

A new species of the genus *Amphiascoides* (Copepoda: Harpacticoida) from Korean waters

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Abstract.—A new species, *Amphiascoides coreanus*, is described from the sandy beaches of Sangju-ri, Namhae, and Dolsan-do, Yeosu, the south coast of Korea. This species is clearly distinguishable from its congeners with the combined characters of the short bulbous caudal setae IV and V, three-segmented antennary exopod, and only one inner seta of the Leg 3 exopod segment 3. Additionally, the species is easily distinguishable from the congeners by the minute spinules on the dorsal body surface. The new species shares the three-segmented antennary exopod and only four setae on the third exopodal segment of Leg 3 with *A. dispar* and *A. paradebilis* but displays the characteristic shape of caudal setae. This is the first record of the genus *Amphiascoides* in the region.

Species of the genus *Amphiascoides* inhabit the interstitial environment, usually sandy beaches, and so far more than 21 species are known in the world (Bodin 1997, Suárez-Morales & Avilés-Torres 2003). Members of the genus are reported mainly from the coasts of the North, Mediterranean, and Black Seas and are not well known in the northwestern Pacific area, except for *A. paradebilis* Chislenko, 1978 from Possjet Bay near the border between North Korea and Russia.

During a survey of the harpacticoid community along the south coast of Korea, a new species of *Amphiascoides* was collected from sandy beaches at Dolsan-do and Sangju-ri. We provide an illustrated description of the new species

and discuss its relationships with other members of the genus.

Materials and Methods

Samples were collected from sandy beaches at Sangju-ri, Namhae, and Dolsan-do, Yeosu on the south coast of Korea. Specimens were dissected in lactic acid, and the dissected parts were mounted on slides in lactophenol mounting medium. Preparations were sealed with Glyceel or transparent nail varnish. All drawings were prepared using a camera lucida on an Olympus BX51 differential interference contrast microscope.

The descriptive terminology is adopted from Huys et al. (1996). Abbreviations used in the text are: A1, antennule; A2, antenna; ae, aesthetasc; exp, exopod; enp, endopod; P1–P6, first to sixth thoracopod; exp (enp)-1(2, 3) to denote the

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proximal (middle, distal) segment of a three-segmented ramus. Specimens are deposited in The Natural History Museum, London (NHM) and the Smithsonian Institution, National Museum of Natural History, Washington, D.C. (USNM). Scale bars in figures are indicated in μm .

Systematics

Family Miraciidae Dana, 1846

Genus *Amphiascooides* Nicholls, 1941

Amphiascooides coreanus, new species

Figs. 1–7

Type locality.—Dolsan beach ($34^{\circ}37'39''\text{N}$, $127^{\circ}47'44''\text{E}$), Dolsan Island, Yeosu, the south coast of Korea.

Material examined.—Holotype 1 σ (NHM 2007.441) from the type locality, collected by S. G. Seon on 20 Feb 1999. Paratypes: 10 $\sigma\sigma$, 10 $\sigma\sigma$ (NHM 2007.442–461) and 2 $\sigma\sigma$, 2 $\sigma\sigma$ (USNM 1101294) in 70% ethanol. All from the type locality, collected by S. G. Seon on 20 Feb 1999: 1 σ dissected on 10 slides, 1 σ on 9 slides, 1 σ on 9 slides and 1 σ on 6 slides, respectively, and 14 $\sigma\sigma$, 5 $\sigma\sigma$ in 70% ethanol from the type locality, and 10 $\sigma\sigma$, 10 $\sigma\sigma$ in 70% ethanol from Sangju beach ($34^{\circ}43'22''\text{N}$, $127^{\circ}59'30''\text{E}$), Sangju-ri, Namhae, the south coast of Korea, collected by W. Lee on 25 Mar 2006, will be deposited in the first author's collection (WL) in the Laboratory of Biodiversity, Department of Life Science, Hanyang University, Seoul.

Description of female.—Total body length 523 μm ($n = 10$, range: 429–536 μm ; measured from anterior margin of cephalic shield to posterior margin of caudal rami). Body cylindrical. Largest width measured at posterior margin of cephalic shield: 140 μm . Entire body surface armed with minute denticles (Figs. 1A, B, 2A).

Prosoma (Fig. 1A, B) 4-segmented, comprising cephalothorax (bearing first pedigerous somite) and 3 free pedigerous

somites. Cephalothorax denticulated (Fig. 1A), with few sensilla and smooth posterior margin. Pleural areas of cephalic shield narrow and posterolateral angles rounded. Succeeding three prosomites without distinct hyaline frills and with smooth posterior margin.

Rostrum well developed, elongated and bell-shaped with round anterior apex, defined at base (Fig. 1A, B). Dorsal surface denticulated as in cephalothorax, with pair of sensilla near anterior margin and with tube-pore on ventral surface near apex.

Urosome (Figs. 1A, B, 2A, B) 5-segmented, comprised of P5-bearing somite, genital double-somite, and 3 free abdominal somites. All urosomites denticulated, with smooth posterior margins.

Genital double-somite completely fused internally, however with surface suture dorsally and ventrally in middle of segment, indicating original segmentation. Genital field (Fig. 2A) located rather proximally and with copulatory pore located near gonophores medially. Gonopores fused medially, forming single genital slit covered on both sides by opercula derived from sixth legs. P6 with small protuberance bearing 1 bare and 2 pinnate setae; innermost seta longest.

Anal somite (Fig. 2B) with well-developed operculum with spinulate posterior margin and flanked by pair of secretory pores.

