Redefinition of *Nipponbathynella* based on the four new species from East Asia (Crustacea: Bathyrellacea: Parabathynellidae)

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Four new species of the parabathynellid genus *Nipponbathynella* Schminke, 1973 are described from South Korea (*Nipponbathynella leesookyungae* sp. nov., *Nipponbathynella donggangensis* sp. nov. and *Nipponbathynella wanjuensis* sp. nov.) and Japan (*Nipponbathynella shigaensis* sp. nov.), raising the number of known species to seven. *Nipponbathynella leesookyungae* is characterized by the convex ventral surface of the labrum and the rich ornamentation (with three spinules and two teeth) of the exopod of male thoracopod VIII; *N. donggangensis* by the distal spine on the distal maxillular segment with many dentils; *N. wanjuensis* by the endopod of the male thoracopod VIII with one seta (instead of two) and the serrated endopodal spur of the uropod; and *N. shigaensis* by the basipod of thoracopods II–VII carrying strong hairs on their outer margin. The three new and one known (*Nipponbathynella pectina*) South Korean species share a bur-like inner lobe of the male thoracopod VIII, suggesting their close relationship. Based on the one-segmented exopod on thoracopod I and two-segmented exopod on the thoracopods II–VII, the bell-shaped male thoracopod VIII and the uropod with sympod carrying a large distal spine in addition to several proximal spines of smaller size, with endopod drawn into a spur and with exopod carrying a seta, a close phylogenetic relationship between *Nipponbathynella* and *Arisubathynella* Park and Eun, 2012 is proposed.

http://zoobank.org/urn:lsid:zoobank.org:pub:9650379F-C249-473C-AAA4-B3D638B96322

**Keywords:** Syncarida; Korea; Japan; hyporheic zone; meiofauna

**Introduction**

Parabathynellidae is a family of bathynellacean Syncarida with about 196 species belonging to 50 genera with a worldwide distribution (cf. Abrams et al. 2013; Nam and Cho 2014; see also Cho and Schminke 2001). Japan has a long history of bathynellacean study (cf. Ueno 1952), and 12 species and subspecies are currently known from this country. (cf. Ueno 1952), and 12 species and subspecies are currently known from this country. The three genera belong to three genera: *Allobathynella* Morimoto and Miura, 1957, *Eobathynella* Birstein and Ljovuschkin, 1964 and *Nipponbathynella* Schminke, 1973. The three genera also occur in the adjacent Korean Peninsula (Morimoto 1970; Cho et al. 2008; Schminke 2011) suggesting a close zoogeographical connection of the two countries. However, the taxonomic status of *Allobathynella* and *Eobathynella* is still in need of revision (Camacho et al. 2006; Park and Cho 2008) so any biogeographic interpretation is premature at this stage. In contrast, *Nipponbathynella*
with three known species has a firm taxonomic status, due to its autapomorphic char-
acters: the six-segmented antennule with the fifth segment having a medial group of setae
on inner margin, the two-segmented antenna, the molar process consisting of stout
spines, the female thoracopod VIII in the form of a radicle-like process, the absence of
pleopod, the uropod displaying two distal setae of the endopod and the exopod without
baso-ventral seta, the pleotelson without seta.

Despite these unique features, the generic diagnosis of *Nipponbathynella* seems to be
still incomplete. For example, description of the type species, *Nipponbathynella miurai*
(Ueno 1952), is just enough to recognize that this species is a member of the genus, based
on the two-segmented antenna, the small molar process of the mandible, the strong distal
seta of the proximal maxillular segment, the male thoracopod VIII with stalwart proto-
pod and the well-developed uropod (Schminke 1973). Another species, *Nipponbathynella uozumii* Morimoto, 2002, is well described, but the description lacks details of the
mouthparts and male thoracopod VIII morphology. On the other hand, *Nipponbathynella pectina* Cho et al. 2008, is described in detail, which allowed the
amendment of the generic diagnosis (see Cho et al. 2008). However, this species displays
very aberrant features (a carinated back of each somite and a comb-shaped uropod),
raising the question of whether the details of *N. pectina* used in the generic diagnosis
indeed cover other species. Here, we describe four new *Nipponbathynella* species, three
from Korea and one from Japan. With a careful comparison of the detailed morphology
of these species, we propose a redefinition of the genus.

