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# A new species and a new genus of Parabathynellidae (Crustacea, Syncarida) from South Korea*

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## Abstract

*Arisubathynella* **gen. nov**. is established for a new species, *A. cheongmiensis* **sp. nov.** from South Korea. An illustrated description is given. The new genus stands out in the family Parabathynellidae by six-segmented antennules, three-segmented antenna without medial seta on inner margin of third segment, absence of mandibulartooth of the ventral edge, bare proximal segment of maxilla, two-segmented exopods of thoracopods II-VII, and male thoracopod VIII with elongated external lobe. *Arisubathynella* **gen. nov**. is the fourth genus known from South Korea and foreshadows the great diversity of bathynellaceans in the Far East.

**KEY WORDS**: Parabathynellidae, *Arisubathynella* **gen. nov.** et **sp. nov**. South Korea

## Introduction

Parabathynellidae is a cosmopolitan family of bathynellacean Syncarida confined to life in continental groundwater. Up to now, 177 species in 45 genera are known worldwide (cf. Camacho et al. 2011). Among them, 34 species in 12 genera have been reported from Asia including India and Central Asia, while 16 species in three genera are known from the Far East. Seven of 12 genera are erected for a single species from Southeast and Central Asia, whereas the three genera of the Far East are speciose: *Allobathynella* Morimoto and Miura, 1957 with eight species; *Eobathynella* Birstein and Ljovuschkin, 1964 with five species; *Nipponbathynella* Schminke, 1973 with three species. Since recent studies on the bathynellacean fauna of the Far East has resulted in the discovery of three new species belonging to the three genera just mentioned (Cho et al. 2008; Park and Cho 2008; Schminke 2011), the parabathynellids of the Far East do not appear to be as diverse at the supraspecific level as those in Southeast Asia.

The new species to be reported here indicates that the current picture is incomplete. The peculiarities of the new species are not covered by any current generic diagnosis within the family. It is thus very likely that the diversity of parabathynellids in the Far East will unfold as a result of future research. This is the fourth genus to be reported from the Korean Peninsula.

## Material and methods

Specimens were collected from a well-developed sandbank on the riverside of a tributary of the Han-River (Cheongmi-Stream). For collection, a pit was dug to the groundwater level (depth: 1 m; distance from surface water: 50 m). Water from the bottom of the pit was filtered through a bolting-silk plankton net (mesh size 50μm), and the filtrate was kept at -20 ℃ before sorting. Sorted specimens were placed into 70% alcohol and later transferred to glycerol.

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The specimens were dissected and mounted in a mixture of glycerin-formalin. For drawing and investigation, a Nikon Eclipse 80i-Microscope with differential interference contrast equipment was used with oil immersion. The type materials of the new species herein described are as permanent preparations deposited in the collection of the National Institute of Biological Resources, Korea (NIBR).

## Systematics

### Family Parabathynellidae Noodt, 1965

#### *Arisubathynella* gen. nov.

**Diagnosis**. Small size. Body elongated and cylindrical. Antennule six-segmented. Antenna three-segmented without medial seta on inner margin of third segment. Mandible: incisor process with three teeth, tooth of the ventral edge absent, lobe with row of five stout spines. Maxilla four-segmented. Exopod of thoracopod I one-segmented with two terminal setae and one ventral seta, exopods of thoracopods II–VII two-segmented. Male thoracopod VIII: protopod massive, with protruding penial region; external lobe present in form of elongated process exceeding penial region; basipod approximately half the size of the protopod with a basipodal seta; endopod small with two apical setae; exopod two-lobed: upper lobe round and smooth, lower lobe with distal teeth. Female thoracopod VIII tooth-like. Pleopod in form of seta. Uropod: sympod with inhomonomous spines, of which the most distal one is larger than the others; endopod drawn out into a dagger-like structure, with three distal setae; exopod with basi-ventral seta. Pleotelson with setae. Anal operculum flat to slightly convex. Furcal rami with more than three spines.

**Etymology**. The generic epithet is derived from the old name of the Han River, Arisu, running through the central region of Korea.

#### *Arisubathynella cheongmiensis* n. sp.
(Figs. 1 – 4)

**Type material.** Holotype: male, dissected and mounted on six slides. South Korea, Kyeonggi-Do, Yeoju-Gun, Jumdong-Myon, Dori (37°13’54.6” N, 127°43’4.1” E), 12. March 2010, (J.-L. Cho) (NIBR IV0000242682). Allotype: female, dissected and mounted on six slides, same data as for holotype (NIBR IV0000242683). Paratypes: 3 males and 2 females each mounted as a whole specimen on a slide (NIBR IV0000242684–IV0000242688), one male and one female each dissected and mounted on six slides (NIBR IV0002242689, IV0000242690), same data as for holotype.