Caudal rami (Fig. 2A, B) as long as broad; seta I obscure; seta II strong, spinulate and located laterally; seta III more than 1.5 times longer than seta II and located dorsally; caudal setae V and IV very short and bulbous; seta VI slightly shorter than seta IV and located on distal inner corner; seta VII bare, close to middle of inner lateral margin, and triarticulated.

Antennule (Fig. 2C) 8-segmented, segment 1 with inner margin ornamented with rows of spinules. Armature formula: 1-[1 pinnate], 2-[9 bare + 1 pinnate], 3-[3

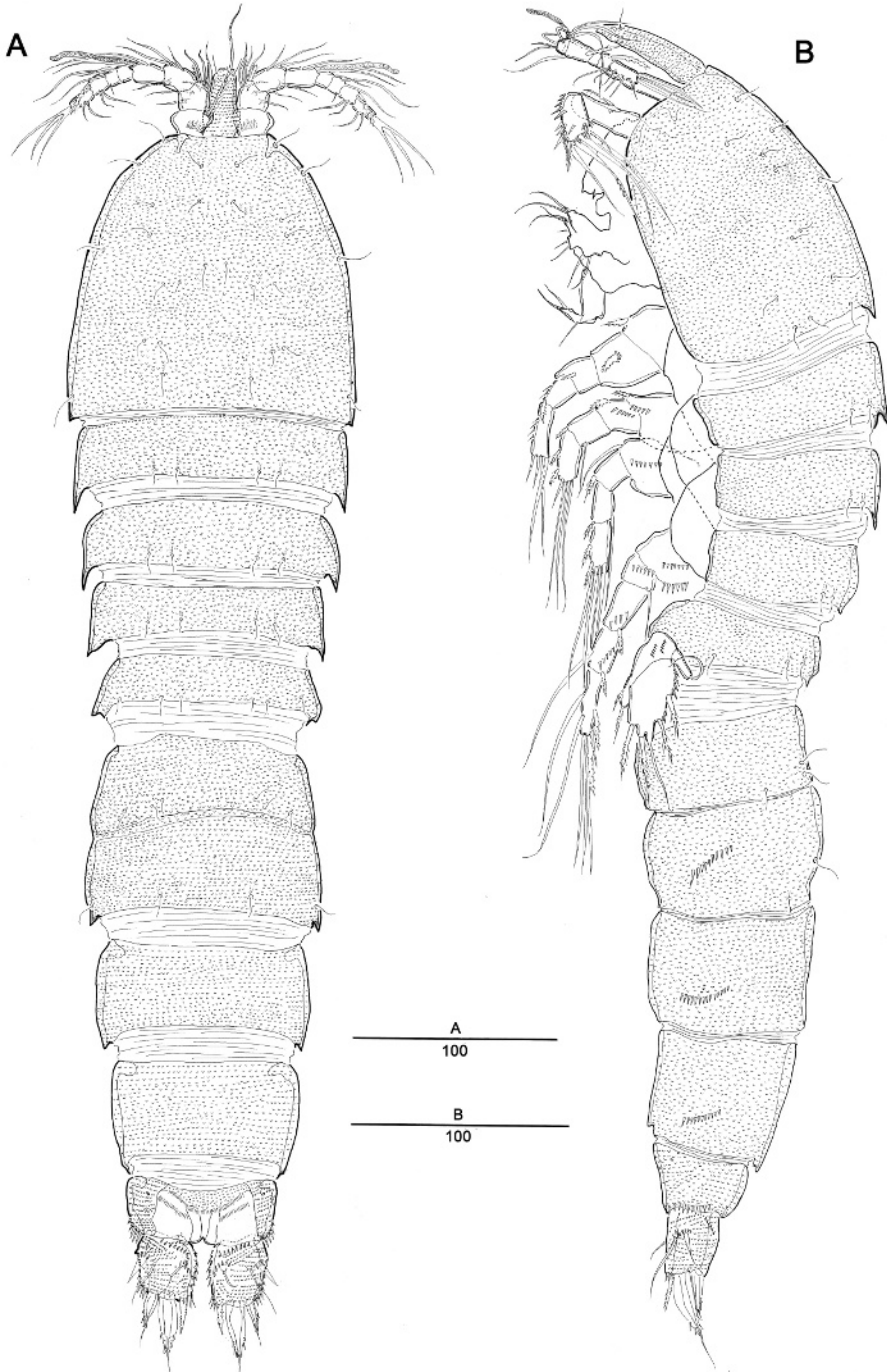


Fig. 1. *Amphascoides coreanus*. 1 (♀). A, habitus, dorsal; B, habitus, lateral.

