

A New Species of the Rarely Known Genus *Apolethon* (Copepoda, Harpacticoida, Laophontidae) from Brackish Waters of Korea

Ji Min Lee and Cheon Young Chang^{1,*}

Institute of Basic Science, Daegu University; ¹Department of Biological Science, Daegu University, Gyeongsan 712-714, Korea

Abstract: A new laophontid copepod species, *Apolethon articulatus* n. sp., is described from the estuaries and salt marshes in South Korea. *Apolethon articulatus* is similar to the three congeneric species currently known in sharing the character combination of the elongate first endopodal segment of leg 1 with inner seta and the expansion of second endopodal segments of legs 2-4 with decrease in the number of setae on them. However, *A. articulatus* differs from them by the separate exopod of female leg 5 and the armature of mandibular palp with 6 setae. Description and taxonomic accounts of the new species are presented herein with detailed illustrations and SEM micrographs. As the true identity of the rarely known genus has not been clarified yet, a revised generic diagnosis is provided with a key to the species hitherto known in the genus.

Key words: *Apolethon*, brackish waters, Copepoda, Harpacticoida, Korea, Laophontidae, taxonomy

The faunistic papers have been published serially for the harpacticoid copepods from various brackish waters in South Korea: *Harpacticella itoi* Chang and Kim, 1991 by Chang and Kim (1991), two *Mesochra* species (*M. alaskana* Wilson, 1958 and *M. suifunensis* Borutzky, 1952) by Lee and Chang (2003), two *Onychocamptus* species [*O. mohammed* (Blanchard and Richard, 1791) and *O. vitiospinulosa* (Shen and Tai, 1963)] by Lee and Chang (2005), two new *Neotachidius* (*N. parvus* and *N. coreanus*) by Huys et al. (2005), three Cletodidae species [*Limnocletodes behningi* Borutzky, 1926, *L. angustodes* Shen and Tai, 1963, and *Kollerua longum* (Shen and Tai, 1979)] by Lee and Chang (2007), *Nitokra koreanus* Chang, 2007 and *Ameira parvula* (Claus, 1886) by Chang (2007), two *Leptocaris* species [*L. brevicornis* (van Douwe, 1905)

and *L. trisetosus pacificus* Lee and Chang, 2008] by Lee and Chang (2008a), five *Nitokra* species by Chang and Yoon (2008), two new species (*Itunella arenaria* and *Mesochra bisetosa*) by Lee and Chang (2008b), and four Tachidiidae species by Chang (2008).

As part of the comprehensive study on the brackish copepod fauna, the authors examined some specimens belonging to a rarely known genus *Apolethon* Wells, 1967, stocked in the specimen room of the Department of Biological Science, Daegu University.

Genus *Apolethon* was established for a peculiar new species, *A. fumator* Wells, 1967 from Mozambique, eastern Africa. The generic name is an anagram of *Laophonte*, the type genus of the family Laophontidae, and the specific name, *fumator*, means 'one who deceives or confuses' (cited from Wells, 1967). As suggested in the generic and specific name, Dr. Wells considered this genus as "a reference to the confusion that is caused in the taxonomy of the family by its description". Thereafter, only two species have been added so far in the genus: *A. bilobatus* Shen and Tai, 1973 and *A. trigonos* Shen and Tai, 1973 from Kwangtung, southern China. Both the Chinese species were described rather inadequately, what is worse, based on females only.

In the present study, we provide a revised generic diagnosis and a key to the species hitherto known in the genus *Apolethon*, based on the description of a new species from the brackish waters in South Korea, with detailed illustrations and SEM photomicrographs.

MATERIALS AND METHODS

Materials examined in the present study were collected from coastal salt marshes and estuaries at five localities (Fig. 1) in South Korea during the period from July, 1994 to October, 2008. Collections were made with a dipnet of 64

*To whom correspondence should be addressed.
Tel: +82-53-850-6454; Fax: +82-53-850-6459
E-mail: cychang@daegu.ac.kr

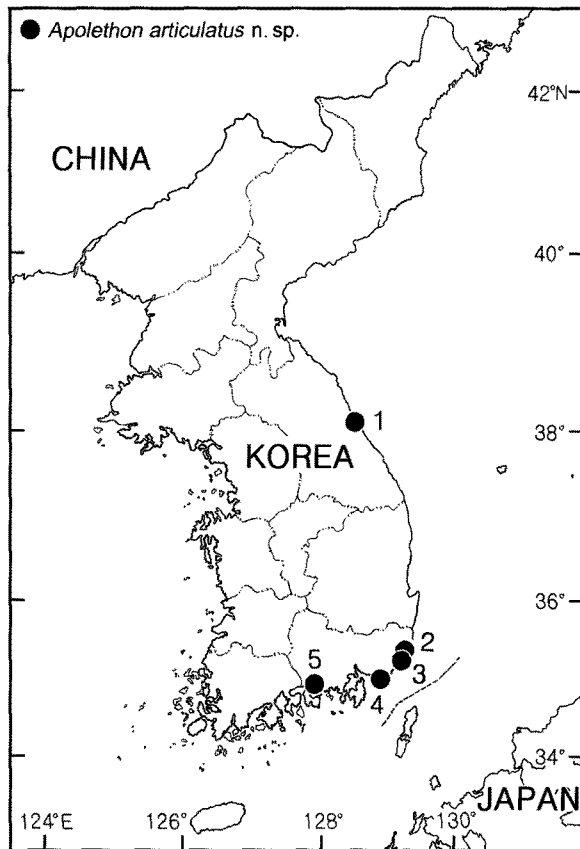


Fig. 1. A map showing localities in South Korea. 1, Hwajinpo Lake, Goseong; 2, estuary of Taehwagang River, Ulsan; 3, estuary of Hoyyacheon Stream, Ulsan; 4, Dadaepo, Busan; 5, estuary of Gwangogcheon Stream, Hadong.

µm mesh. Copepods were fixed and stored in 4% buffered formalin.

Specimens were dissected and mounted in lactophenol on H-S slide (Shirayama *et al.*, 1993), a recent variation of Cobb slide, after treatment in a solution of 5% glycerin - 95% ethyl alcohol for 1-2 days. Dissection was performed using two needles made from 0.5 mm diameter tungsten wire, sharpened by electrolysis (Huys and Boxshall, 1991). Mounted specimens were observed using a differential interference contrast microscope (Olympus BX-51) equipped with Nomarski optics. All drawings were made with the aid of a camera lucida.