**Description of adult male (Holotype).** Body length 1.03 mm (other males: 0.94–1.01 mm). Approximately 16 times wide. Head slightly longer than anterior two thoracic segments together (Fig. 1A).

Antennule (Fig. 1B) six-segmented. First segment with one seta on inner distal corner, with one simple dorsal seta and with one dorso-lateral, one medio-lateral and one ventro-lateral plumose seta. Second segment with one group of four plumose setae and with one simple seta on inner distal corner. Third segment with one seta on inner distal corner, two lateral simple setae of very unequal size and one simple ventro-lateral seta. Inner flagellum of third segment with three simple setae. Fourth segment with one stub seta and one plumose seta on dorsal margin, and with two stub setae and two plumose setae on outer distal apophysis. Fifth segment with three simple setae on inner distal margin and three dorsal aesthetascs. Sixth segment with three subterminal aesthetascs of different size and four simple setae.

Antenna (Fig. 1C) three-segmented, as long as first antennular segment. Two proximal segments without setae, distal segment with two simple setae of different size and one plumose seta terminally. Plumose seta as long as long simple seta.

Labrum (Fig. 1D) flat, with eight median teeth of more or less similar size flanked by two smaller distally dentate teeth on both sides. Inner surface with one nipple-like protrusion and six rows of ctenidia on both sides.

Mandible (Fig. 1E) with incisor process of three teeth. Tooth of the ventral edge absent. Lobe with row consisting of five spines. Palp of one segment, four times as long as wide, with one apical seta.

Maxillule (Fig. 1F) two-segmented. Proximal segment with four setae on inner distal margin. Distal segment with two terminal smooth spines, three dentate spines on inner edge and with three simple setae of different size on outer distal margin.

Maxilla (Fig. 1G) four-segmented, setal formula 0-4-7-7.