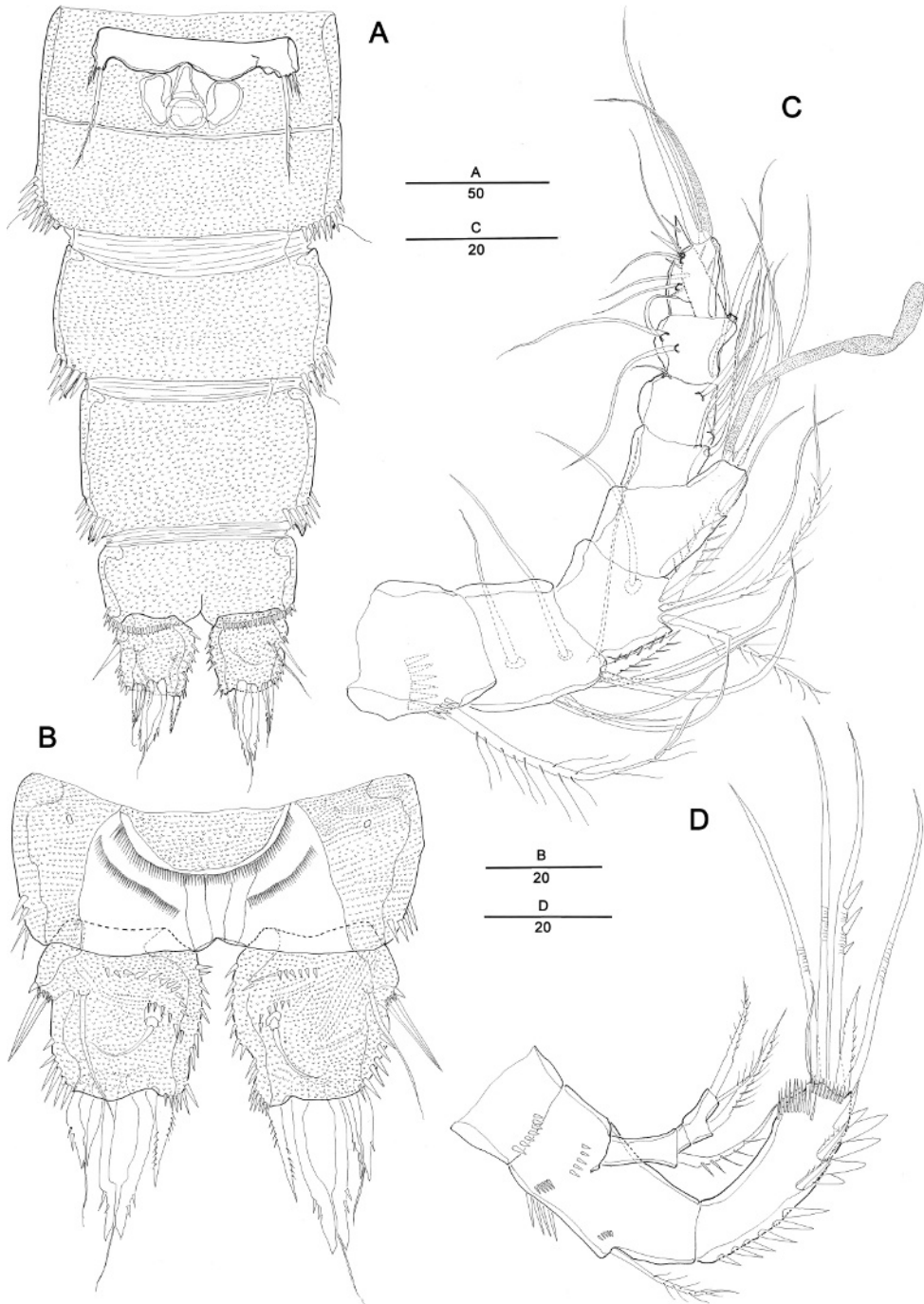


Fig. 2. *Amphiascoides coreanus*. 1 (♀). A, urosome, ventral (excluding P5-bearing somite); B, anal somite and caudal rami, dorsal; C, antennule; D, Antenna.

