

Three Aetideid Species of Copepods (Copepoda: Calanoida: Aetideidae) from East Sea of Korea

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ABSTRACT

Three aetideid copepods collected from the East Sea of Korea are described: *Bradyidius angustus* (Tanaka, 1957), *Gaetanus minutus* (Sars, 1907), and *Aetideus acutus* Farran, 1929. The former two species are new to the Korean copepod fauna. The sequences of cytochrome *c* oxidase subunit 1 were determined to be the molecular characteristics of these three species.

Keywords: Aetideidae, *Aetideus acutus*, *Bradyidius angustus*, *Gaetanus minutus*, cytochrome *c* oxidase subunit 1, Korea

INTRODUCTION

Aetideid copepods are relatively large-sized marine calanoids with most found in the deep sea between the mesopelagic and bathypelagic depths, even though a few species are known to be epipelagic (Boxshall and Halsey, 2004). Copepods in this group are mixed feeders and their mouthparts are well adapted for seizing and filtration (Arashkevich, 1969).

The family Aetideidae consists of 213 known species in 30 genera worldwide (Razouls et al., 2010) whereas only three species have been reported from Korea: *Aetideus acutus* Farran, 1929, *Gaetanus brevisrostris* Brodsky, 1950 and *G. minor* Farran, 1905 (see Kim, 1985).

In this study, the following three aetideid species are reported from the East Sea of Korea, based on the samples collected by vertical towing of a plankton net from the surface level up to 300 m depth: *Bradyidius angustus* (Tanaka, 1957), *Gaetanus minutus* (Sars, 1907), and *Aetideus acutus* Farran, 1929. Among them, *B. angustus* and *G. minutus* are new records of Korean fauna and are known as mesopelagic species (Tanaka, 1957; Park, 1975; Markhaseva, 1996). Korean *Aetideus acutus* was first reported by Kim (1985) with a short description. This paper redescribes this species to provide additional taxonomical information.

The sequences of the mitochondrial cytochrome *c* oxidase subunit 1 (CO1) for these three species are also provided as supplementary data for their molecular characteristics.

MATERIALS AND METHODS

Morphological taxonomy

The samples were collected by vertical tows (0-300 m) using a plankton net (45 cm mouth diameter, 330 μ m mesh) at three sites in the East Sea. The specimens were preserved in 95% ethanol immediately after collection. The appendages of the specimens were dissected in glycerol on a cavity slide glass under a stereomicroscope (Olympus SZX-7; Olympus, Tokyo, Japan) and observed using a microscope (Leica DM 2500; Leica Microsystems, Wetzlar, Germany). All drawings and measurements were made using a drawing tube. Voucher specimens were deposited in the Department of Biological Sciences, Inha University, South Korea.

The Roman and Arabic numerals in the armature formula represent spines and setae, respectively.

Molecular taxonomy

Single antennas were removed from each specimen for genomic DNA extraction. The other body parts were used for the morphological observation. The genomic DNA was extracted using a RED Extract-N-Amp Tissue PCR kit (Sigma, St. Louis, MO, USA) according to the manufacturer's instructions. Mitochondrial CO1 was amplified by PCR using universal primers of LCO1490 and HCO2198 (Folmer et al., 1994). PCR amplification was carried out under the following conditions: 3 min at 94°C, 35 cycles of 95°C for 15 sec, 48°C for 30 sec, and 72°C for 90 sec, with a final 72°C ex-

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tension reaction for 7 min. The PCR products were gel-purified using a QIAquick® Gel Extraction Kit (Qiagen, Valencia, CA, USA) and sequenced with an ABI PRISM® 3700 DNA Analyzer using a BigDye Terminator Cycle Sequencing Ready Reaction Kit (Applied Biosystems, Foster City, CA, USA).

SYSTEMATIC ACCOUNTS

Order Calanoida Sars, 1903

Family Aetideidae Giesbrecht, 1893

¹*Genus *Aetideus* Brady, 1883

²**Aetideus acutus* Farran, 1929 (Figs. 1-3)

Aetideus acutus Farran, 1929: 228, fig. 5; Tanaka, 1957: 36, fig. 25; Bradford and Jillett, 1980: 14, fig. 5.

Euaetideus acutus: Tanaka and Omori, 1970: 110; Kim, 1985: 60, fig. 14.

Material examined. Korea: 1 ♀, East Sea, 36° 30'N, 131° 20'E, Oct 2009.

Redescription. Female: Body as in Fig. 1A, B. Body length 1.75 mm. Prosome about 3.8 times as long as urosome. Cephalosome and first pedigerous somite fused forming cephalothorax. Fourth and fifth pedigerous somites also fused with each other. Anterior part of cephalosome with dorsal crest. In dorsal view, posterior corners of last pedigerous somite extending to 2/3 region of second abdominal somite. Rostrum (Fig. 1C) strong and bifurcate, with furcations confluent at base. Concave area near bases of furcations with a pair of small, rounded projections.

Antennule 24-segmented, reaching slightly beyond end of caudal rami. Antenna (Fig. 1D), coxa with 1 seta; basis with 2 setae. Endopod 2-segmented; first segment with 2 distal setae; second segment with 8 inner and 7 outer setae. Exopod 7-segmented; first segment unarmed; second segment with 3 setae; third to sixth segments with 1 seta each; distal segment with 3 setae.

Mandible (Fig. 2A, E). Gnathobase with 14 teeth and 1 long and 1 short setae. Basis with 2 short setae. Endopod 2-segmented; first segment with 2 setae; second segment with 10 setae. Exopod 5-segmented; first segment unarmed; second to fourth segments with 1 seta, each distal segment with 3 setae.

Maxillule (Fig. 2B). Arthrite with 5 posterior setae and 9 spines. Coxal epipodite with 7 large and 2 minute setae. Coxal endite with 3 setae; Basal endites with 4+4 setae. Endopod with 12 setae. Exopod with 11 setae.

Maxilla (Fig. 2C). First and second praecoxal endites and first coxal endite each with 2 long and 1 short spinulose setae and row of spinules on one side. Second coxal endite with 1 long and 1 short spinulose setae and 1 thickened seta, and row of spinules on one side. First basal endite with 3 setae, one of them thickened and claw-like. Endopod with 6 setae.

Maxilliped (Fig. 2D). Coxa with 8 setae. Basis with 3 medial setae. Endopod 6-segmented; first segment with 2 setae; second to sixth segments with 4, 4, 3, 3+1, and 4 setae respectively.

Leg 1 (Fig. 3A). Coxa with inner hairs sub-distally. Basis with hairs and 1 distal seta on inner margin. Endopod 1-segmented; outer margin swollen with 1 row of spinules and 5 setae. Exopod 3-segmented, first segment without outer spine, second with 1 inner seta and 1 outer spine, distal segment with 4 setae and 1 outer spine.