Measurements were done with a digital camera for microscope (Cool SNAP 5.0M, Roper Scientific Co., USA) and a calibration software QCapture Pro (ver. 5.0, Media Cybernetics Inc., USA).

Materials for scanning electron microscopy were prefixed overnight at 4°C in 2.5% glutaraldehyde, followed by rinsing with 0.1 M phosphate buffer (pH 7.2-7.4) three times, each for 10 minutes. Specimens were postfixed for 2 hours in 2% cold osmium tetroxide in 0.1 M phosphate buffer, and left in phosphate buffer overnight. After

dehydration through a graded series of ethanol (50-100% at 10% interval) for 30 minutes each, the material was critical point dried, and coated with gold-palladium in high evaporator, and then examined with a scanning electron microscope (Hitachi S-4800) operated at 15 KV.

Type specimens are deposited in the National Institute of Biological Resources (NIBR), Incheon, Korea, and the specimen room of the Department of Biological Science, Daegu University (DB), Korea.

Abbreviations used in the text and figure legend follow the conventional ones frequently used in the taxonomy of copepods: A1, antennule; A2, antenna; enp 1-3 or exp 1-3, the first to third endopodal or exopodal segment of each leg; Fu, caudal rami; P1-P6, first to sixth pereopods (thoracic legs).

SYSTEMATIC ACCOUNTS

Order Harpacticoida Sars, 1903

Family Laophontidae T. Scott, 1904

Genus *Apoletion* Wells, 1967

Diagnosis. Laophontidae. Body cylindrical, without distinct demarcation between prosome and urosome. Cephalothorax incorporating first pedigerous somite. Rostrum not developed, subdivided at base. Genital double-somite incompletely fused, marked by transverse surface ridge and spinule row dorsally and laterally. Genital apertures fused medially forming common genital slit, anterior to large median copulatory pore. Outer distal margins of genital double-somite and next urosomites not expanded. Anal operculum round with denticulate posterior margin. Fu truncate, a little longer than wide, bearing 7 caudal setae. A1 5-segmented, with 1 aesthetasc on segment 3. Antennary exopod 1-segmented, bearing 4 setae. Mandibular palp 1-segmented, with 5 or 6 setae in total. Maxilliped subchelate; endopod 1-segmented, representing 1 strong and curved claw.

P1, exopod 3-segmented; endopod 2-segmented; enp 1 strikingly elongated, about 5-7 times as long as wide, usually much longer than whole exopod, bearing 1 inner seta; enp 2 with 1 plumose inner distal seta and 1 sharp claw-like spine apically; exp 2 not elongated, without inner seta; exp 3 armed with 2 outer spines and 2 long apical geniculate setae. Female P2-P4, exopods 3-segmented; endopods 2-segmented; enp 1 small, lacking inner seta; enp 2 very elongate, bearing 1-3 elements. Armature formula as follows:

- P2 exp I-0; I-1; II,2,0 enp 0-0; 0,1,0
- P3 exp I-0; I-1; II,2,0 enp 0-0; I,1,1
- P4 exp I-0; I-1; II,2,0 enp 0-0; I,1,0

Exopod and baseopod of P5 completely fused in

both sexes, or sometimes separate (in female *A. articulatus*); in female, baseoendopod strongly protruded, bearing 5 spiniform setae; exopod (exopodal lobe) small, bearing 3 setae.

Sexual dimorphism shown in A1, maxilliped, P3, P4, P5, and genital segmentation. In male, endopod of maxilliped armed with 5-6 conical teeth along inner margin; P3 exp 2 forming apophysis; P3-P4 exp 1 a little more elongated than in female; baseoendopod and exopod of P5 fully fused into 1 plate-like lobe, bearing 6 setal elements in total; P6 completely lacking.

Free-living. Found in sand bottom (near mangrove swamp) of shallow inlet (Wells, 1967); streams or freshwaters near seashore (Shen and Tai, 1973); estuaries, reed marshes, lagoons, and coastal bogs (this study).

Type species: Apoletion fumator Wells, 1967

Other species: A. bilobatus Shen and Tai, 1973; *A. trigonos* Shen and Tai, 1973; *A. articulatus* n. sp.

Apoletion articulatus n. sp. (Figs. 2-7)

Type. Holotype ♀ (DB20022), allotype ♂ (DB20023), dissected in lactophenol, estuary of Taehwagang River (Myeongchongyo Bridge: 35°36'17"N, 129°25'56"E), Ulsan, 23 Oct. 2008 (*leg.* C.Y. Chang and J.M. Lee). Paratypes: 3 ♀♀, 2 ♂♂, collection details same as in holotype, including 3 undissected individuals (2 ♀♀, 1 ♂, NIBRIV 0000117088) and 2 dissected paratypes (♀, DB20024; ♂, DB20025).

Additional material examined. 1 ♀, Hwajinpo Lake (coastal marsh), 1 Mar. 2005 (C.Y. Chang and J.M. Lee); 3 ♀♀, estuary of Taehwagang River (Myeongchongyo Bridge), Ulsan, 29 Jan. 2005 (J.M. Jeon); 3 ♀♀, same locality, 31 Mar. 2007 (C.Y. Chang); 4 ♀♀ (2 ovi.), 1 ♂, estuary of Hoiyacheon Stream (Seosaenggyo Bridge), Ulsan, 24 Sep. 2006 (S.B. Lim and S.Y. Cho); 2 ♀♀, Dadaepo Beach (reed marsh), Busan, 28 Sep. 2006 (C.Y. Chang and J.M. Lee); 4 ♀♀ (1 ovi.), 1 ♂, estuary of Gwangogcheon Stream, Jingyo, Hadong, 26 Apr. 2007 (C.Y. Chang, J.M. Lee and H.J. Yoon).

Description. *Female.* Body (Figs. 2A, B, 7A-C) cylindrical, without distinct demarcation between prosome and urosome, rather small, $503 \pm 32 \mu\text{m}$ (N=8) in length, tinged with yellow brown. Cephalothorax bell-shaped, a little shorter than sum of next 3 prosomites. Rostrum not discernible in dorsal view, with round apex in frontal view, bearing 2 sensillae, not defined at base (remaining faint scar of fusion). First 3 prosomites with setule row lining posterior borders of each tergites; all somites except cephalothorax ornamented with spinules along posterior margin dorsally; posterior margins of urosomites denticulate ventrally. Sensillae

scattered on dorsal and lateral surface of cephalothorax; each prosomites and urosomites armed with 2-3 pairs of sensillae near posterior margin of dorsal surface. Rudimentary tergites appeared, conspicuous especially in cephalothorax, third, fourth and fifth pedigerous somites.