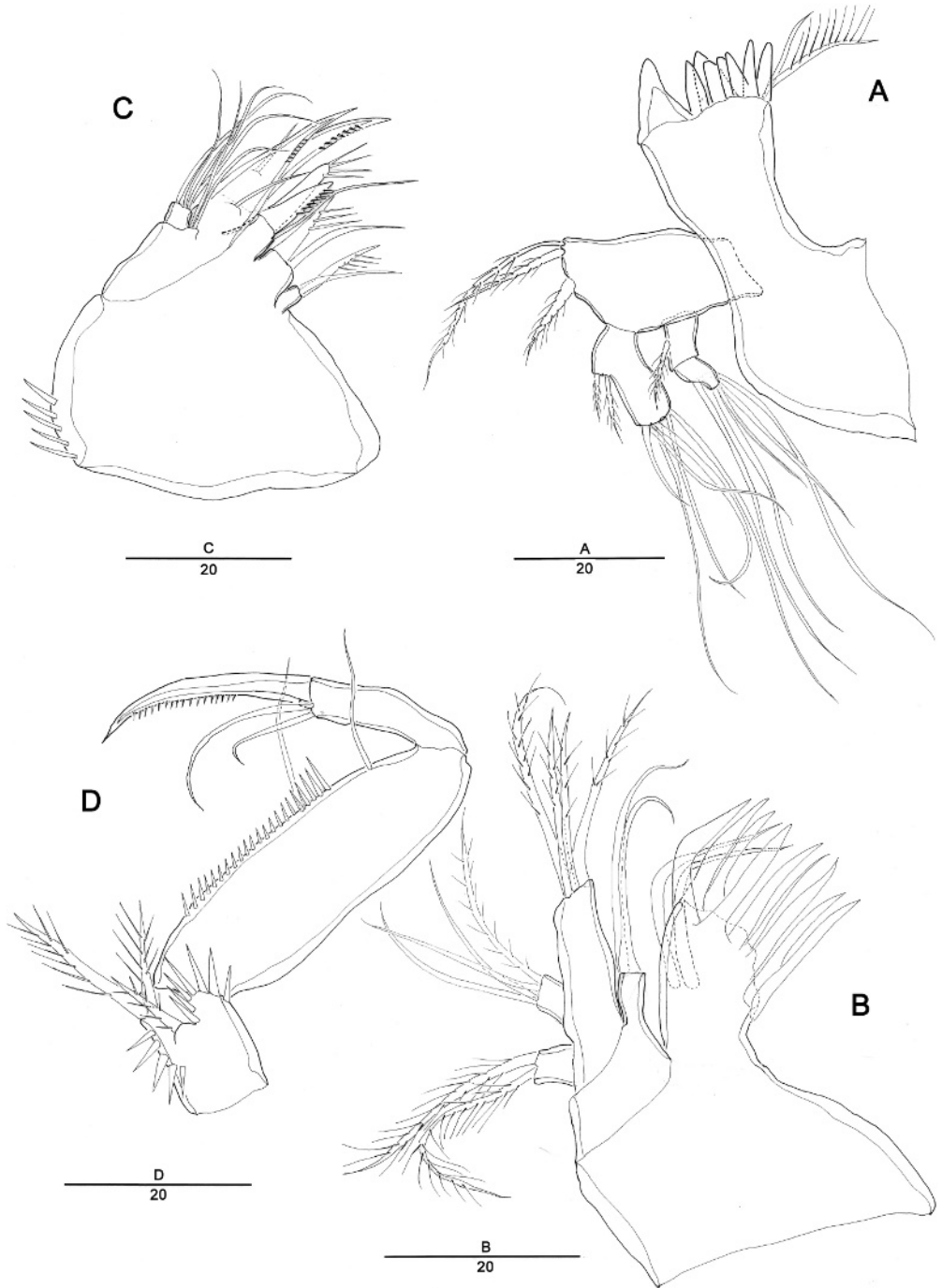


Fig. 3. *Amphascoides coreanus*. 1 (♀). A, mandible; B, maxillule; C, maxilla; D, maxilliped.

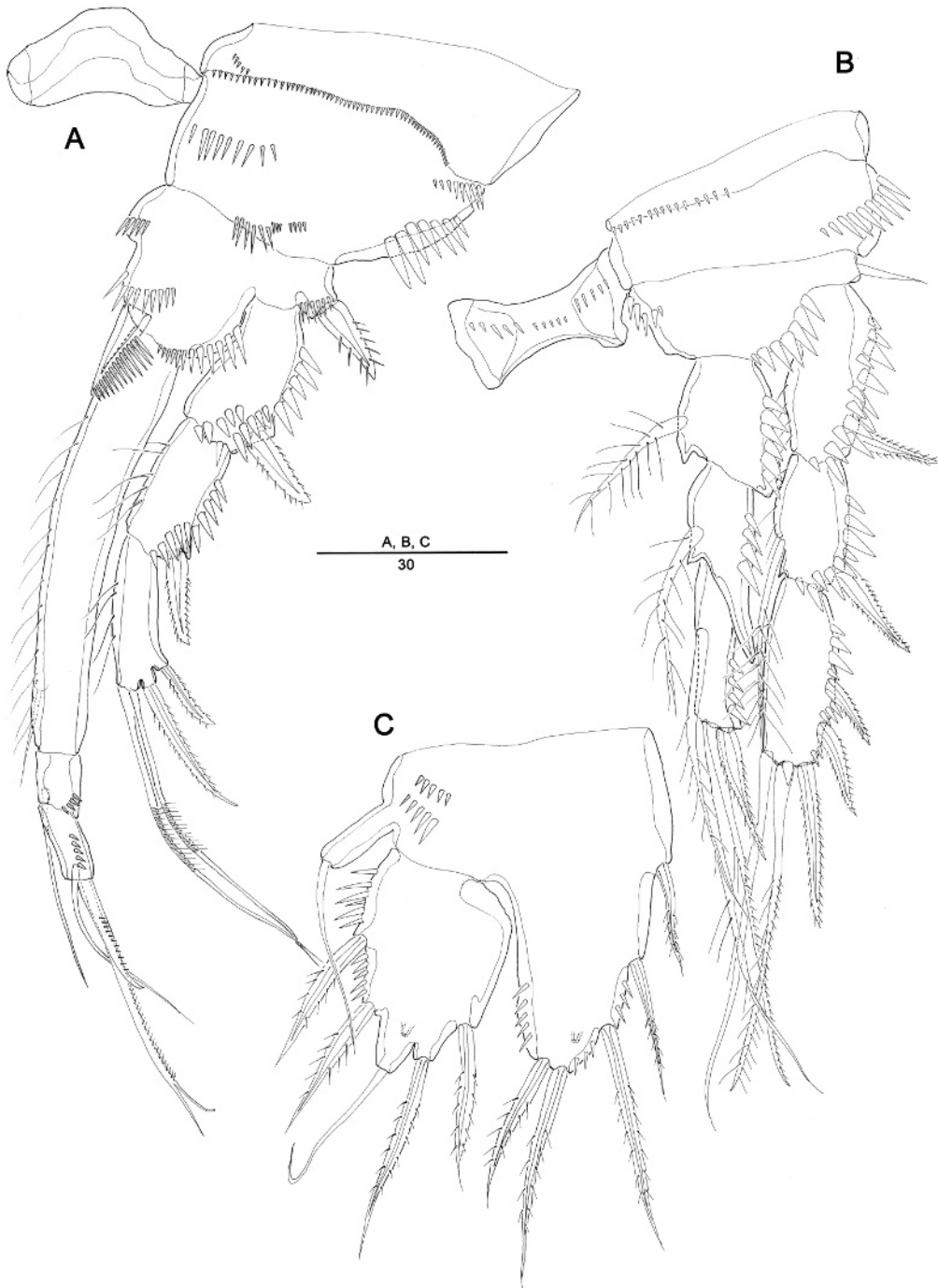


Fig. 4. *Amphiascoides coreanus*. (♀). A, P1, anterior; B, P2, anterior; C, P5.