Leg 2 (Fig. 3B). Coxa with inner hairs and 1 inner seta. Basis unarmed. Endopod incompletely 1-segmented, with 6 setae. Exopod 3-segmented; first and second segments with 1 inner seta and 1 outer spine respectively; distal segment with 3 spines, 4 setae and 1 serrated spine bearing 12 teeth on outer edge.

Leg 3 (Fig. 3C). Coxa with 1 inner seta. Endopod 3-segmented; first segment with 1 inner seta; second and third segments with 1 inner seta, 5 setae, respectively. Exopod 3-segmented; distal segment with 3 spines, 4 setae and 1 serrated spine bearing 13 outer teeth.

Leg 4 (Fig. 3D) similar to leg 3 except for coxa with 1 inner seta and 5 small spines (Fig. 3E) and distal segment of exopod with 14 outer teeth. Armature formula of swimming legs 1-4 as follows:

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

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

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

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

Male: Not found.

Distribution. East Sea (Korea), New Zealand, South Atlantic, Izu region (Japan), and tropical Pacific Ocean.

Remarks. This species is quite rare and with only a few specimens have been reported (Chen and Zhang, 1965; Tanaka and Omori, 1970; Kim, 1985). Only a single female specimen was found.

The genus *Aetideus* Brady, 1883 consists of 11 species. *Aetideus acutus* is quite similar to *A. giesbrechti* Cleve, 1904 in terms of the following characteristics: the anterior part of the cephalosome bears a crest and the coxa of leg 4 has 5 short spines. On the other hand, in the dorsal view, the base

Korean name: ¹*참수리노벌레속 (신칭), ²*참수리노벌레

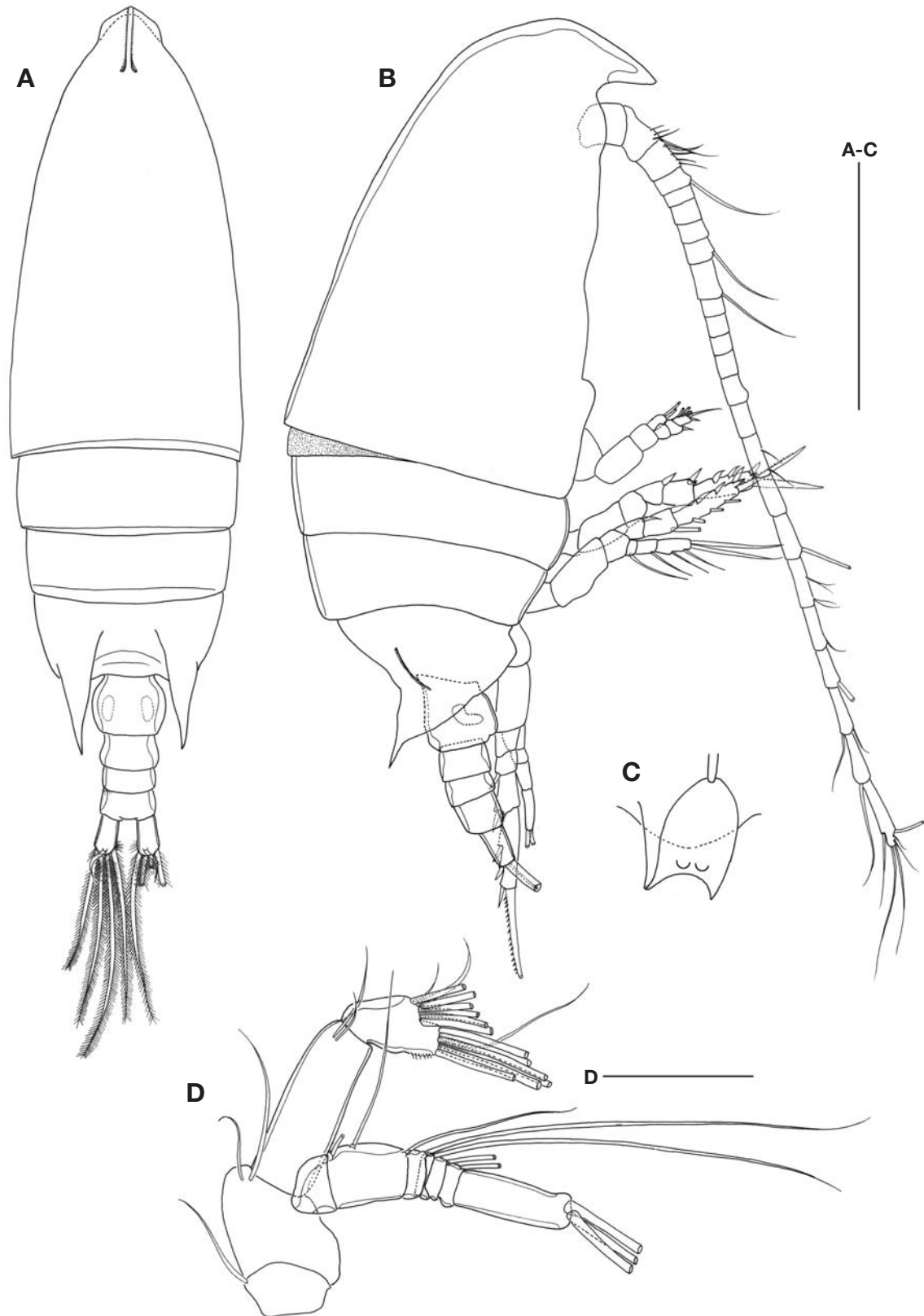


Fig. 1. *Aetideus acutus* Farran, female. A, Habitus, dorsal; B, Habitus, lateral; C, Rostrum; D, Antenna. Scale bars: A-C=0.5 mm, D=0.1 mm.