Genital and first abdominal somites incompletely fused to form genital double-somite, marked by weak lateral notches, transverse surface ridge and spinule row dorsally and laterally, showing original segmentation (Figs. 2A, B, 3A). Outer distal margins of genital double-somite and next urosomites little expanded, not showing wing-like projection. Genital apertures fused medially, forming common genital slit, wrinkled on either side, bearing 1 seta, represented by P6; median copulatory pore hidden beneath a concave groove (Fig. 3A, arrow); genital somite with 2 oblique spinule rows ventrolaterally.

Anal somite (Figs. 3B, 7D) a little shorter than preceding abdominal somites, with 12-15 spinules along each side of posterior margin dorsally; outer distal corner not protruded; setae on anal somite lappet slightly not reaching middle of medial margin of caudal rami. Anal operculum convex, with its posterior margin gently rounded, armed with 24-29 denticles.

Fu (Figs. 3B, C, 7D) a little divergent posteriorly, each ramus truncate, tapering posteriorly, 1.1-1.2 times longer than wide. Dorsal surface rather smooth, except for several spinules anterior to lateral caudal setae and distolateral corner of Fu; 1 integumental pore present on ventral surface near middle of lateral margin; 4-5 triangular spinules present along posterior margin of caudal ramus ventrally. Fu bearing 7 caudal setae. Paired lateral caudal setae (caudal setae I and II) naked, locating at about distal quarter of lateral margin of rami; caudal seta I (Fig. 3C, arrow) vestigial, situated ventrolaterally. Outer caudal seta (caudal seta III) slender, not spiniform, about 1.2 times longer than lateral caudal seta, 1.4 times as long as inner caudal seta (caudal seta VI). Outer terminal caudal seta (caudal seta IV) pinnate, with secondary setules after proximal 1/3 of it, a little shorter than half the inner terminal caudal seta (caudal seta V). Inner terminal caudal seta pinnate, not swollen at its base, a little shorter than 3/4 times as long as urosome including Fu. Both terminal caudal setae with fracture planes. Dorsal caudal seta (caudal seta VII) tri-articulate at base and naked, situated a little posterior to middle of Fu, a little longer than outer caudal seta.

A1 (Fig. 4A) short, 5-segmented; segment 1 armed with 1 oblique row of spinules proximally, bearing 1 naked seta and a few spinules anterodistally; segment 2 slightly swollen distally; segment 3 bearing 1 long aesthetasc anterodistally, its tip far exceeding last segment; last segment with 2 stout pinnate spiniform setae on anterior margin. Armature formula: 1-[1], 2-[8], 3-[6+(1+aesthetasc)], 4-[1], 5-[9+2 (pinnate)].

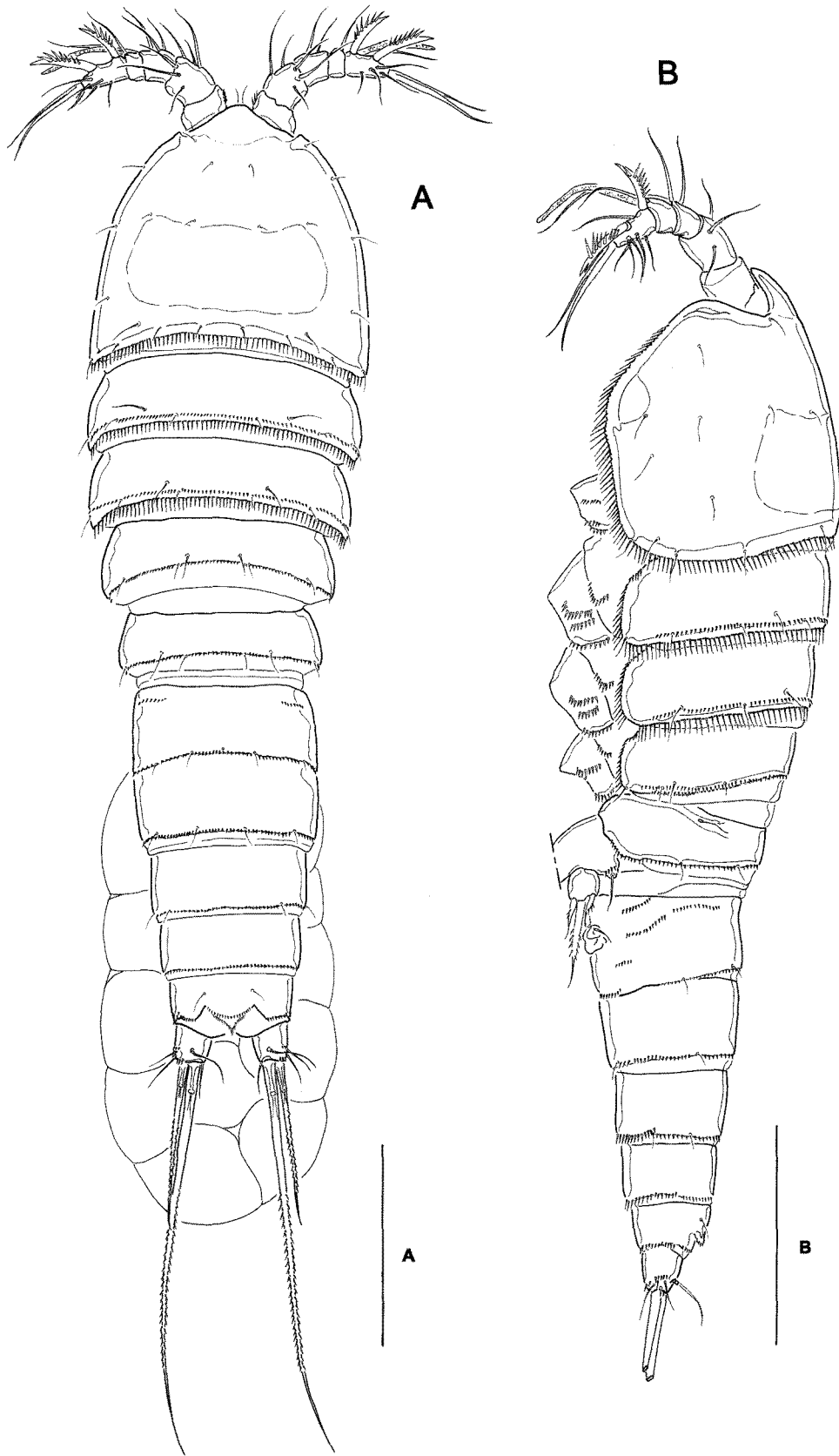


Fig. 2. *Apolethon articulatus* n. sp., female. A, habitus, dorsal; B, habitus, lateral. Scale bars=100 μ m.