Fig. 5. *Amphascoides coreanus*. (♀). A, P3; B, P4.

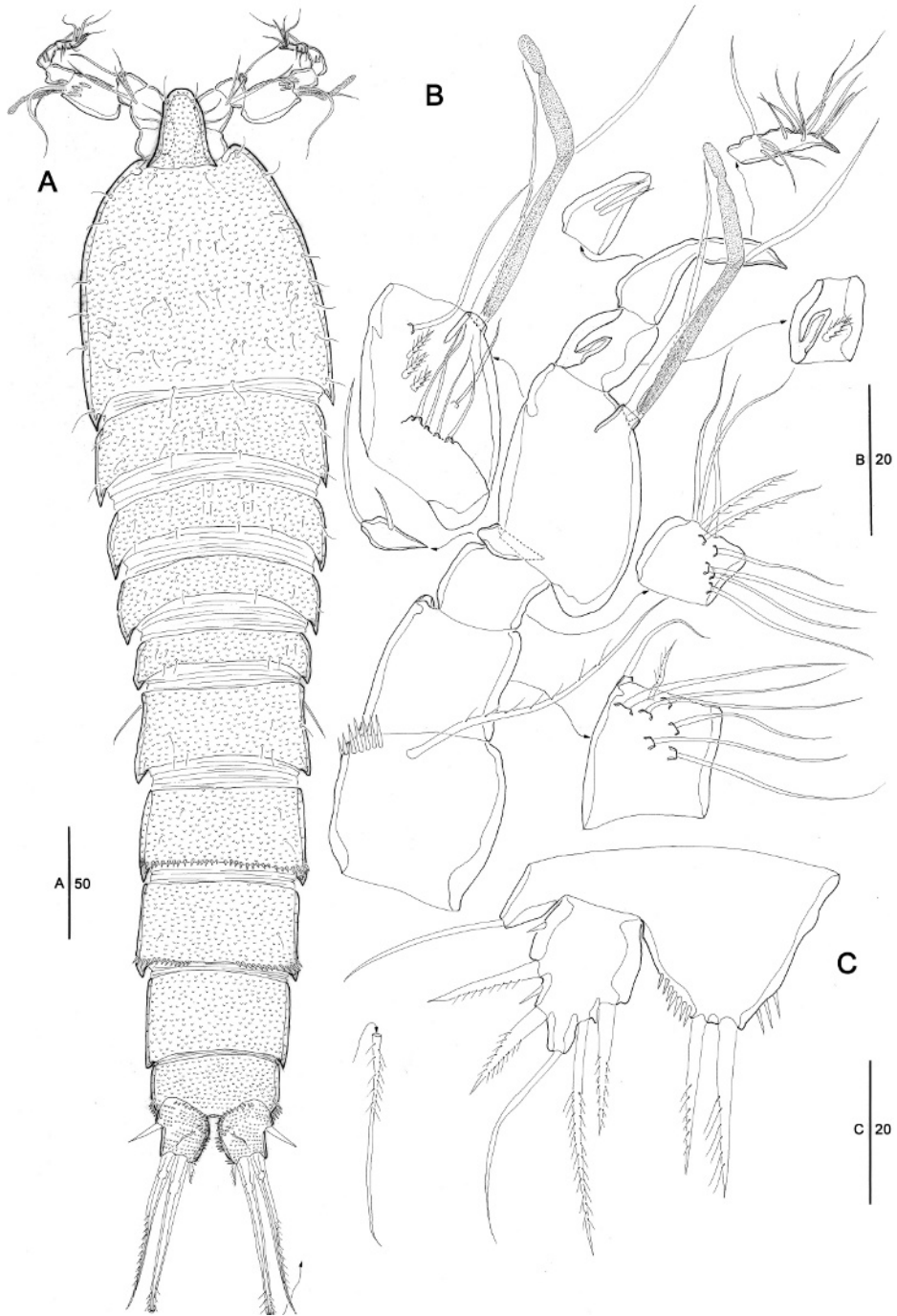


Fig. 6. *Amphascoides coreanus*. (♂). A, habitus, dorsal; B, antennule; C, P5.