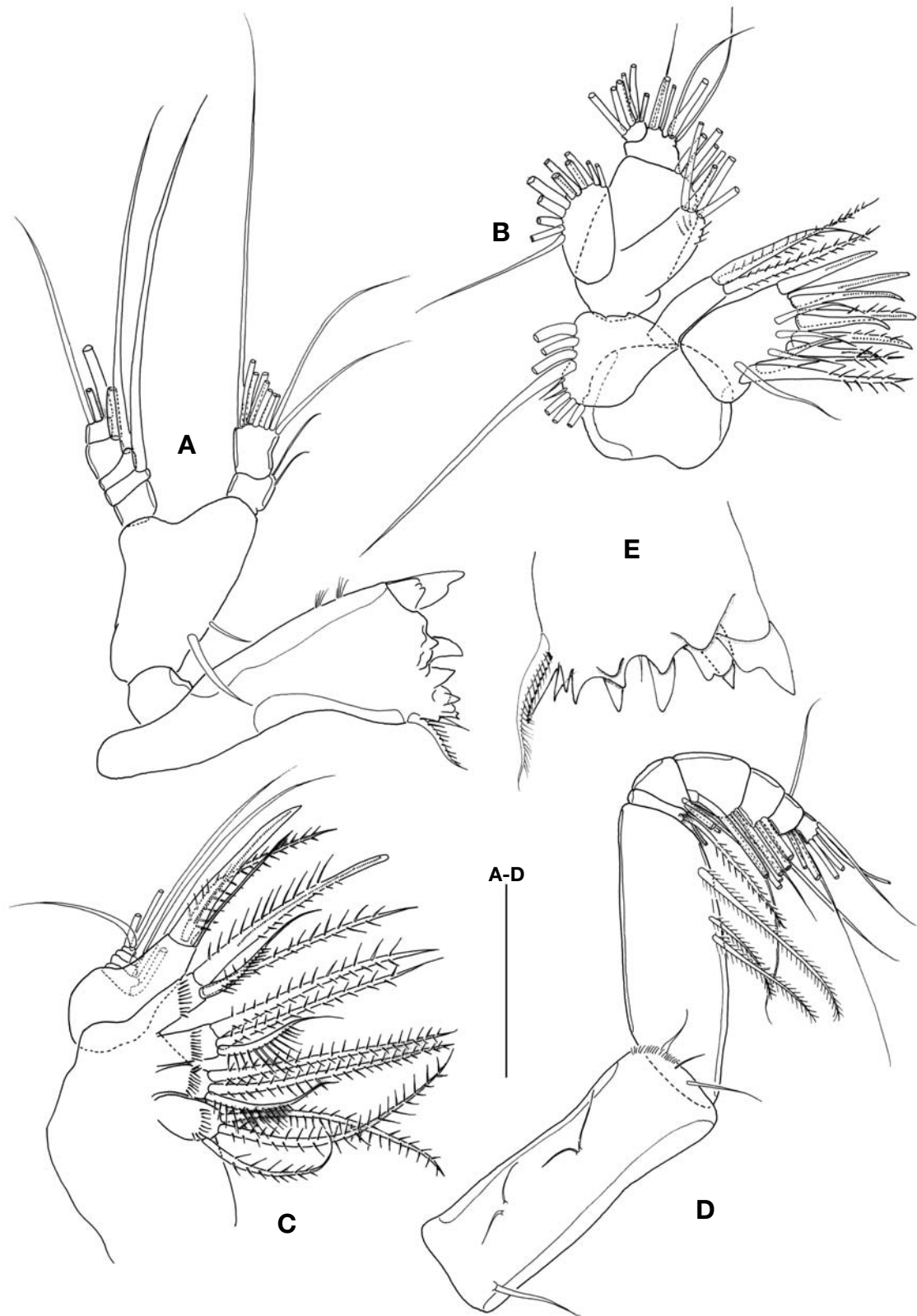


Fig. 2. *Aetideus acutus* Farran, female. A, Mandible; B, Maxillule; C, Maxilla; D, Maxilliped; E, Gnathobase of the mandible. Scale bar: A-D=0.1 mm.

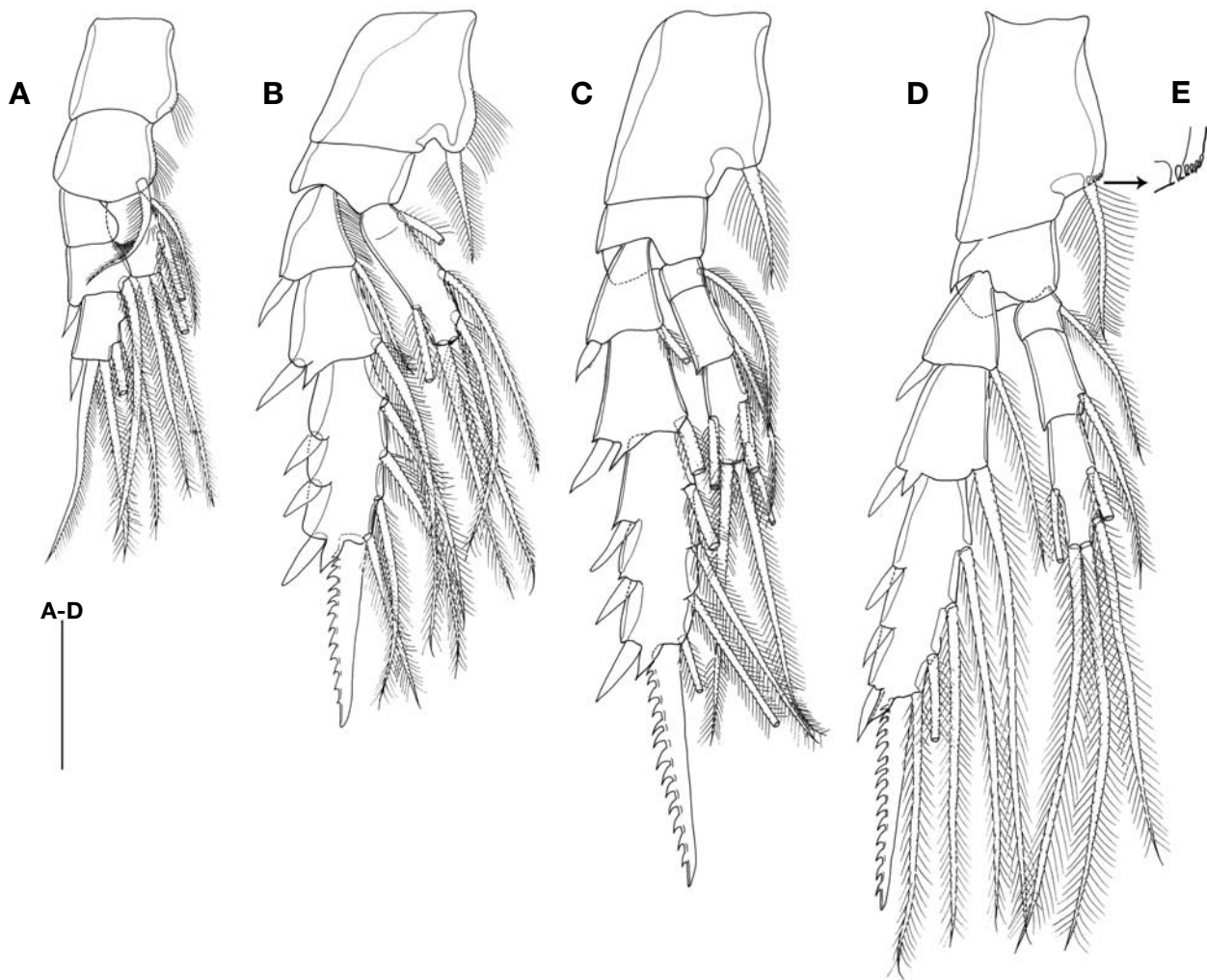


Fig. 3. *Aetideus acutus* Farran, female. A, Leg 1; B, Leg 2; C, Leg 3; D, Leg 4; E, Posterior coxal margin of leg 4. Scale bar: A-D=0.1 mm.

of the rostrum is not protruded from the top of the head in the female of *A. giesbrechti*, whereas it is protruded in *A. acutus*.