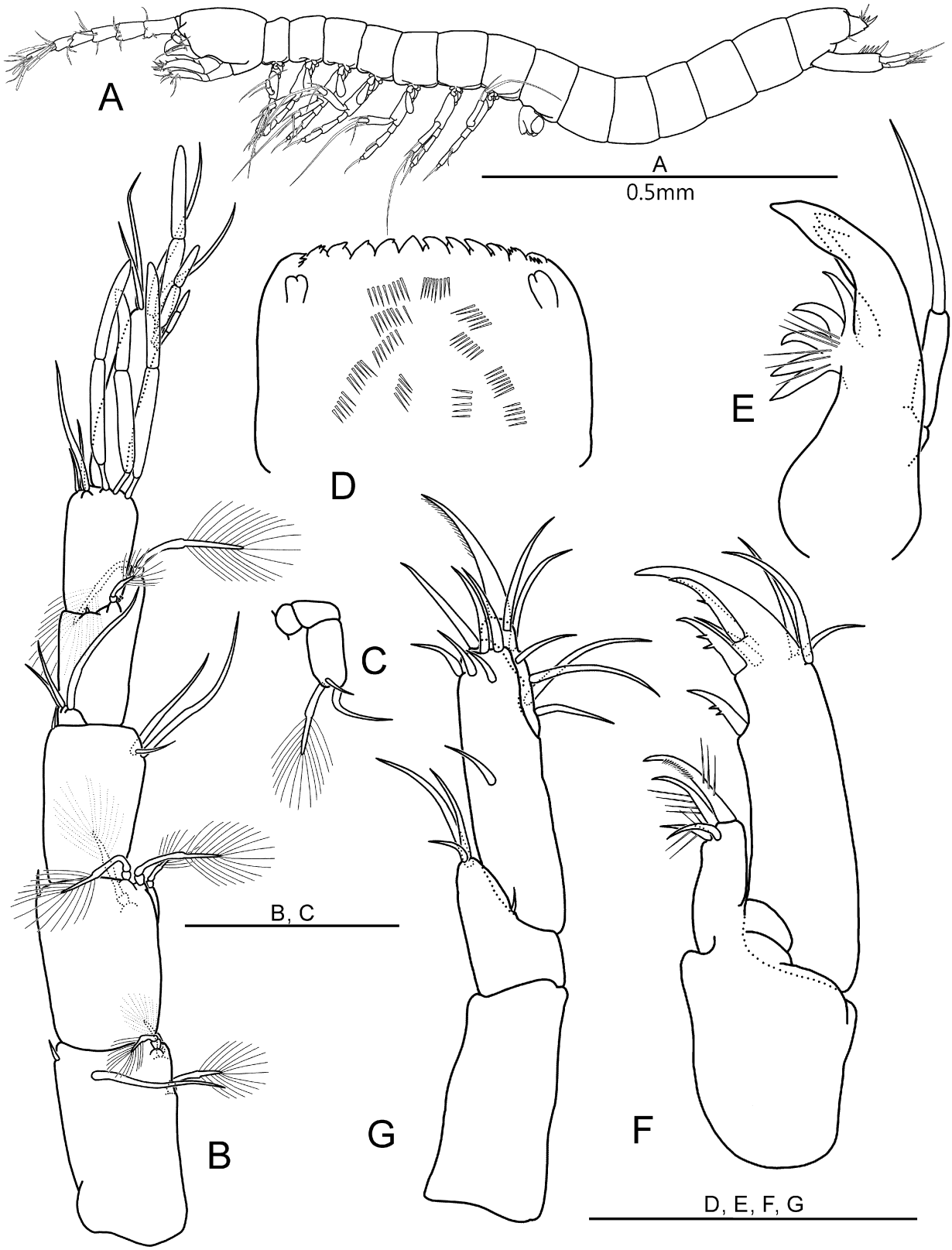


**FIGURE 1**. *Arisubathynella cheongmiensis* **gen. nov.** et **sp. nov.**, holotype male: A, General habitus (lateral); B, Antennule (dorsal); C, Antenna (dorsal); D, Labrum (ventral); E, Mandible (ventral); F, Maxillule (dorsal); G, Maxilla (dorsal). Scale bars = 0.05 mm, unless specified otherwise.