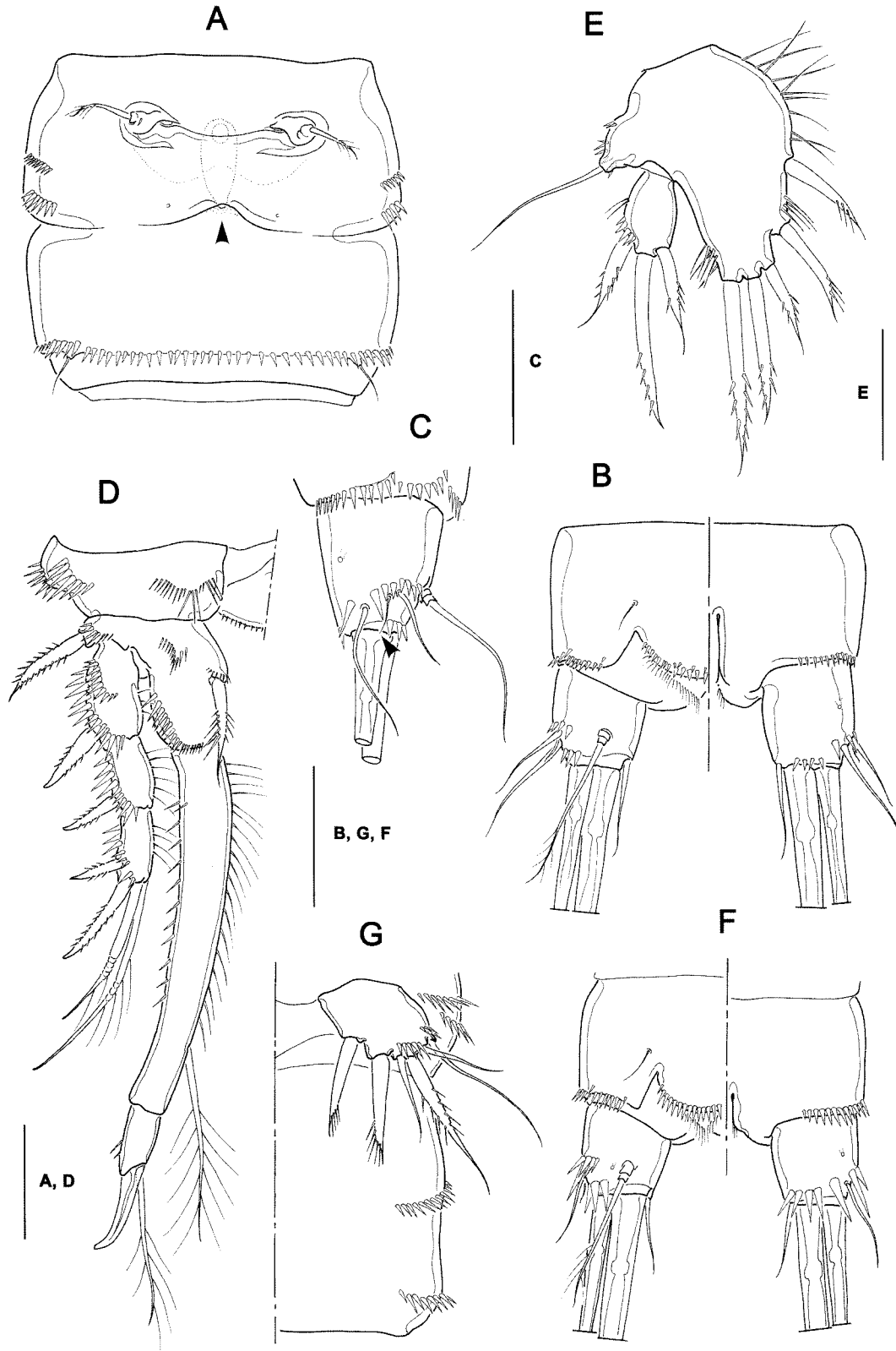


Fig. 3. *Apolethon articulatus* n. sp. A-E, female: A, genital double-somite, ventral; B, anal somite and Fu (left part, dorsal; right part, ventral); C, Fu, lateral; D, P1; E, P5, caudal. F-G, male: F, anal somite and Fu (left part, dorsal; right part, ventral); G, left P5 and genital somite, ventral. Scale bars=25 μ m.

