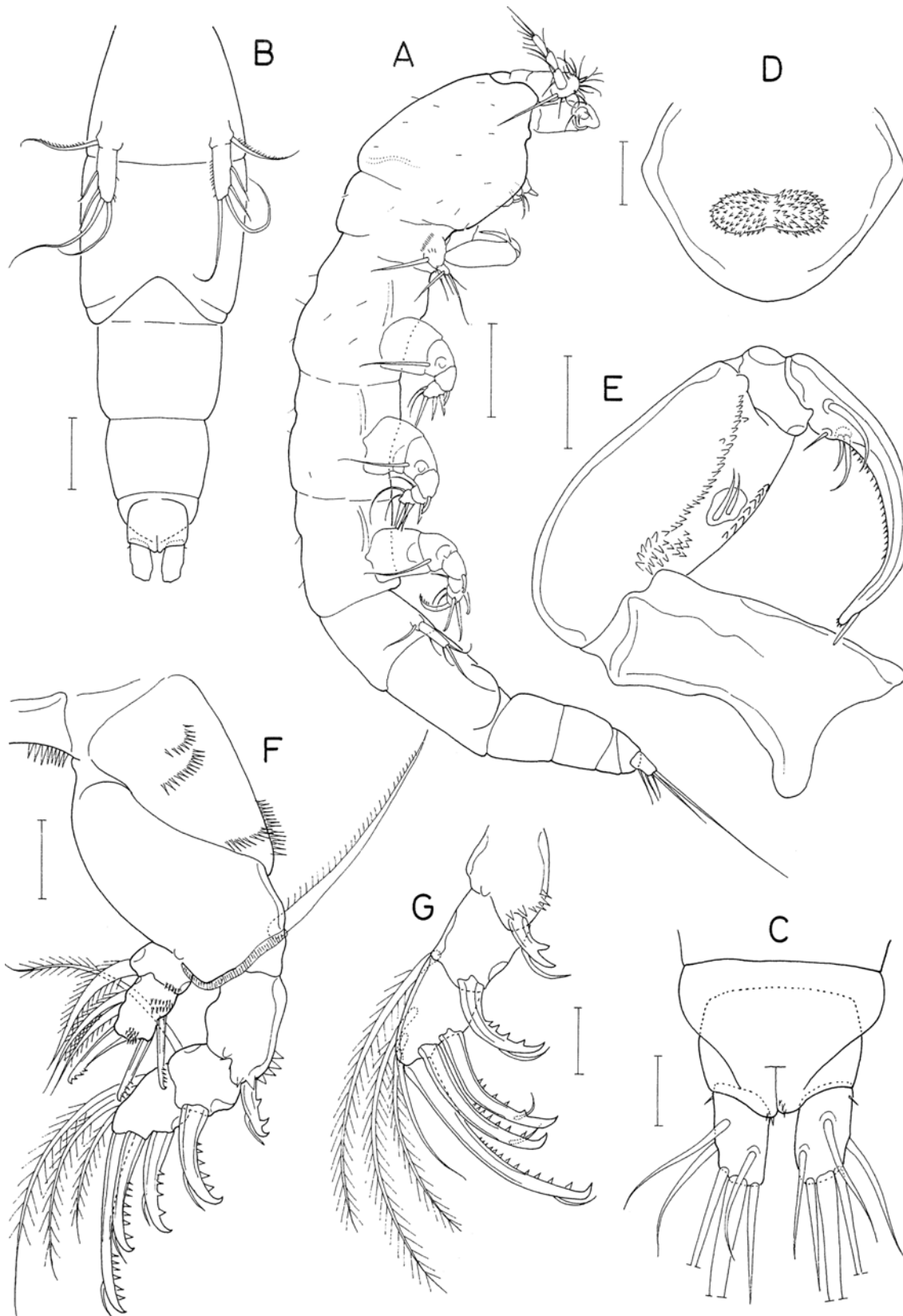


Fig. 24. *Umazuracola geminus* n. sp., male. A, habitus, right; B, urosome, ventral; C, anal somite and caudal rami, dorsal; D, labrum; E, antenna; F, leg 2; G, exopod of leg 4. Scale bars: A, 0.1 mm; B, 0.05 mm; C-G, 0.02 mm

exopod of leg 1 has an inner seta but none in *U. elongatus*; (5) the endopod of leg 1 is 2-segmented but unsegmented in *U. elongatus*; (6) the second exopodal segment of leg 4 has an inner seta but lacks in *U. elongatus*; and (7) the exopod of male leg 5 is 2.85 times as long as wide but more elongate, about 5 times as long as wide in *U. elongatus* when measured based on the illustration given by Ho et al. (2006).

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