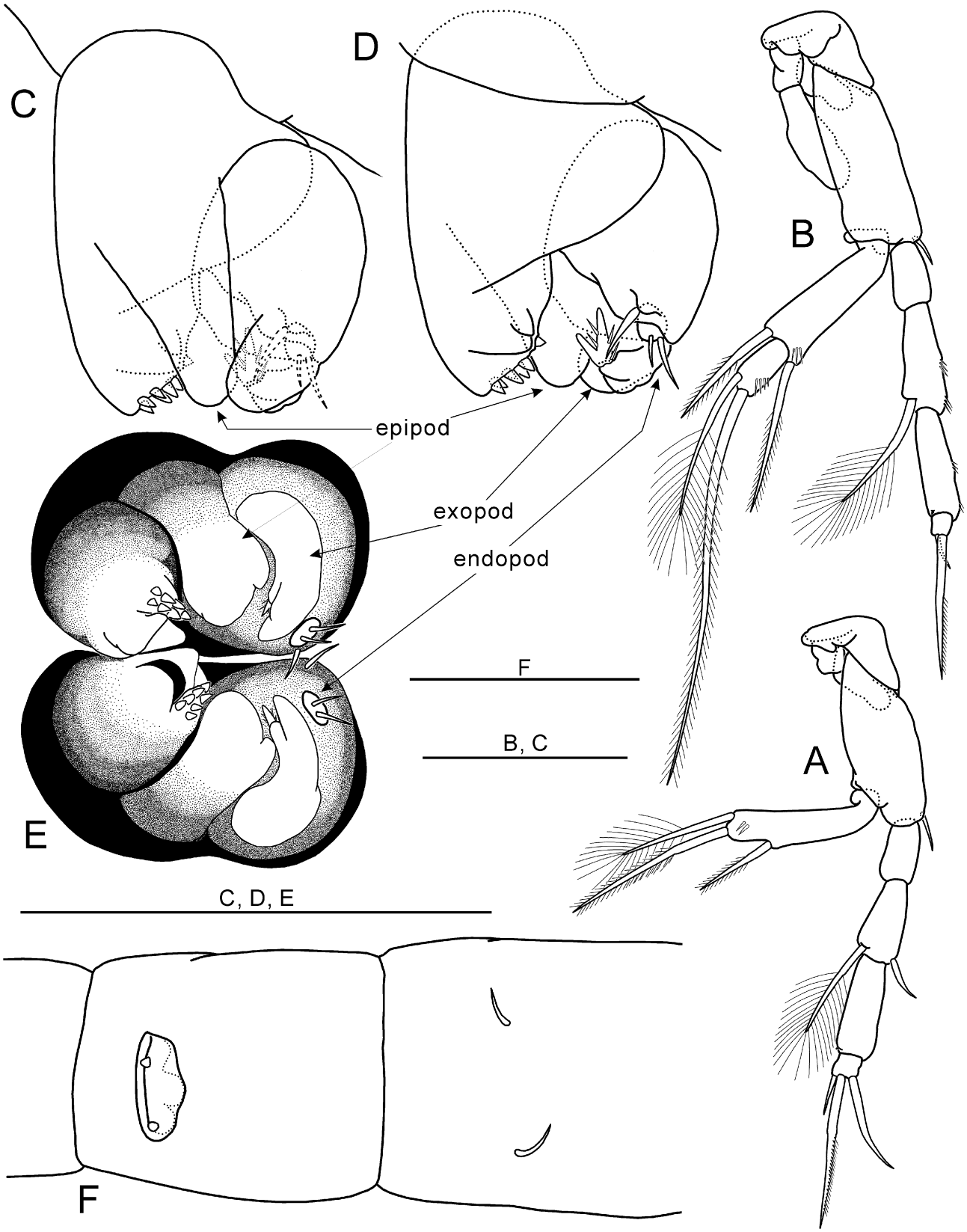


**FIGURE 2.** *Arisubathynella cheongmiensis* **gen. nov.** et **sp. nov.**, holotype male: A, Thoracopod I (frontal); B, Thoracopod II (frontal); C, Thoracopod VIII (latero-external); D, Thoracopod VIII (latero-internal); E, Right and left thoracopod VIII (ventral). Allotype female: F, 7th thoracomere with thoracopods VIII and 1st pleomere with pleopod (ventral). Scale bars = 0.05 mm.