The Korean specimen is congruent with that of the original description with minor differences: the last pedigerous somite of the present specimen has a process that reaches the 2/3 region of the second abdominal somite, but that of the type specimen is longer than the Korean specimen and extends beyond the second abdominal somite.

The CO1 sequence of the Korean specimen showed 99% similarity to that of the previously known sequence of *A. acutus* (Genbank accession no: EU599526).

¹*Genus *Bradyidius* Giesbrecht, 1897

²**Bradyidius angustus* (Tanaka, 1957) (Figs. 4, 5)

Undinopsis angustus Tanaka, 1957: 45, fig. 29.

Bradyidius angustus: Markhaseva, 1996: 70, fig. 49.

Material examined. Korea: 1 ♂, East Sea, 36°05'N, 131°40'E, Jun 2009.

Redescription. Male: Body as Fig. 4A. Body length 1.57 mm. Prosome about 2.3 times as long as urosome. Cephalosome and first pedigerous somite fused forming cephalothorax. Posterior corners of last pedigerous somite extending to distal margin of first abdominal somite. Rostrum (Fig. 4B) bifurcate and weakly divergent. Caudal rami about 1.3 times longer than width.

Antennule (Fig. 4C). 22-segmented, reaching posterior

Korean name: ¹*두갈래이마빨노벌레속 (신칭), ²*두갈래이마빨노벌레 (신칭)

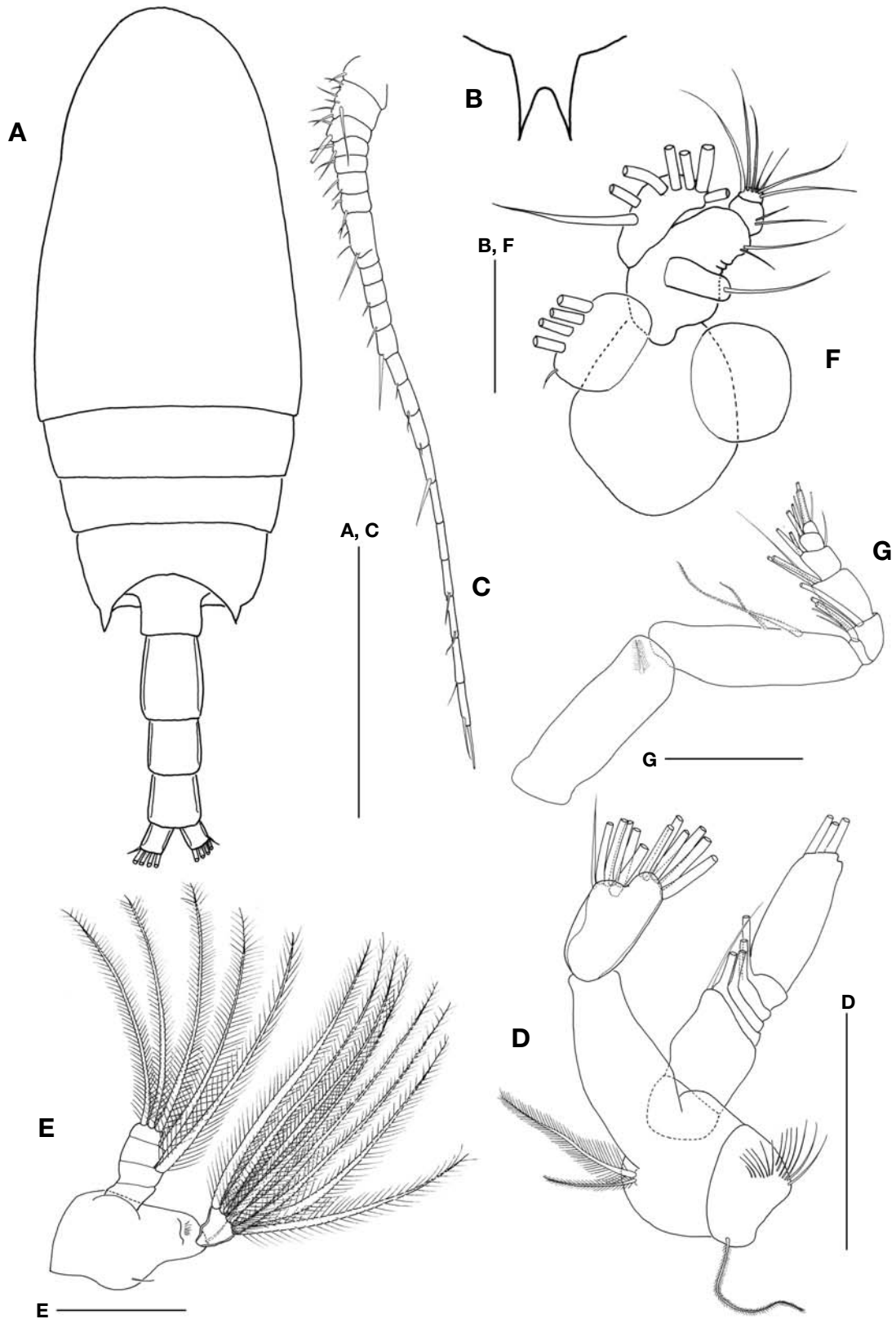


Fig. 4. *Bradyidius angustus* (Tanaka), male. A, Habitus, dorsal; B, Rostrum; C, Antennule; D, Antenna; E, Mandible; F, Maxillule; G, Maxilliped. Scale bars: A, C=0.5 mm, D, E, G=0.1 mm, B, F=0.05 mm.