**Material and methods**

The material of the new species was collected using the Karaman–Chappuis method by
digging a hole to the groundwater level. After sorting, all specimens were transferred into
70% alcohol for fixation and later into a mixture of glycerine–formalin (glycerine : 5%
formalin; i.e. 19 : 1), which was used for dissection and as a mounting medium. Dissected
animals were studied under a Nikon Eclipse 80i-Microscope with differential interference
contrast equipment, and drawings were made with the camera lucida attached to the same
microscope. The material is, as permanent preparations, deposited in the collection of the
National Institute of Biological Resources, Korea (NIBR) (*Nipponbathynella leesookyungae* sp. nov., *Nipponbathynella donggangensis* sp. nov., *Nipponbathynella wanjuensis* sp. nov) and Lake Biwa Museum (LBM) (*Nipponbathynella shigaensis* sp. nov.).

**Systematics**

Order **BATHYNELLACEA** Grobben
Family **PARABATHYNELLIDAE** Noodt
Genus *Nipponbathynella* Schminke, 1973

*Type species*
*Nipponbathynella miurai* Ueno, 1952

*Other species*
*Nipponbathynella uozumii* Morimoto, 2002, *Nipponbathynella pectina* Cho et al. 2008,
*Nipponbathynella leesookyungae* sp. nov., *Nipponbathynella donggangensis* sp. nov.,
*Nipponbathynella wanjuensis* sp. nov. and *Nipponbathynella shigaensis* sp. nov.
Amended generic diagnosis after Schminke (1973), Cho et al. (2008) and Schminke (2011)

Body elongated and cylindrical. Antennule six-segmented. Fifth antennular segment long with a medial group of setae on inner margin. Antenna two-segmented with three setae on distal segment. Labrum with dentate-free margin. Mandible with incisor process of three teeth, triangular proximal tooth, molar process of four stout spines and one-segmented palp. Maxilla four-segmented with setal formula of 2-4(5)-n-7. Thoracopods I–VII with one-segmented exopod of thoracopod I and two-segmented exopod of thoracopods II–VII. Female thoracopod VIII one-segmented, radicle-like process directing backwards. Male thoracopod VIII with massive protopod consisting of three lobes: frontal lobe, inner lobe bur-like or absent, dentate lobe being sometimes smooth; epipod present in form of either conical, elongated process or triangular tooth; basis approximately one-third size of protopod, with or without basal seta; endopod with two apical setae. Pleopod absent. Uropod with rod- or comb-shaped sympod carrying spines; most distal spine usually thicker and larger than others decreasing slightly in size distally; endopod drawn out as a spine, with two distal setae; exopod with one strong seta on inner margin, without basi-ventral seta. Pleotelson without seta. Anal operculum protruded. Furcal rami with numerous spines.

Remarks
We supplement the generic diagnosis proposed by Cho et al. (2008) based on the morphology of four new species: *N. leesookkyungae* sp. nov., *N. donggangensis* sp. nov., *N. wanjuensis* sp. nov. and *N. shigaensis* sp. nov. The added novelties are the setal formula of the maxillule (2-4(5)-n-7 meaning variation in the number of setae occurring on third endite), the segmental feature of the exopod in thoracopods I–VII, details of the protopod and epipod on the male thoracopod VIII, features of spines on the uropodal sympod and the inner seta on the uropodal exopod. Such a seta is apparently absent in *N. uozumii* (see Morimoto 2002) and misinterpreted in the case of *N. pectina* (see Cho et al. 2008). Its position at two thirds height of the inner margin in *N. leesookkyungae* and *N. donggangensis* evidently indicates that the uropodal exopod of *N. pectina* also carries a seta on the inner margin.

*Nipponbathynella leesookkyungae* sp. nov.
(Figures 1–5)

Etymology
The species name is derived from Mrs Soo-Kyung Lee, who helped in preparing the figures.