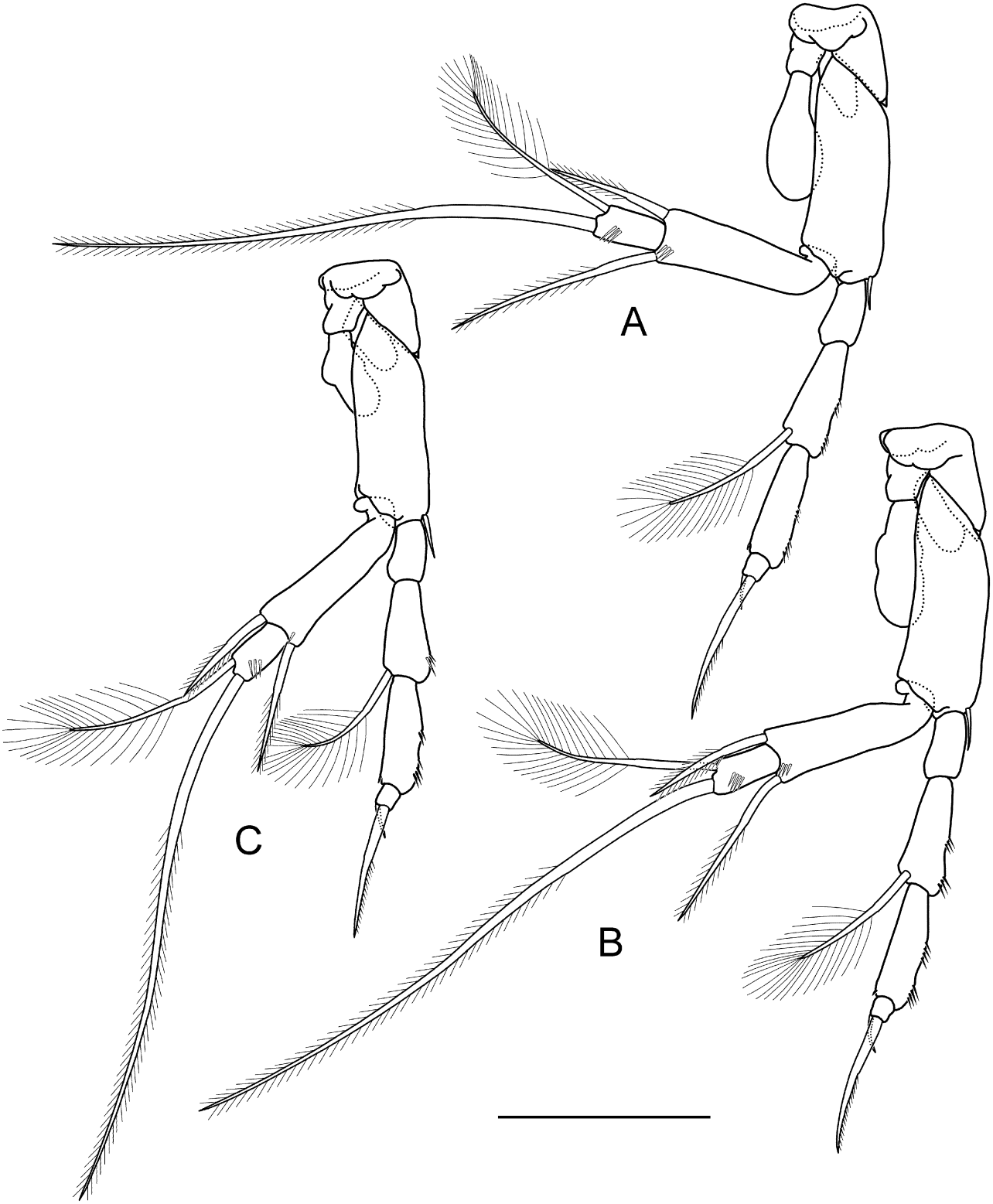


**FIGURE 3**. *Arisubathynella cheongmiensis* **gen. nov.** et **sp. nov.**, holotype male: A, Thoracopod III (frontal); B, Thoracopod IV (frontal); C, Thoracopod V (frontal). Scale bar = 0.05 mm.

Thoracopods I – VII (Figs. 2A, B, 3A, B, C, 4A, B, C) similar in size except thoracopod I. Thoracopods II – V each with one epipod. Thoracopods I, VI-VII without epipod. Basipod of thoracopods I – VII with one seta at inner distal corner. Exopod of thoracopod I one-segmented, with one medial seta on ventral edge and terminally with one long seta and one shorter plumose seta. Exopods of thoracopods II – VII two-segmented. Proximal segment being longer than distal one and with one dorsal and one ventral seta. Distal segment with one long seta and one plumose seta terminally. Endopods of thoracopods I – VII four-segmented, setal formulae:

Thoracopod I 0+0/1+1/0+1/3(1)
Thoracopod II – VII 0+0/0+1/0+1/2(1)

Thoracopod VIII (Figs. 2C, D, E) bell-shaped in lateral view, 1.2 times longer than wide. Main axis tilting backwards. Protopod massive with prominent penial region displaying distal opening encircled by frontal, dentate and with inner lobe. Frontal and inner lobe smooth. Dentate lobe with seven tiny denticles. External lobe (epipod) conical in lateral view, balloon-shaped in ventral view, exceeding penial region in lateral view. Basipod as large as half protopod, with one basipodal seta near base of endopod. Exopod one third the size of basipod, two-lobed distally; upper lobe smooth, lower lobe with bifurcate tooth. Endopod small with two termintal setae.

First pleopod in form of seta (cf. Fig. 2F).