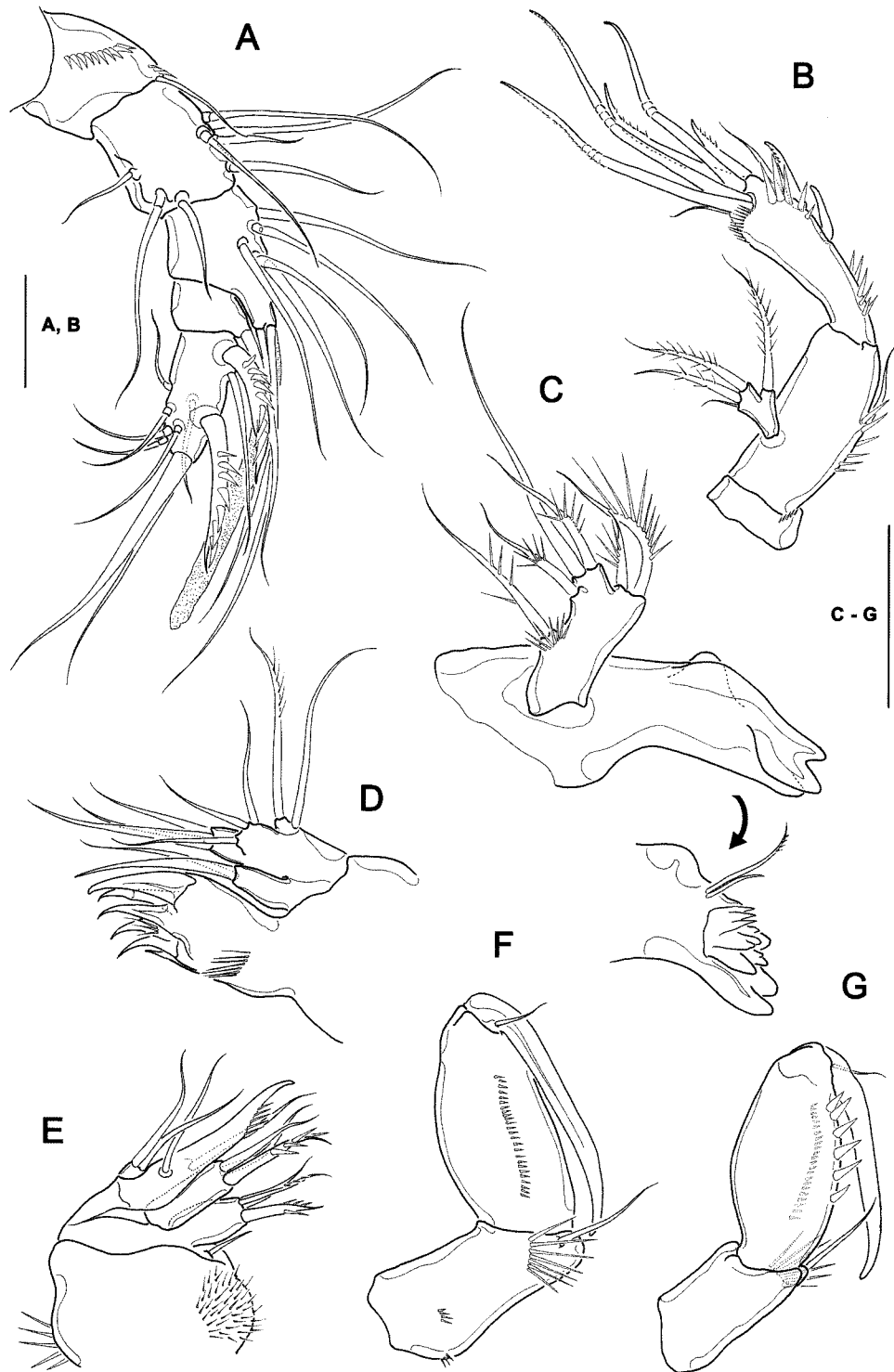


Fig. 4. *Apoletthon articulatus* n. sp. A-F, female: A, A1; B, A2; C, mandible, with dorsal face of coxal gnathobase (below); D, maxillule; E, maxilla; F, maxilliped. G, male maxilliped. Scale bars=20 μ m.

A2 (Fig. 4B), allobasis bearing 1 naked seta near distal 1/3 of medial margin with 1 spinule row. Endopod bearing 2 outer spines and 1 slender seta (flanking 5-6 spinules), 3 terminal geniculate setae, 2 spiniform distal setae and 1 small outer distal seta. Exopod 1-segmented, about 1.5

times longer than broad, bearing 1 lateral and 2 apical pinnate setae with 1 small, naked seta on outer distal corner.

Mandible (Fig. 4C) with well developed coxal gnathobase bearing 5-6 bidentate or tridentate teeth along distal margin with 2 setae dorsally; palp 1-segmented with both rami