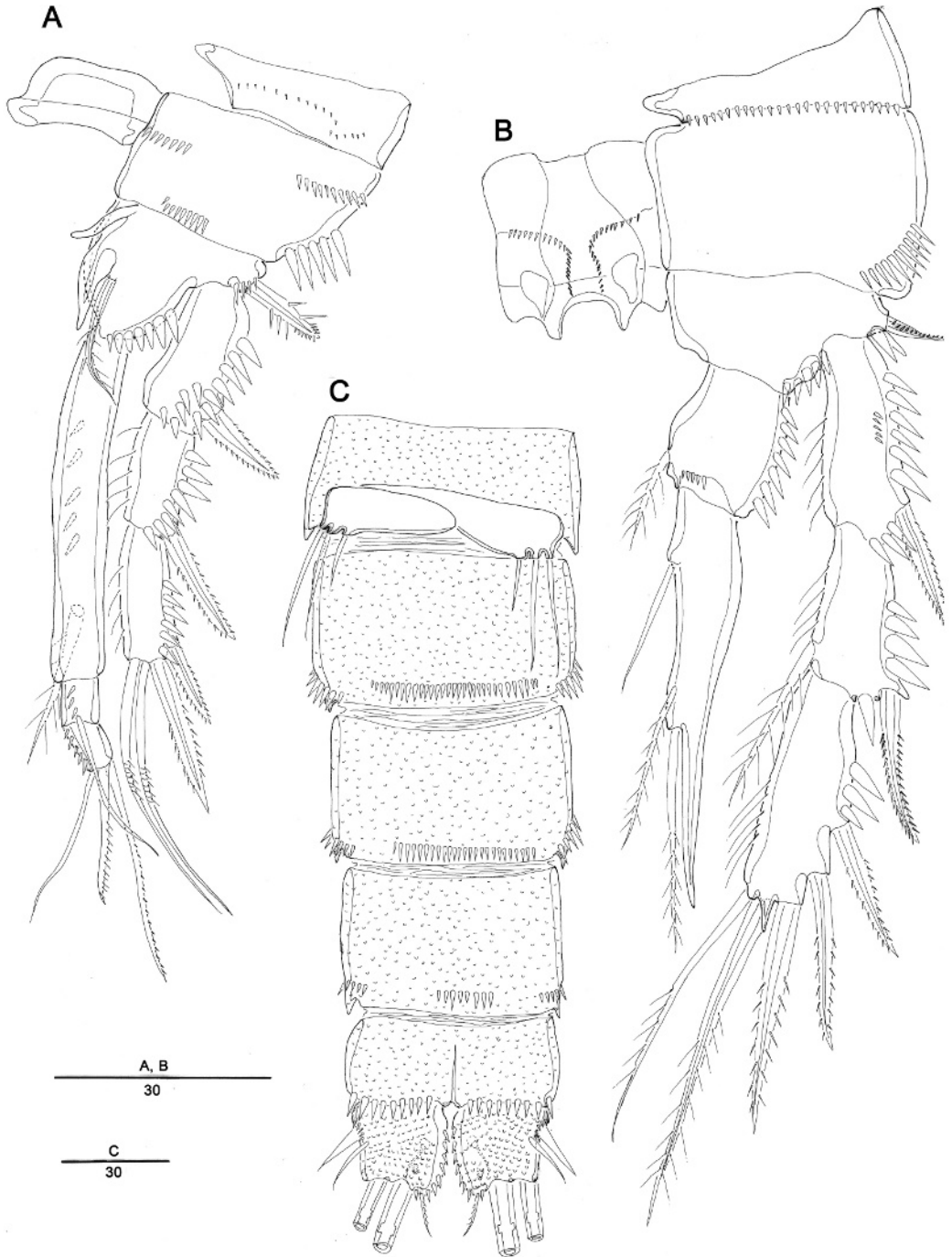


Fig. 7. *Amphiascoides coreanus*. (♂). A, P1; B, P2; C, urosome, ventral (excluding P5-bearing somite).

bare + 3 pinnate], 4-[2 bare + (1 + ae)], 5-[2 bare], 6-[4 bare], 7-[5 bare + 1 strong pinnate], 8-[4 bare + 1 acrothek]. Aesthetasc on segment 4 large and fused to long slender seta. Apical acrothek consisting of well-developed aesthetasc fused basally to 2 slender naked setae.

Antenna (Fig. 2D) 3-segmented, comprising coxa, allobasis, and free 1-segmented endopod. Allobasis with 1 plumose abexopodal seta medially. Exopod 3-segmented, with seta formula 1.0.120, respectively; all setae pinnate. Free endopodal segment with strong spinules along inner proximal margin, and with 2 pinnate spines laterally and 4 geniculate setae and 1 pinnate spine apically; outermost geniculate seta fused to small slender seta proximally.

Mandible (Fig. 3A) with large coxa bearing well-developed gnathobase; cutting edge with 8 major blunt teeth overlapping each other; accessory seta plumose, with 1 slender seta additionally. Mandibular palp developed. Basis with 3 plumose setae. Endopod 1-segmented, with 2 pinnate lateral and 6 naked apical setae. Exopod 2-segmented; segment 1 with 1 plumose seta; segment 2 with 5 naked setae.

Maxillule (Fig. 3B), arthrite well developed, with 2 surface setae and 9 apical setae and spines. Coxa with cylindrical endite bearing 2 naked slender setae. Basis with 4 pinnate setae apically. Endopod 1-segmented, with 1 pinnate and 3 naked setae apically. Exopod 1-segmented, with 2 plumose setae.

Maxilla (Fig. 3C), syncoxa with row of spinules on outer lateral margin and 3 endites; proximal endite with 1 pinnate and 1 naked setae; middle endite with 1 pinnate and 1 slender setae; and distal endite with 2 strong pinnate and 1 slender setae. Allobasis produced into strong claw, with 1 strong pinnate spine and 1 short slender seta posteriorly, 1 slender seta on median surface, and 2 slender setae near proximal area of endopod.

Endopod 1-segmented, with 4 slender apical setae.

Maxilliped (Fig. 3D) comprising syncoxa, basis, and 2-segmented endopod. Syncoxa with 3 pinnate spines distally. Basis with 2 slender setae and row of spinules along palmar margin. Endopod 2-segmented; proximal segment with 2 slender setae; distal segment produced into strong pinnate spine.