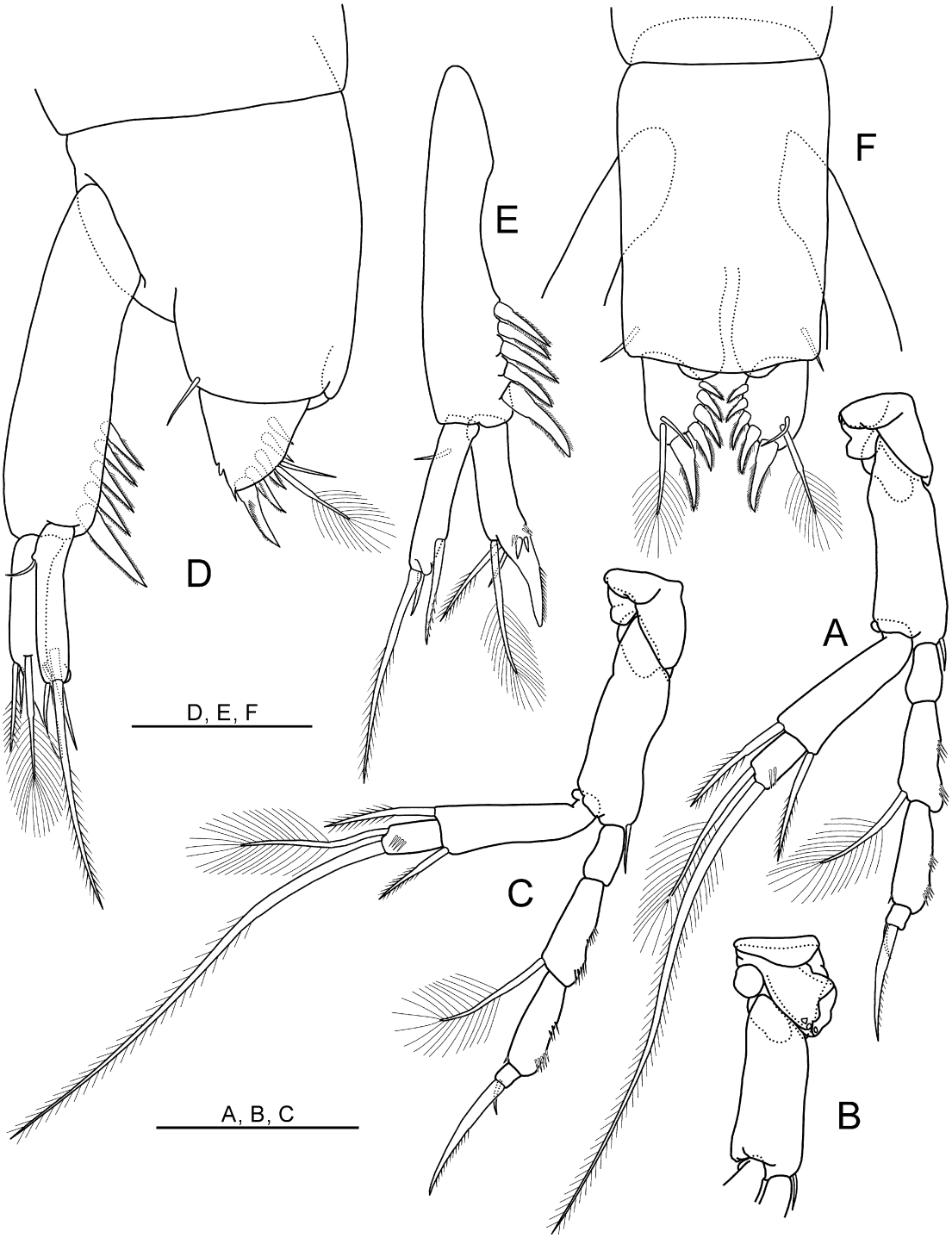


**FIGURE 4**. *Arisubathynella cheongmiensis* **gen. nov.** et **sp. nov.**, A, C-F, holotype male; B, allotype female: A, Thoracopod VI (frontal); B, Protopod of thoracopod VI (frontal); C, Thoracopod VII (frontal); D, Uropod, pleotelson and furcal rami (lateral); E, Uropod; F, Pleotelson and furcal rami (dorsal). Scale bars = 0.05 mm.

Uropod (Fig. 4D, E) with sympod bearing five spines. Most distal spine thicker and longer than the others which are of similar size. Endopod 40 % as long as sympod, with one large, fused, distal spur and two much smaller spines at its base, two simple setae and one plumose seta on outer distal margin. Exopod longer than endopod, with one basi-ventral seta and distally with one subterminal latero-internal seta, one projection and two terminal setae, of which the outer seta is six times longer than the inner one.

Pleotelson (Figs. 4D, F) with one seta near base of furcal rami. Anal operculum slightly convex. Furcal rami slightly longer than wide, with five spines and two setae, of which the longer one is plumose.

**Description of adult female (Allotype).** The female differs from the male in the protopod of thoracopod VI and in thoracopod VIII. Body length1.05 (other females: 0.95 – 1.05mm). Protopod of thoracopod VI (Fig. 4B) with tubular protrusion directed inwards. Distal margin of protrusion undulate. Thoracopod (Fig. 2F) form of two tiny teeth on hemispherical plate.

**Etymology** . The specific epithet is derived from a tributary of the Han-River (Cheongmi Stream), where the new species was discovered.

## Discussion

The number of antennal segments, the structure of mouth parts and the form of male thoracopod VIII are considered to be decisive in recognizing groupings of species within the family Parabathynellidae (Schminke 1973). As the new species shows peculiarities in these appendages, the discussion on its taxonomic position begins with comparing these characters.