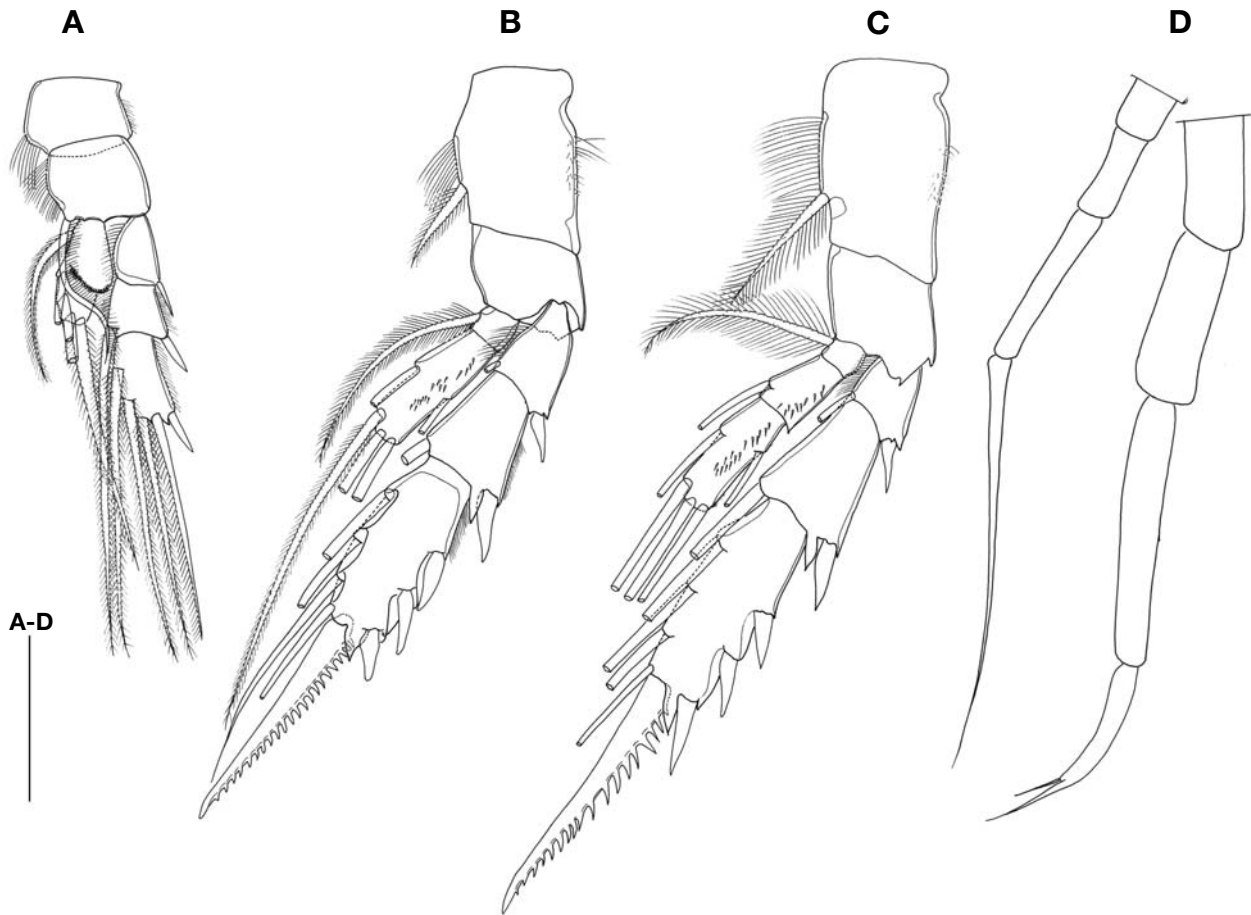


Fig. 5. *Bradyidius angustus* (Tanaka), male. A. Leg 1; B, Leg 2; C, Leg 3; D, Leg 5. Scale bar: A-D=0.1 mm.

border of genital somite.

Antenna (Fig. 4D). Coxa with 1 long seta and hairs; basis with 2 setae. Endopod 2-segmented; first segment unarmed; second segment with 6 inner and 6 outer setae. Exopod 7-segmented; first segment unarmed; second to sixth segments with 1 seta each; distal segment with 3 setae.

Mandible (Fig. 4E). Basis with 2 short setae. Endopodal segment with 8 setae. Exopod indistinctly 4-segmented; first segment unarmed; second and third segments with 1 seta, respectively; distal segment with 3 plumose setae.

Maxillule (Fig. 4F). Arthrite unarmed. Coxal endite degenerate. Coxal epipodite with 4 large and 1 minute setae. Basal endites with 1, 2 setae respectively. Endopod with 9 setae. Exopod with 7 setae.

Maxilla strongly reduced in size and structure.

Maxilliped (Fig. 4G). Coxa with 1 distal seta. Basis with 2 medial setae. Endopod 6-segmented; first segment with 1 seta; second to sixth segments with 4, 3, 2+1, 2, and 4 setae respectively.

Leg 1 (Fig. 5A). Coxa with hairs along outer margin and

distal part of inner margin. Basis with hairs and 1 distal seta on inner margin. Endopod 1-segmented; outer margin swollen with 1 row of spinules and 5 setae. Exopod 3-segmented; first segment with inner hairs and 1 outer spine; second segment with 1 inner seta and 1 outer spine; distal segment with 4 setae and 1 outer spine.

Leg 2 (Fig. 5B). Coxa with hairs on both margins and 1 inner seta. Basis unarmed. Endopod 2-segmented; first segment with 1 inner seta; second segment with minute spinules on posterior surface and 5 setae. Exopod 3-segmented; first and second segments with 1 inner seta and 1 outer spine, respectively; distal segment with 3 spines, 4 setae, and 1 serrated spine bearing 22 teeth on outer edge.

Leg 3 (Fig. 5C). Coxa and basis same as in leg 2. Endopod 3-segmented; first segment with 1 inner seta; second and third segments with 1 inner seta and 5 setae, respectively and minute spinules on posterior surface. Exopod 3-segmented; first and second segments with 1 inner seta and 1 outer spine; distal segment with 3 spines, 4 setae, and 1 serrated spine with 17 outer teeth. Armature formula of swimming

legs 1-4 as follows:

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

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

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

Leg 4, missing.

Leg 5 (Fig. 5D) uniramous and asymmetrical; right and left exopod without seta and spine; third segment of right exopod spiniform, about 2.4 times longer than second segment; third segment of left exopod forming a sharp process with 1 subdistal seta.

Female: Not found.

Distribution. The East Sea (Korea), Sagami, and Suruga (Japan).

Remarks. Sixteen species have been recorded in the genus *Bradyidius* Giesbrecht, 1897 thus far (Boxshall and Halsey, 2004). The male of *B. angustus* is most similar to *B. hirsutus* Bradford, 1976 and *B. spinifer* Bradford, 1969 in having uniramous leg 5 with almost equal lengths of the left and right exopods. On the other hand, *B. angustus* can be distinguished from the two congeners by the following characteristics: first outer spine on leg 1 exopod of *B. hirsutus* is short, whereas that of *B. angustus* is long, exceeding half of the length of the next segment; the endopod of legs 2-4 of *B. spinifer* has extremely dense spinules, whereas *B. angustus* has moderately dense spinules.

The Korean specimen coincides well with the Japanese specimen of the original description (Tanaka, 1957). Nevertheless, the Korean and Japanese specimens show the following differences: 1) Tanaka's specimen has a short outer spine on the first exopodal segment of leg 1, whereas the same spine of our specimen extends to the middle of the second segment; 2) according to Tanaka's description, the serrated spines of legs 2 and 3 each have 24 and 25 outer teeth, whereas the specimen in the present study has 22 and 18, respectively; and 3) the original illustration shows that the first endopodal and exopodal segments of the antenna have a distal seta, respectively, but no seta was found in the present specimen. These differences are considered variations within the species.

The partial CO1 sequence of genus *Bradyidius* was determined for the first time and registered at GenBank (Genbank accession no: GU319976).

¹*Genus *Gaetanus* Giesbrecht, 1888

²**Gaetanus minutus* (Sars, 1907) (Figs. 6-8)

Gaidius minutus Sars, 1907: 10, 1924-1925: 49, Pl. 14, figs. 14-18; Tanaka, 1957: 64, fig. 39a-f.