Swimming legs 1-4 (Figs. 4A, B, 5A, B) biramous, P1-P4 with 3-segmented exopod and 3-segmented endopod, and each ramus ornamented with setules and spinules along inner and outer margins as illustrated. Intercoxal sclerites well developed; those of P2-P4 ornamented with row of spinules in middle of anterior surface.

P1 (Fig. 4A), praecoxa with spinules on distal margin. Coxa wider than long and trapezoidal. Basis with 1 outer and 1 inner strong pinnate spine. Endopod 3-segmented, segment 1 longest, exceeding exopod in length; enp-1 with 1 naked seta on near inner distal margin; enp-2 with 1 slender inner seta; enp-3 with 2 pinnate spines and 1 slender seta. Exopod 3-segmented, each segment subequal in length; exp-3 with 2 geniculate distal setae and 2 strong spinulose outer spines; 2 distal setae subequal in length.

P2 (Fig. 4B), praecoxa, small with row of spinules along distal inner margin. Coxa with row of spinules on anterior surface and along outer margin. Basis with short naked outer seta and spinules on inner lateral margin, and row of spinules along distal margin near articulation with exopod. Endopod 3-segmented, not extending to distal end of exopod; row of strong spinules along outer margin of each segment; enp-1 as long as its width, with 1 plumose seta; enp-2 with elongated outer distal end forming blunt triangular tip; enp-3 rectangular. Exopod 3-segmented. Each segment with row of spinules along outer margins; exp-1 as long as exp-3; exp-2 shortest.

P3 (Fig. 5A), praecoxa with spinules on distal margin. Coxa with row of spinules along outer margin on anterior surface. Basis with long naked outer seta; row of spinules, near proximal area of outer seta, along distal margin near articulation with exopod and along inner lateral margin. Endopod 3-segmented, reaching almost to end of exp-3; each endopodal segment with row of spinules along outer lateral margin; enp-1 as long as its width; enp-2 with elongated outer distal end forming triangular tip; enp-3 rectangular. Exopod 3-segmented; first two segments with hair-like setules along inner lateral margin; each segment with row of spinules along outer margins; exp-1 as long as exp-3; exp-2 shortest.

P4 (Fig. 5B), praecoxa with row of spinules on distal margin. Coxa with row of spinules along outer margin on anterior surface. Basis with long naked outer seta, and row of spinules near proximal area of outer seta and along distal margin near articulation with exopod. Endopod 3-segmented, reaching to middle of exp-3; each endopodal segment with row of spinules along outer lateral margin; enp-1 as long as its width; enp-2 with elongated outer distal end forming triangular tip; enp-3 rectangular. Exopod 3-segmented; first two segments with hair-like setules along inner lateral margin; each segment with row of spinules along its outer margin; each segment subequal in length.

Armature formula as follows:

Thoracopod	Exopod	Endopod
P2	0.1.023	1.1.121
P3	0.1.123	1.1.121
P4	0.1.223	1.1.121

P5 (Fig. 4C), baseoendopod forming long, outer setophore bearing basal seta and rows of spinules along inner and outer margin. Endopodal lobe long but not reaching distal margin of exopod, with 3 pinnate inner lateral and 2 pinnate apical setae; inner proximal lateral seta

shortest; one secretory pore near apical margin of endopod; rows of short spinules near outer setophore on anterior surface. Exopod ovoid, as long as wide, with 1 slender apical, and 2 inner and 2 outer bipinnate setae of different lengths; one secretory pore near apical margin; rows of spinules along outer margin.

Description of male.—Male smaller and more slender than female. Body length 474 μm ($n = 10$, range: 353–459 μm , measured from anterior margin of cephalic shield to posterior margin of caudal rami). Greatest width measured at posterior margin of cephalic shield: 110 μm . Cephalic shield densely denticulated. Other somites also covered with tiny denticles, as illustrated in Fig. 6A.

Prosome (Fig. 6A) 4-segmented, comprised of cephalothorax (bearing first pedigerous somite) and 3 free pedigerous somites. Cephalothorax slightly narrower than in female and with smooth posterior margin. Succeeding three prosomites with smooth posterior margins. Rostrum same as in female.

Urosome (Figs. 6A, 7C) 6-segmented, comprised of P5-bearing somite, genital somite, and 4 free abdominal somites. All urosomites with pattern of surface ornamentation consisting of dense denticles dorsally and ventrally. Second and third urosomites with spinulose dorsal posterior margins, and other urosomites with smooth posterior margins; urosomites 3–6 each with row of spinules on ventral posterior margin. Caudal setae IV and V binate, long, clearly different from bulbous shape of female. Sexual dimorphism in A1, enp P2, P5, genital field, and caudal setae.

Antennule (Fig. 6B) 8-segmented and subchirocer with geniculation between segments 6 and 7. Segment 4 represented by small sclerite. Segment 5 swollen, largest. Aesthetascs on segments 5 and 8. Armature formula: 1-[1 pinnate], 2-[7 bare + 1 pinnate], 3-[7 bare + 2 pinnate], 4-[2 bare], 5-[7 bare + 3 pinnate + (1 + ae)], 6-[1 pinnate

+ 1 spinulate process], 7-[2 bare], 8-[10 bare + acrothek]. Apical acrothek consisting of minute aesthetasc and 2 naked setae.

P1 (Fig. 7A) enp-1 slightly shorter than that of female. Basis with 2 conical outgrowths along inner lateral margin.

P2 (Fig. 7B) endopod 2-segmented and enp-2 longer than enp-1; enp-1 with 1 pinnate inner seta, and row of spinules along outer margin; enp-2 with 1 bare and 1 pinnate inner setae, 1 pinnate distal seta and 1 well-developed apophysis on outer lateral margin. Setae and spines of exopod slightly thicker than those in female.