Within Parabathynellidae a three-segmented antenna, as displayed by the new species, is present otherwise in Iberobathynellini Camacho and Serben 1998 (comprising *Californibathynella* Camacho & Serban, 1998, *Guadalopebathynella* Camacho & Serban, 1998, *Hexaiberobathynella* Camacho & Serban, 1998, *Iberobathynella* Schminke, 1973, *Paraiberobathynella* Camacho & Serban, 1998, *Texanobathynella* Delamare et al., 1975) and in *Afrobathynella* Schminke, 1976. The antenna of Iberobathynellini is similar to that of the new species in that the first two segments are bare whereas the third one carries two simple setae and one plumose seta terminally, but it differs in having an additional simple seta half length on the inner margin of the third segment. The antenna of *Afrobathynella* differs even more in that only the first segment is bare, the second segment has an inner seta and the third segment two simple setae and a plumose seta terminally as well as one marginal simple seta at half length on both sides (Schminke 1976). It must be noted that the antenna of *Noodtibathynella* Schminke, 1973, originally described as three-segmented, requires revision. A study of two specimens of *Noodtibathynella neotropica* Noodt, 1965 has revealed that the antenna of this species is in fact four-segmented: first and second segments bare; second segment with one inner seta; third segment with three terminal setae (see Schminke 2011, Fig. 51B).

The second peculiarity of the new species, the absence of the tooth of the ventral edge of the mandible, is so far known for *Haplophallonella heterodonta* Serban and Coineau 1975 and some species of *Allobathynella* Schminke, 1973, which comprise the "*mirabilis*-group" (*A. japonica* Morimoto and Miura, 1957, *A. mirabilis* Ueno, 1961, *A. coreana* Morimoto, 1970 and *A. shinjongieei* Park and Cho, 2008). In all these species, however, the mandible has an incisor process of four teeth (three in the new species). The lobe has a row consisting of more than five spines (*Allobathynella*) or of five spines (*Haplophallonella* and the new species).

The third peculiarity, the proximal maxillar segment lacking setae, is otherwise displayed by the derived genera of the "*Cteniobathynella*-group" (sensu Schminke 1973) such as *Brasilibathynella* Jakobi, 1958, *Califobathynella* Cho, 1997, *Leptobathynella* Noodt, 1964, *Odontobathynella* Delamare Deboutteville and Serban, 1979, and *Parvulobathynella* Schminke, 1973 and several species of *Iberobathynella* (*I. asturiensis* Serban and Comas i Navarro, 1978, *I. parasturiensis* Camacho and Serban, 1998, *I. cavadoensis* Noodt and Galhano, 1969, *I. ortizi* Camacho, 1989, *I.guarenensis* Camacho, 2003, *I. pedroi* Camacho, 2003, *I. serbani* Camacho, 2003, *I. lamasonensis* Camacho, 2005, ) as well as by *Hexaiberobathynella* Camacho & Serban, 1998. In the genera of the "*Cteniobathynella*-group", the proximal segment is, unlike that of the new species, always as long as wide and the second and third segments of the maxilla are fused to one segment, while the maxilla of the mentioned species of *Iberobathynella* and *Hexaiberobathynella* is not 4-segmented, but always 3-segmented (see Camacho 2003, 2005).

So far, the new species is the only East Asian parabathynellid with a prominent external lobe of the male thoracopod VIII: The external lobe (epipod) is round and flat in the "*mirabilis* group" of *Allobathynella* Morimoto

and Miura, 1957 (Park and Cho 2008) and seems to be absent in *Eobathynella* Birstein and Ljovuschkin, 1964 (see *E. yeojuensis* Schminke, 2011). For *Nipponbathynella*, two forms of external lobe appear to exist: Small and triangular (in *N. pectina* Cho et al., 2008) and elongated (in *N. uozumii* Morimoto, 2002). The latter case is in need of revision, as it is only indicated by a figure depicting the ventral view of the male thoracopod VIII (Morimoto 2002; Fig. 10a). It is not mentioned in the text, though, nor depicted in lateral view (Morimoto 2002; Fig. 10b). On the other hand, a prominent external lobe of the male thoracopod VIII is present in a great number of parabathynellids, such as species of *Afrobathynella* Schminke, 1976, *Billibathynella* Cho, 2006, *Brevisomabathynella* Cho et al., 2008, and *Montanabathynella* Camacho et al, 2009, *Paraeobathynella* Camacho et al., 2005, *Sketinella* Camacho et al., 2005 and *Sinobathynella* Camacho et al., 2006. All these species, however, are characterized by a great number of segments of antennules (seven-segmented), antennae (at least five-segmented), thoracopodal exopods (multisegmented) and a profusion of setae on these appendages. Considering that this profusion of segments and setae is regarded as primitive, the prominent external lobe of the male thoracopod VIII in combination with apomorphic character states in the new species (six-segmented antennules, three-segmented antennae, two- segmented thoracopodal exopods and reduced setation) is peculiar.