Gaidius variabilis Brodsky, 1950: 160, fig. 74; Tanaka and Omori, 1970: 127, fig. 6a-k.

Gaetanus moderatus Tanaka, 1957: 66, fig. 40.

Material examined. Korea: 1 ♀, East Sea, 37°05'N, 131°20'E; 5 ♀ ♀, 36°30'N, 131°20'E, Jun 2009.

Redescription. Female: Body as Fig. 6A. Body length 4.46 mm. Prosome about 3.7 times as long as urosome. Cephalosome and first pedigerous somite fused forming cephalothorax. Posterior corners of last pedigerous somite (Fig. 6B) with short spine on each side. Rostrum (Fig. 6C, D) short and acute, but slightly notched at apex (Fig. 6E).

Antennule (Fig. 6H). 24-segmented, reaching end of caudal rami. Endopod of antenna (Fig. 7A) slightly shorter than exopod; coxa with 1 seta; basis with 2 setae. Endopod 2-segmented; first segment with 2 distal setae; second segment with 8 inner and 7 outer setae. Exopod 7-segmented; first segment without seta; second segment with 2 setae; third to sixth segments with 1 seta each; distal segment with 3 terminal setae and medial seta.

Mandible (Fig. 7B, C). Gnathobase with 6 large and 5 small teeth, 1 long seta and 2 rows of setules. Basis with 2 setae. Endopod 2-segmented; first segment with 1 seta; second segment with 9 setae. Exopod 5-segmented; first to fourth segments with 1 seta each; distal segment with 2 setae.

Maxillule (Fig. 7D). Arthrite with 4 posterior setae, 9 spines and 1 medial seta. Coxal epipodite with 9 setae. Coxal endite with 4 setae. Basal endites with 4+5 setae. Endopod with 14 setae. Exopod with 11 setae.

Maxilla (Fig. 7E). First and second praecoxal endites with 3 setae and row of spinules on one side. First coxal endite with 2 long setae and row of spinules on one side. Second coxal endite with 2 setae and 1 thickened seta and with a proximal border spinulose on one side. Basal endite with 3 setae, one of them thickened. Endopod with 5 setae.

Maxilliped (Fig. 7F). Coxa with 3 groups (from proximal to distal end of segment) of 2, 3 and 3 setae (distal group with small spinules). Basis with spinules on proximal edge and 3 medial setae. Endopod 6-segmented; first segment with 2 setae; second to sixth segments with 4, 4, 3, 3+1, and 4 setae, respectively.

Leg 1 (Fig. 8A). Coxa with hairs on inner border. Basis with hairs on inner border and 1 inner distal seta on anterior surface. Endopod 1-segmented; outer margin swollen with 1 row of spinules. Exopod 2-segmented; first and second segments incompletely fused with 1 outer spine and 1 inner seta; third segment with 1 outer spine and 4 inner setae.

Leg 2 (Fig. 8B). Coxa with hairs on inner border and 1 inner seta. Basis unarmed. Endopod 2-segmented; first seg-

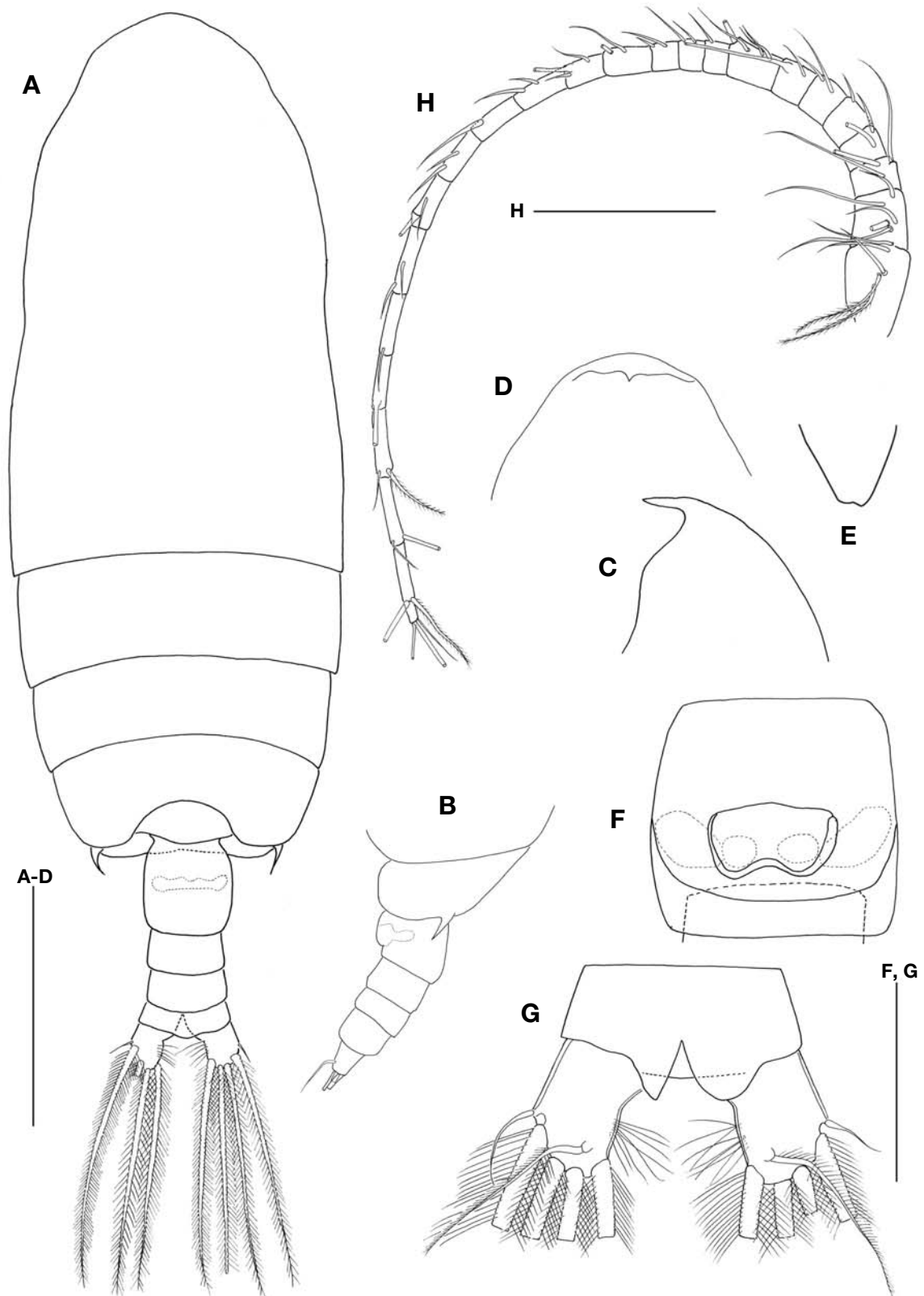


Fig. 6. *Gaetanus minutus* (Sars), female. A, Habidus, dorsal; B, Urosome, lateral; C, Rostrum, lateral; D, E, Rostrum, ventral; F, Genital segment; G, Urosome, ventral; H, Antennule. Scale bars: A-D=1 mm, F, G=0.25 mm, H=0.5 mm.