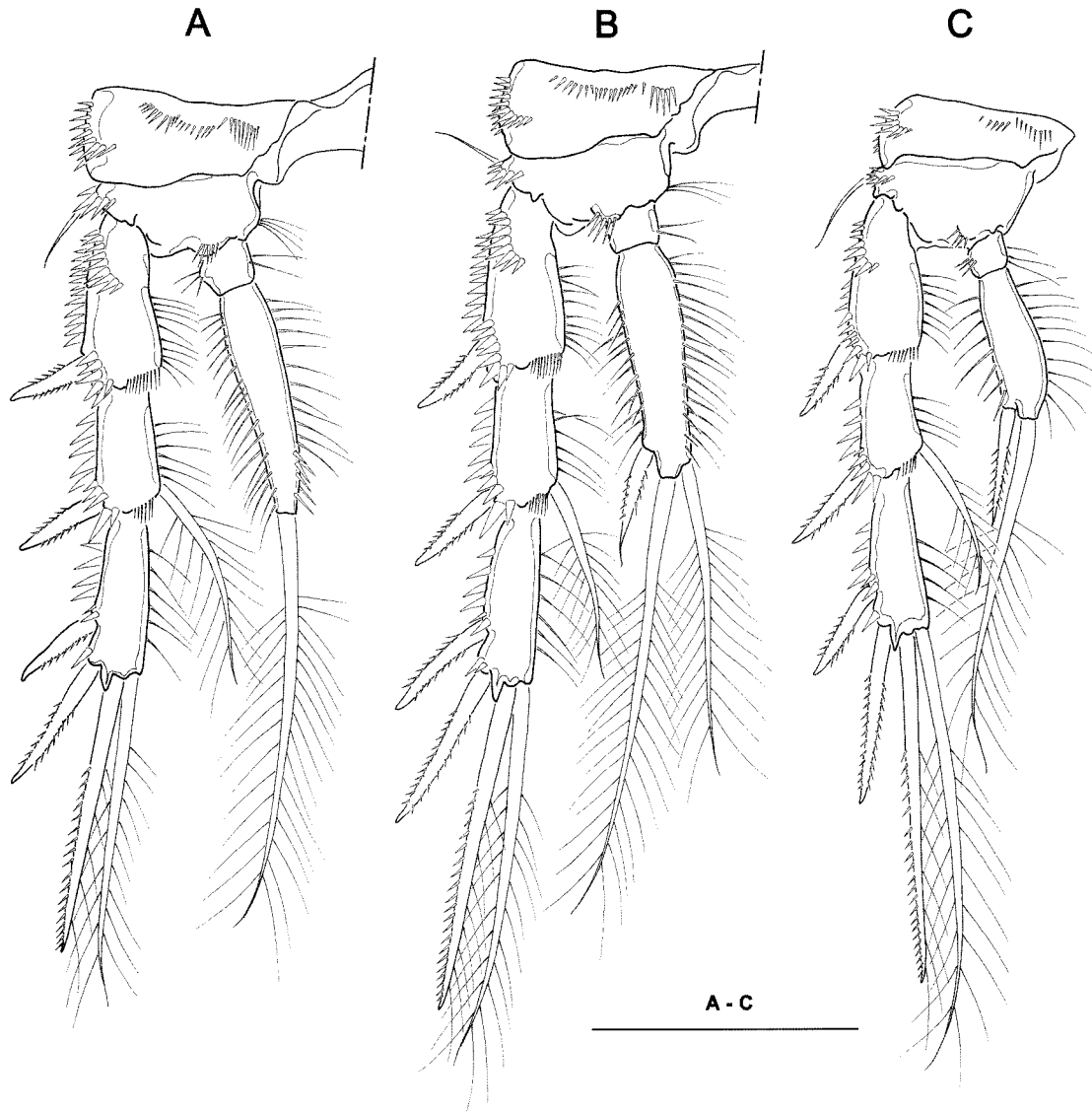


Fig. 5. *Apoletion articulatus* n. sp., female. A-C, P2-P4, frontal. Scale bar=50 μ m.

fused to basis, armed with 6 (1 long, naked and 5 pinnate) setae in total. Maxillule (Fig. 4D) with praecoxal arthrite bearing 6 elements; coxal endite cylindrical, bearing 1 large spine and 1 seta; basis bearing 1 spine and 2 setae, representing distal basal endite; exopod and endopod fused to basis, each lobe bearing 3 and 2 setae, respectively. Maxilla (Fig. 4E) armed with 1 seta (representing praecoxal endite) and 2 syncoxal endites, each endite bearing 3 setal elements; allobasis forming 1 strong pectinate claw flanking 2 long setae basally; endopod represented by small protuberance bearing 2 long naked setae. Maxilliped (Fig. 4F) subchelate; syncoxa a little protruded distomedially bearing 1 naked seta with 1 row of setules; basis with 1 row of spinules along inner margin; endopod represented by 1 strong and curved claw, bearing 1 minute seta proximally as

accessory armature.

P1 (Fig. 3D), exopod 3-segmented; endopod 2-segmented; coxa armed with 2 rows of sharp spinules at outer margin, with 1 medial spinule row on frontal face; basis protruded distally, with 1 pinnate seta near middle of inner margin; enp 1 strikingly elongated, about 7.2 times as long as wide, 5.7 times longer than enp 2, about 1.5 times longer than whole exopod; with 1 inner seta situated at about distal 1/5; enp 2 with 1 plumose inner distal seta and 1 sharp claw-like spine apically; both exp 1 and exp 2 without inner seta; exp 2 not elongated; exp 3 armed with 2 outer spines and 2 long apical geniculate setae.

P2-P4 (Fig. 5A-C), exopods 3-segmented; endopods 2-segmented; enp 1 small, lacking inner seta, with setules or spinules along lateral margins; exopods somewhat elongated.

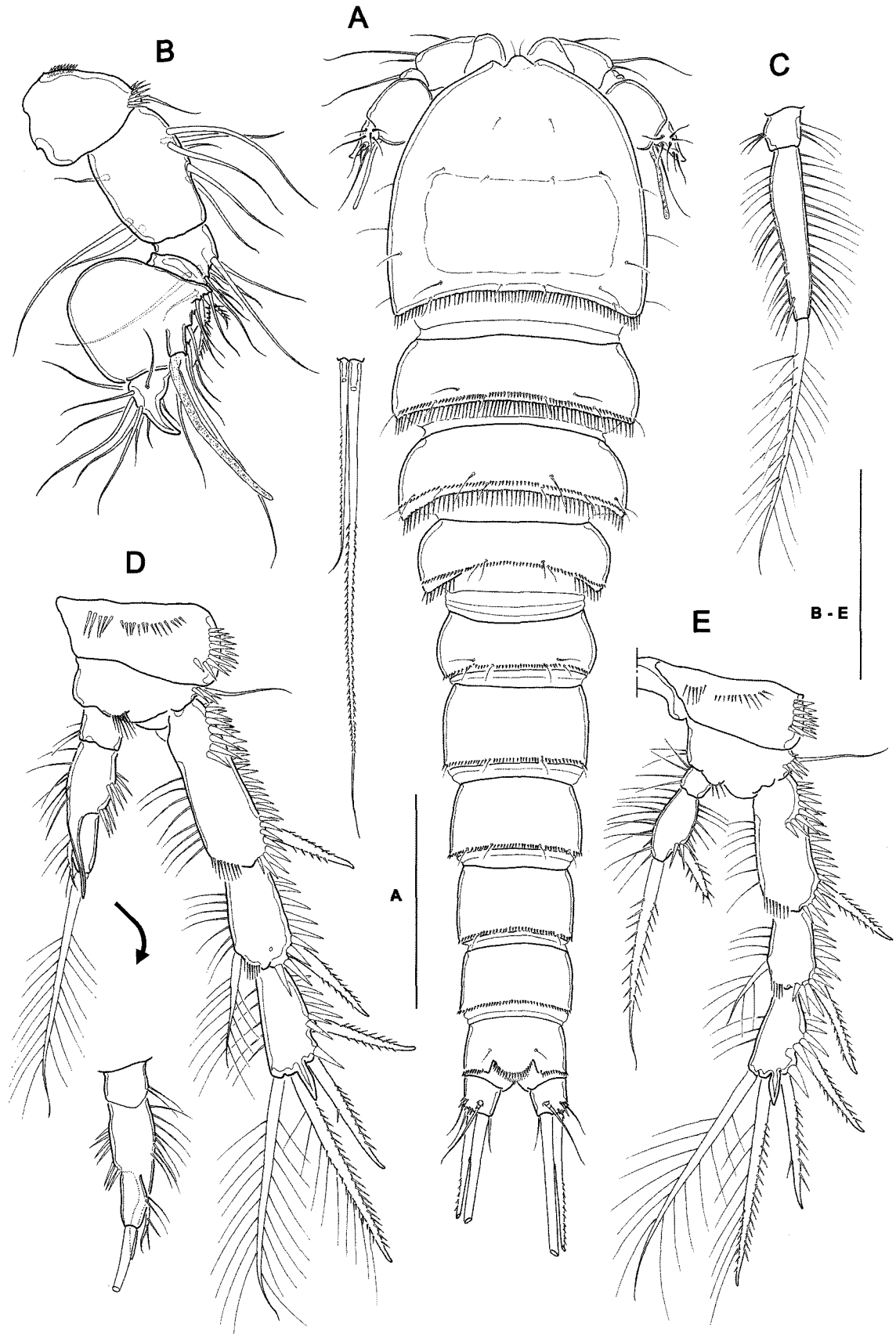


Fig. 6. *Apoletion articulatus* n. sp, male. A, habitus, dorsal; B, A1; C, P2 endopod, frontal; D, P3, frontal, with caudal view of endopod (below); E, P4, frontal. Scale bars=100 μ m (A), 50 μ m (B-E).