In addition to the four peculiarities just discussed, which are not covered by the diagnosis of any known genus and which justify the erection of a new one, *Arisubathynella* **gen. nov.**, there are other characters of the new species, *A. cheongmiensis* **sp. nov.**, to be mentioned. The first one is the presence of two tiny spines at the base of the endopodal spur of the uropod. A similar condition is displayed by all species of *Eobathynella* and by *Nipponbathynella pectina*, *Chilibathynella australiensis* Schminke, 1973, and *Atopobathynella gascoynensis* Cho et al, 2006, *A. hinzeae* Cho et al, 2006 and *A. hospitalis* Cho et al, 2006 where the endopodal spur is not assimilated but closely escorted by three (*N. pectina*) or one (remaining species) small spine(s). It must be noted that the presence of an auxiliary spine on the uropodal endopod is, with the exception of *Eobathynella*, not constant for a genus and thus not included in the generic diagnosis of *Arisubathynella*. The same holds true for the uropodal exopod of *A. cheongmiensis* **sp. nov.** in which the distal part is reminiscent of that displayed by species of the "*knoepffleri*-group" (sensu Cho and Schminke 2006) of *Hexabathynella* Schminke, 1972. According to Cho and Schminke (2006), the uropodal exopod of these species protrudes medio-distally and bears one short inner seta, one long outer seta, and one dorsal seta (*H. decora* Schminke, 1973, *H. pauliani* (Delamare Deboutteville, 1954), *H. aotearoae* Schminke, 1973, *H. monoaesthetasca* Cho and Schminke, 2006, *H. africana* Cho and Schminke, 2006), or one long outer seta and one dorsal seta (*H. halophila* Schminke, 1973), where the dorsal seta is always stronger than the inner one. The agreement of the uropodal exopod of *A. cheongmiensis* **sp. nov.** and the six species of *Hexabathynella* in this peculiarity seems to be due to convergence rather than phylogenetic affinity, as the latter genus is characterized by an antennal organ, a five-segmented antenna and a male thoracopod VIII having a long endopod (Cho and Schminke 2006).

The absence of epipod in thoracopods VI and VII is scarcely known within the family. So far as known, a similar condition is displayed by *Atopobathynella readi* Cho et al., 2006, in which thoracopod VII lacks the epipod (Cho et al. 2006). In all other species of *Atopobathynella* Schminke, 1973, the thoracopod VII is equipped with an epipod, i.e., the absence of the epipod could vary according to species within a genus such as *Parvulobathynella* (see Cho and Schminke 2001) or *Hexabathynella* (see Cho and Schminke 2006). Therefore, it does not seem to be proper to include this character to the generic diagnosis of *Arisubathynella*.

It is to note that the sexual dimorphism of the protopod of the thoracopod VI is already mentiond by Schminke (1973), but has been overlooked thereafter. According to Cho (per. comm.), such sexual dimorphism is displayed by all the Korean parabathynellids as well as bathynellids observed by him.

A few characters indicate the taxonomic position of *A. cheongmiensis* **sp. nov.** within Asian parabathynellids. For example, the two-segmented exopod of thoracopod II-VII is also shown by *Nipponbathynella*, *Siambathynella* Camacho et al., 2011 and *Eobathynella*. However, the latter genus has a six-segmented antenna, a two-segmented exopod of thoracopod I and a uropodal sympod with homonomous spines increasing in size proximally. In *Siambathynella*, the exopod of thoracopod I is one-segmented, that of thoracopods II-VII is two-segmented and the uropodal sympod has a row of inhomonomous spines as in *A. cheongmiensis* **sp. nov.**, but antennule and antenna are seven-segmented. When taking into account the combination of characters just mentioned, *Nipponbathynella* represented by *N. uozumii* has the closest affinity to *A. cheongmiensis* **sp. nov.** It displays six-segmented antennules, one-segmented exopods of thoracopod I, two-segmented exopods of thoracopods II-VII and a uropodal sympod with inhomonomous spines.

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