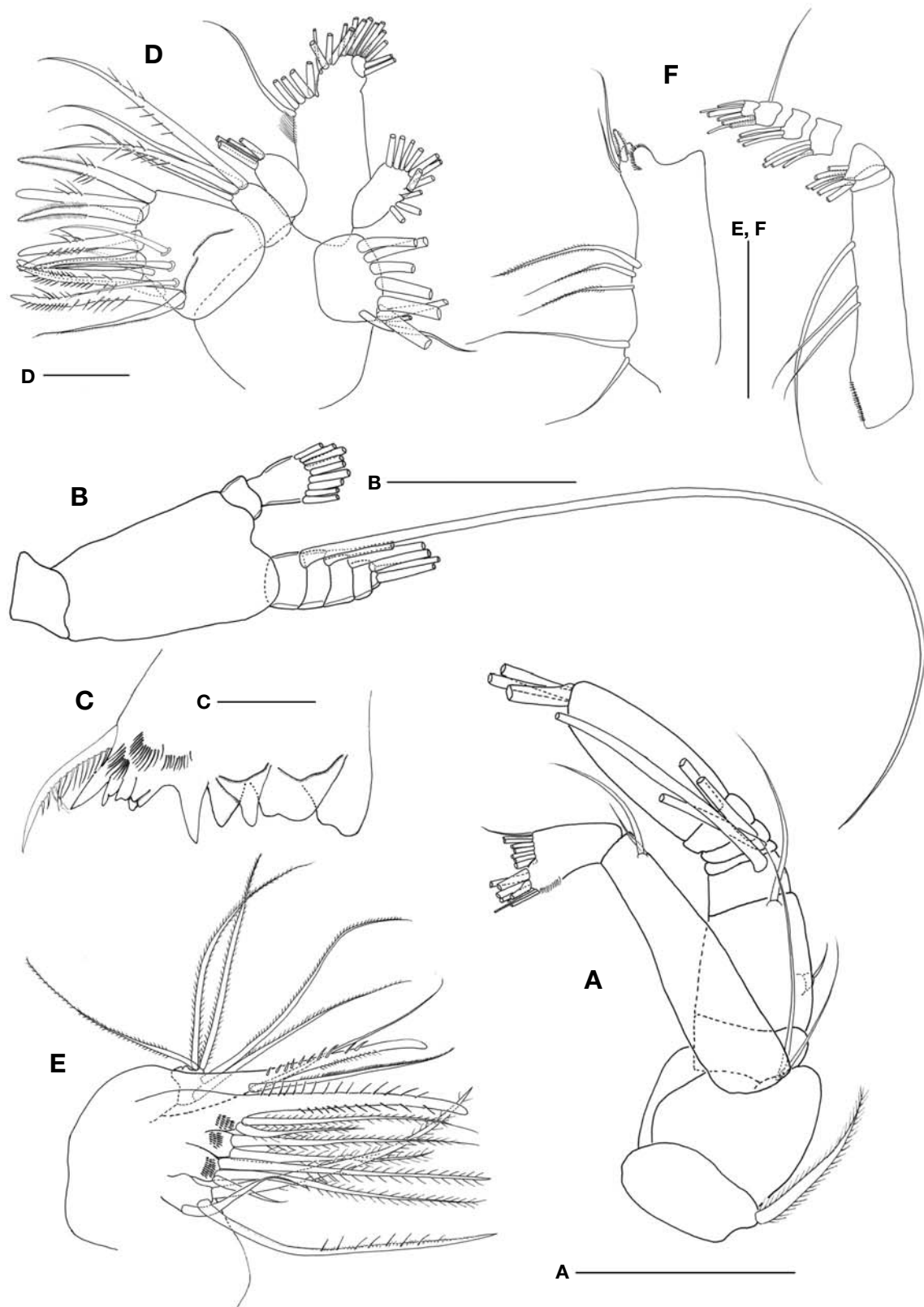


Fig. 7. *Gaetanus minutus* (Sars), female. A, Antenna; B, Mandible; C, Gnathobase of the mandible; D, Maxillule; E, Maxilla; F, Maxilliped. Scale bars: A-C, E, F=0.25 mm, D=0.1 mm.