P2 (Fig. 5A), enp 2 very elongate, about 4.5 times as long as broad, distal end reaching to posterior end of exp 2, bearing 1 long plumose seta apically with setules and spinules along lateral margins. P3 (Fig. 5B), enp 2 elongate, about 3.5 times as long as broad, bearing 1 outer distal spine and 2 long plumose setae apically or subapically (apical seta a little less than 1.5 times longer), with setules along lateral margins. P4 (Fig. 5C), enp 2 rather ellipsoidal, swollen distomedially, about 3 times as long as broad, bearing 1 outer distal spine and 1 long plumose seta apically. Seta/spine armature of P2-P4 as follows (Arabic numerals representing setae, while Roman numerals indicating spines):

P2	basis	1-0	exp	I-0; I-1; II,2,0	enp	0-0; 0,1,0
P3	basis	1-0	exp	I-0; I-1; II,2,0	enp	0-0; I,1,1
P4	basis	1-0	exp	I-0; I-1; II,2,0	enp	0-0; I,1,0

P5, exopod distinctly separate from baseoendopod on frontal surface (Fig. 7E, arrow), with a faint suture line between them on caudal face (Fig. 3E). Baseoendopod strongly protruded, much exceeding exopod, without any projection between outer margin of expansion and exopod, bearing 5 spiniform setae, outermost seta longest; frontal surface smooth without spinule rows. Exopod oval, less than 1.5 times as long as wide, bearing 1 long apical pinnate seta flanking 2 subapical pinnate setae, with spinule row along posterior margin of exopod.

Male. Body (Figs. 6A, 7F, G) a little slenderer than in female, $462 \pm 30 \mu\text{m}$ ($N=3$) in length. Sexual dimorphism shown in A1, maxilliped, P3, P4, P5, and genital segmentation. Integumental depression appeared somewhat stronger on posterior part of cephalothorax than in female (Fig. 7F). Anal somite and Fu (Figs. 3F, 7H) nearly same with those of females in general appearance and seta/spinule arrangements, except for much stronger spinules on posterior margins of anal operculum and anal somite, and on lateral and distolateral part of dorsal surface of Fu.

A1 (Fig. 6B) subchirocerate, 6-segmented; geniculated between segments 4 and 5. Segment 1 with sclerite around base, armed with 2 spinule rows proximally and distally, with 1 naked seta distally. Segment 2 large, not subdivided, different from typical segmentation of Laophontidae, without surface sutures marking original segmentation, bearing 9 naked setae in total. Segments 3 and 4 minute, folded, forming sclerite. Segment 5 bulbous ventrally, armed with 2 pinnate setae proximally; anterior margin with multicuspidate (usually with 8-9 cusps) process proximally, 1 long aesthetasc distally. Last segment unguiform, hooked, with 10 naked setae in total. Maxilliped (Fig. 4G), basis armed with 5-6 conical teeth along inner margin.

P3 (Fig. 6D), endopod 3-segmented, enp 1 lacking inner seta; enp 2 elongated, its inner distal margin produced to 1

slender apophysis without barb at tip, about 1.5 times longer than enp 3; enp 3 armed with 1 medial and 1 apical setae. P3 exp 1 a little more elongated than in female. P4 (Fig. 6E) largely similar to female's, including setae/spines armature, except for elongated exp 1, shorter exp 3, and shorter enp 2.

P5 (Fig. 3G), baseoendopod and exopod fully fused into 1 plate-like lobe, bearing 3 pinnate spiniform setae, 2 naked slender setae and 1 outer basal seta, with 1 spinule row along distal margin of frontal surface; intercoxal sclerite absent. Genital somite bearing paired ventrolateral spinule rows near middle of lateral margin and distolateral corner. P6 (typically represented by opercular plates with marginal setae) completely lacking.

Etymology. The proposed specific name, *articulatus*, means 'jointed', referring to the separate exopodal segment from baseoendopod of leg 5 in female, one of the diagnostic characteristic from the congeneric species.

Ecology. This species occurred from a coastal lake (lagoon), estuaries and reed marshes in Korea. This species is supposed as euryhaline, and abundant in the muddy sand sediments with high organic content around reed marshes in the estuaries. This species co-occurred with *Sinodiaptomus tenellus*, *Pseudodiaptomus inopinus* (Calanoida), *Leptocaris brevicornis*, *Tachidius parvus*, *Tigriopus japonicus*, *Nitokra koreanus*, *Schizopera clandestina*, *S. neglecta*, *Kollerua longum*, *Limnocletodes behningi*, *Onychocamptus vitiospinulosa*, *O. mohammed* (Harpacticoida), *Paracyclops nana*, *Halicyclops sinensis*, and *H. japonicus* (Cyclopoida), often together with goby fishes (*Acanthogobius flavimanus*).

Remarks. *Apolethon* Wells, 1967 appears most similar to *Onychocamptus* in the family Laophontidae, but differs from it in showing the tendencies of fusion of baseoendopod and exopod in female P5, elongated P1 enp 1 with inner seta, absence of male P6, and elongation of enp 2 of P2-P4 with decrease in the number of setae on them. Only three species have been recognized as yet in this rarely known genus: *Apolethon fumator* Wells, 1967 from Mozambique, *A. bilobatus* Shen and Tai, 1973 and *A. trigonos* Shen and Tai, 1973 from China. The latter two species from southern China (Kwangtung) were described on the basis on females only (Shen and Tai, 1973; Tai and Song, 1979), and have not been reported thereafter.