P5 (Fig. 6C). Both legs defined. Baseoendopod with 2 pinnate setae and row of spinules along inner and outer margins. Exopod with 5 setae: 2 inner and 2 outer pinnate setae and 1 naked terminal seta set on peduncle. Outer basal seta bare.

Sixth legs (Fig. 7C) asymmetrical, each represented by small plate with 3 naked setae; innermost seta shortest and others subequal in length (fused to ventral wall of supporting somite along one side, articulating at base, and covering gonopore along other side).

Etymology.—The specific name refers to the type locality, the south coast of Korea.

Discussion

The new species is placed in the genus *Amphiascoides* because of the 8-segmented female antennule, well-developed and elongated rostrum, short caudal ramus, elongated endopodal segment 1 of P1, the pattern of sexual dimorphism in P2, and the three setae on female P6.

Lotufo & Fleeger (1995) recognized two groups within *Amphiascoides*, divided according to the number of setae on the third exopodal segment of P4. *Amphiascoides coreanus* belongs to a group bearing 7 elements on the segment, with *A. atopus* Lotufo & Fleeger, *A. brevifurca* (Czernivaski), *A. neglectus* (Norman & T. Scott), *A. subdebilis* (Willey), *A. lancisetiger* Lang, *A. petkovskii* Lang, *A. dimor-*

phus Lang, *A. nichollsi* Lang, *A. bulbiseta* Pallares, *A. koltuni* Kunz, *A. breviararticulatus* Kunz, and *A. walteri* Suárez-Morales & Avilés-Torres. However, *A. coreanus* differs from all the above species in respect to its bulbous caudal setae IV and V, and fewer elements on the third endopodal segment of P3.

Amphiascoides coreanus has a unique set of apomorphies including 1) denticulated body surface, 2) sexually dimorphic caudal seta IV and V (bulbous only in the female), 3) the strong pinnate spine on the seventh segment of antennule in the female, 4) the three-segmented antenna, and 5) only four elements on the third endopodal segment of P3. *Amphiascoides coreanus* is the only species in the genus to have minute denticles on the entire body surface. None of its congeners has similar patterns of denticulated ornamentation on the body surface (see Fig. 1A, B). Several congeners including *A. limicolus* sensu Brady, 1900 [see Lang 1948, p. 722, Abb. 292, 1. Currently *A. limicolus* (Brady) is treated as a junior synonym of *A. debilis* since Lorenzen's (1969) and Moore's (1976) confirmation of the existence of intermediate forms between the two species], *A. bulbiseta* (see Pallares 1975, p. 226, Pl. XII, 12 and 13), and *A. dimorphus* (see Lang 1965, pp. 317, 319, figs. 176, 178) display the bulbous or modified caudal seta IV in the female as in *A. coreanus*. Those four species, including *A. coreanus*, have normal slender seta IV in the male. The bulbous caudal seta V in the female of *A. coreanus* is a unique apomorphic character within the genus. The strong pinnate spine on the seventh segment of the female antennule is also a unique apomorphy of *A. coreanus* within the genus. The relatively short antennule bearing several stout and strong pinnate spines (Fig. 2C) and the denticles on the entire body surface in *A. coreanus* possibly reflect its habitat in coarse and fine sand, because a member of Rhizothricidae, *Rhizothrix sejongi*

Nam & Lee, 2005, from the same locality, displays identical features (see Nam & Lee 2005, p. 694, Fig. 1A–C, p. 695, Fig. 2 A–C). The majority of congeners have a three-segmented antennary exopod as in *A. coreanus*, but several species, including *A. koltuni* and *A. walteri*, have a two-segmented exopod; whereas in some other species, this state is unknown. The two-segmented antennary exopod possibly resulted from fusion of the original proximal and middle segments of the exopod, because the seta on the proximal segment of the exopod is located at the distal end of the segment (compare Fig. 2D and Chislenko 1977, p. 181, Pl. 14, 4). *Amphiascooides coreanus* bears only four setae on the last endopodal segment of P3, sharing the same seta number with *A. dispar* (T. & A. Scott) and *A. paradebilis* Chislenko; whereas the other congeners display five setae on the same segment. *Amphiascooides coreanus* is readily distinguished from both species, *A. dispar* and *A. paradebilis*, by the two inner setae on the last exopodal segment in P4 (only one seta is present in *A. dispar* and *A. paradebilis*) and the bulbous caudal setae IV and V in the female.

Sexually dimorphic features appear in the P1 and P2 of *Amphiascooides coreanus*. The basal process along the inner lateral margin of P1 consists of two conical outgrowths with blunt tips in the male (Fig. 7A). The modified endopod of the male P2 has a simple mucroniform terminal process and two distal setae located close to each other (Fig. 7B). *Amphiascooides paradebilis* (see Chislenko 1978, pl. 16, 3, 4) and *A. dimorphus* (see Lang 1965, p. 319, Fig. 178, f) also have the two, closely set distal setae on the P2 enp-2, showing a similar appearance to those in *A. coreanus*; both species are distinguished from *A. coreanus* by the setation of the swimming legs and the shape of caudal seta IV and V in the female.

Suárez-Morales & Avilés-Torres (2003) summarize the world distribution of *Am-*

phascooides. According to them, the only species recorded on the northwestern Pacific coasts is *A. paradebilis* from Possjet Bay near the border between North Korea and Russia (Chislenko 1978).

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