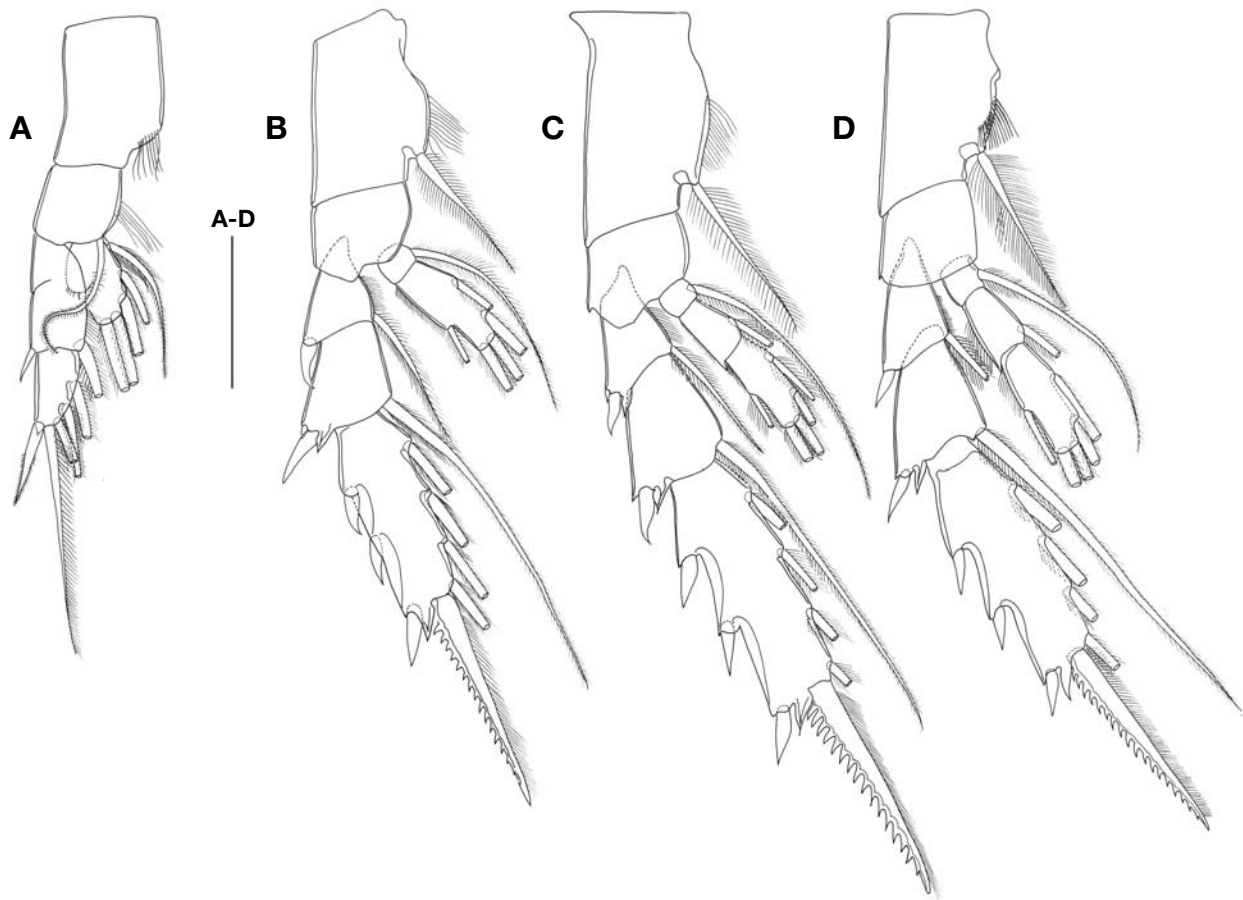


Fig. 8. *Gaetanus minutus* (Sars), female. A, Leg 1; B, Leg 2; C, Leg 3; D, Leg 4. Scale bar: A-D=0.25 mm.

ment with 1 seta; second segment with 5 setae. Exopod 3-segmented; first and second segments with 1 outer spine and 1 inner seta, respectively; third segment with 3 spines and 1 terminal spine bearing 17 teeth on outer edge.

Leg 3 (Fig. 8C). Coxa with hairs on inner border and 1 inner seta. Basis unarmed. Endopod 3-segmented; first and second segments with 1 seta, respectively; distal segment with 5 setae. Exopod 3-segmented; first and second segments with 1 outer spine and 1 inner seta; distal segment with 3 spines, 5 setae and 1 serrated spine bearing 16 teeth on outer edge.

Leg 4 (Fig. 8D). Coxa with thin spines similar to setae. Basis unarmed. Endopod and exopod same as leg 3. Distal segment of exopod with serrated spine bearing 18 teeth on outer edge. Armature formula of swimming legs 1-4 as follows:

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

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

Leg 5 absent.

Male: Not found.

Distribution. East Sea (Korea), Sea of Okhotsk, Bering Sea, Izu (Japan), Gulf of Mexico, New Zealand, Kurile-Kamchatka and Mariana Trench.

Remarks. *Gaetanus minutus* is a morphologically highly variable species and is distributed worldwide (Markhaseva, 1996). The species was reported first as *Gaidius minutus* by Sars (1907), but Park (1975) incorporated *Gaidius* into the genus *Gaetanus* based on the inconsistency of the cephalic process and similarity of other morphological features.

Female *Gaetanus minutus* is similar to *G. brevirostris* (Brodsky, 1950) in having a cephalosome without a spine and posterior corners of the last pedigerous somite with a short spine on each side. On the other hand, *G. brevirostris* has 3-segmented leg 1 exopod, which is fused incompletely in *G. minutus*.

The specimen (4.46 mm) examined in this study is larger

than those of other previous records (Tanaka, 1957; Tanaka and Omori, 1970; Park, 1975). The Korean specimen is congruent with the Japanese one described by Tanaka (1957). However, the present specimen shows some minor differences from Tanaka's specimen as follows: 1) the maxilliped does not have a small lamellous process on the distal margin of the basis; 2) the terminal spines of legs 2, 3, and 4 were recorded to have 19, 17, and 20 outer teeth (Tanaka, 1957), respectively, whereas there were 15, 16, and 18, respectively, in the present specimen. These differences variations were considered to be within the species.

The CO1 sequence of the Korean specimen showed 99.8% similarity to the previous sequence of the same species (Genbank accession no: AB379980).

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REFERENCES

- Arashkevich YG, 1969. The character of feeding of copepods in the north-western Pacific. *Okeanologiya*, 9:857-873.
- Boxshall GA, Halsey SH, 2004. An introduction to copepod diversity. Part 1. The Ray Society, London, pp. 1-421.
- Bradford JM, Jillett JB, 1980. The marine fauna of New Zealand: Pelagic calanoid copepods: family Aetideidae. *Memoirs of the New Zealand Oceanographic Institute*, 86:1-102.
- Brodsky KA, 1950. Calanoida of the Far Eastern Seas and Polar Basin of the U.S.S.R. *Opredeliteli po Faune SSSR*, 35:1-442 (in Russian).
- Chen QC, Zhang SZ, 1965. The planktonic copepods of the Yellow Sea and the East China Sea. 1. Calanoida. *Studia Marina Sinica*, 7:20-131.
- Farran GP, 1929. Crustacea. Part X. Copepoda. *Natural History Reports. British Antarctic ("Terra Nova") Expedition, 1910. Zoology*, 8:203-306.
- Folmer O, Black M, Hoeh W, Lutz R, Vrijenhoek R, 1994. DNA primers for amplification of mitochondrial cytochrome *c* oxidase subunit 1 from diverse metazoan invertebrates. *Molecular Marine Biology and Biotechnology*, 3:294-299.
- Kim DY, 1985. Taxonomical study on calanoid (Crustacea: Copepoda) in Korean Waters. PhD dissertation, Hanyang University, Seoul, Korea, pp. 1-180.
- Markhaseva EL, 1996. Calanoid copepods of the family Aetideidae of the world ocean. *Proceedings of the Zoological Institute, Russian Academy of Sciences*, 268:1-331.
- Park T, 1975. Calanoid copepods of the genera *Gaetanus* and *Gaidius* from the Gulf of Mexico. *Bulletin of Marine Science*, 25:9-34.
- Razouls C, de Bovée F, Kouwenberg J, 2010. Diversity and geographic distribution of marine planktonic copepods [Internet]. Centre National de la Recherche Scientifique, Paris, Accessed 2 Dec 2010, <<http://www.copepodes.obs-banyuls.fr/en>>.
- Sars GO, 1907. Notes supplémentaires sur les Calanoides de la Princesse-Alice. (Corrections et additions). *Bulletin de l'Institut Océanographique, Monaco*, 101:1-27.
- Tanaka O, 1957. The pelagic copepods of the Izu region, Middle Japan. Systematic account III. Family Aetideidae (Part 1). *Publications of the Seto Marine Biological Laboratory*, 6:31-68.
- Tanaka O, Omori M, 1970. Additional report on calanoid copepods from the Izu region. Part 3A. *Euaetideus*, *Aetideopsis*, *Chiridius*, *Gaidius*, and *Gaetanus*. *Publications of the Seto Marine Biological Laboratory*, 18:109-141.

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