Apolethon articulatus n. sp. shares the character combination above with the three congeneric species, except for the separate exopod of female leg 5, as indicated in the specific name *articulatus* (=jointed or segmented). Moreover, it is clearly distinguished from the congeners by the armature of mandibular palp with 6 setae (against 5 setae in all the congeners). The latter characteristic seems to



Fig. 7. *Apolethon articulatus* n. sp., SEM micrographs. A-E, female: A, habitus, dorsal; B, habitus, lateral (carrying an ovisac); C, habitus, ventral; D, anal somite and Fu, dorsal; E, P5 (arrow indicates segmentation of exopod). F-H, male: F, habitus, dorsal; G, habitus, ventral; H, anal somite and Fu, dorsal. Scale bars=100 μ m (A-C, F, G), 20 μ m (D), 15 μ m (E, H).

be the first case even in the family Laophontidae (so far known as up to 5 setae) according to Boxshall and Halsey's (2004) familial synopsis.

Besides the two common differences above, *A. articulatus* shows a few discrepancies from *A. fumator* by the more elongated enp 1 of P1 (7.2 times longer than wide and 5.7

times longer than enp 2, while about 5 times longer than wide and 4 times longer than enp 2 in *A. fumator*), elongated exopod of female P2 (endopod nearly reaching to posterior margin of exp 2, while endopod beyond middle of exp 3 of in *A. fumator*), and short enp 3 of male P3 with 1 apical and 1 medial setae (about 1.54 times as long as wide, and its tip even not reaching to posterior end of exp 1 of P3, while more than 3 times longer, and its tip nearly reaching to posterior end of exp 2, with 2 apical setae in *A. fumator*).

Considering the female characters only, especially the general shape of P5, the present new species from Korea most resembles *A. bilobatus* among the three congeneric species, but it differs from *A. bilobatus* by more elongated enp 1 of P1 (5.7 times longer than enp 2, while 3.7 times in *A. bilobatus*), longer subapical seta on enp 2 of female P3 (more than 0.7 times as long as apical seta, while less than half the apical seta in *A. bilobatus*), and medially swollen enp 2 of female P4.

Finally, *A. articulatus* n. sp. is similar to *A. trigonos* in sharing the very elongate P1 enp 1 and P2-P3 exopods. However, the latter species is clearly discernible from the former by the triangular protrusion between circular exopodal lobe and outer margin of baseoendopodal expansion.

A key to the species of the genus *Apolethon*

1. In female P5, exopod separate; mandibular palp with 6 setae *A. articulatus* n. sp.
In female P5, exopod and baseoendopod completely fused; mandibular palp with 5 setae 2
2. In female P5, exopodal lobe wider than long; P2-P3 exopods not elongated, P2 endopod beyond middle of exp 3 *A. fumator* Wells
In female P5, exopodal lobe longer than wide; P2-P3 exopods elongated, P2 endopod nearly reaching to posterior margin of exp 2 3
3. Triangular protrusion present between exopodal lobe and outer margin of baseoendopodal expansion
..... *A. trigonos* Shen and Tai
The protrusion above absent
..... *A. bilobatus* Shen and Tai

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REFERENCES

- Boxshall GO and Halsey SH (2004) An Introduction to Copepod Diversity, vol. I. The Ray Society, London, pp 1-421.
- Chang CY (2007) Two harpacticoid species of genera *Nitokra* and *Ameira* (Harpacticoida: Ameiridae) from brackish waters in Korea. *Integr Biosci* 11: 247-253.
- Chang CY (2008) Brackish-water copepods of the family Tachidiidae (Copepoda: Harpacticoida) from South Korea. *Korean J Syst Zool* 24(2): 229-240.
- Chang CY and Kim HS (1991) *Harpacticella itoi*, a new harpacticoid species (Copepoda: Harpacticoida: Harpacticidae) from Korea. *Korean J Syst Zool* 7(1): 73-80.
- Chang CY and Yoon HJ (2008) *Nitokra* copepods (Harpacticoida: Ameiridae) from Korea. *Korean J Syst Zool* 24(1): 115-127.
- Huys R and Boxshall GA (1991) Copepod Evolution. The Ray Society, London, pp 1-468.
- Huys R, Ohtsuka S, Conroy-Dalton S, and Kikuchi Y (2005) Description of two new species of *Neotachidius* Shen and Tai (Copepoda, Harpacticoida, Tachidiidae) from Korean brackish waters and proposal of a new genus for *Tachidius* (*Tachidius*) *vicinospinalis* Shen and Tai, 1964. *Zool J Linn Soc* 143: 133-159.
- Lee JM and Chang CY (2003) Taxonomy on freshwater canthocamptid harpacticoids from Korea III. Genera *Mesochra* and *Elaphoidella*. *Korean J Syst Zool* 19(2): 203-216.
- Lee JM and Chang CY (2005) Harpacticoid copepods of genus *Onychocamptus* (Laophontidae) from Korea. *Korean J Syst Zool* 21(1): 31-34.
- Lee JM and Chang CY (2007) Three cletodid copepods of the genera *Limnocletodes* and *Kollerua* (Harpacticoida, Cletodidae) from coastal marshes and estuaries in South Korea. *Ocean Sci J* 42: 255-267.
- Lee JM and Chang CY (2008a) Copepods of the genus *Leptocaris* (Harpacticoida, Darcythompsoniidae) from salt marshes in South Korea. *Korean J Syst Zool* 24(1): 89-98.
- Lee JM and Chang CY (2008b) Two canthocamptid copepods of the genera *Itunella* and *Mesochra* (Harpacticoida, Canthocamptidae) from brackish waters in South Korea. *J Nat Hist* 42: 1729-1747.
- Shen CJ and Tai AY (1973) Preliminary analysis of the characteristics of the harpacticoid copepod fauna of China and description of some new species. *Acta Zool Sinica* 19(4): 365-384.
- Shirayama Y, Kaku T, and Higgins RP (1993) Double-sided microscopic observation of meiofauna using an HS-slide. *Benthos Res* 44: 41-44.
- Tai AY and Song YZ (1979) Harpacticoida Sars, 1903. In: Shen CJ (ed), Fauna Sinica, Crustacea, Freshwater Copepoda, Science Press, Peking, pp 164-300.
- Wells JBJ (1967) The littoral Copepoda (Crustacea) of Inhaca Island, Mozambique. *Trans Roy Soc Edin* 67(7): 189-358.

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