Material examined

Type material

*Holotype.* Male, dissected on six slides. South Korea, Jeollanam-Do (province), Yeongam-Gun (county), Yeongam-Eup (town), Gaeshin Village, a stream near a temple (34°46’18.0 "N, 126°42’59.3" E), 24 May 2014 (J.-L. Cho and J.-G. Park) (NIBR IV0000267080).
Figure 1. *Nipponbathynella leesookyangae* sp. nov. (♂: holotype, ♀: allotype). (A) General habitus ♀; (B) antennule ♂ (dorsal); (C) antenna ♂ (dorsal); (D) labrum ♂ (ventral); (E) mandible ♂ (ventral); (F) maxillule ♂ (dorsal). Scale bars = 0.05 mm (unless otherwise specified).
Allotype. Female, dissected on six slides, same data as holotype (NIBR IV0000267081).

Paratypes. One male dissected on seven slides and one female kept as a whole specimen on a slide, same data as holotype (NIBR IV0000267082, 0000267083).

Figure 2. *Nipponbathynella leesookyungae* sp. nov. (♂: holotype). (A) Maxilla (dorsal); (B) thoracopod I (frontal); (C) thoracopod II (frontal); (D) thoracopod III (frontal). Scale bars = 0.05 mm.
Figure 3. *Nipponbathynella leesookyungae* sp. nov. (♂: holotype, ♀: allotype). (A) Thoracopod IV ♂ (frontal); (B) thoracopod V ♂ (frontal); (C) thoracopod VI ♂ (frontal). (D) Thoracopod VII ♂ (frontal); (E) thoracopod VIII ♀ (ventral). Scale bars = 0.05 mm.
Description of adult male (holotype)

Body (Figure 1A). Elongated and cylindrical, length 1.20 mm (other male: 1.14 mm), approximately 10 times as long as wide. Head as long as wide, shorter than anterior three thoracic segments combined.

Antennule (Figure 1B) six-segmented. First segment with one seta on inner distal margin, with two simple dorsal setae and with each one plumose seta dorso-laterally, laterally and ventro-laterally. Second segment with one group of four plumose setae, with one simple seta on inner distal margin and with one ventral seta inner laterally. Third segment with two lateral setae, one seta on inner distal margin and with one ventral seta inner laterally. 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 being slightly protruded. Fifth segment with a medial group of two inner setae, one dorsal aesthetasc and one dorsal simple seta, and distally with three setae, two dorsal aesthetascs, one dorsal seta and one lateral aesthetasc. Sixth segment as large as one half of the fifth segment, with three subterminal aesthetascs and four simple setae.

Antenna (Figure 1C) two-segmented, as long as the length of the first antennular segment. Proximal segment without setae, distal segment with two simple terminal setae and one subterminal seta.
Labrum (Figure 1D) flat, with eight median teeth of more or less similar size flanked by one (left) or two (right) lateral teeth. Inner surface convex, with two pairs of nipple-like lateral protrusions and with ctenidia and one tiny projection in middle region.
**Mandible** (Figure 1E) with incisor process of three teeth. Tooth of ventral edge triangular. Spine row consisting of four spines. Palp of one segment, with one apical seta exceeding incisor process in length.

**Maxillule** (Figure 1F) two-segmented. Proximal segment with three setae on inner distal margin. Distal segment with two terminal spines, with three spines and one small spine on inner edge, and with three simple setae on outer distal margin. Distal most spine smooth.

**Maxilla** (Figure 2A) four-segmented, setal formula 2-4-9-7.

Thoracopods I–VII (Figures 2B–D, 3A–D) slightly increasing in size up to thoracopod III, thoracopods III–VII similar in size. Thoracopods II–VII each bearing one epipod on protopod. Basis of thoracopods I–VII with one seta each. Exopod of thoracopod I one-segmented with one medial seta on ventral margin. Exopod of thoracopods II–VII two-segmented. Endopods of thoracopods I–VII four-segmented, setal formulae:

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

Thoracopod VIII (Figure 4A, B) bell-shaped tilting backwards in lateral view, 1.2 times longer than wide. Protopod massive, with penial region of three lobes: frontal lobe with four small spines; dentate lobe with nine teeth; inner lobe spinulated, in form of bur. Epipod small, round distal end not reaching penial region. Basis nearly trapezoid, without distal spur, with one seta. Exopod one-third as long as basis, longer than wide, medially with two spines, distally two-lobed. Upper lobe with two distal spines, lower lobe distally serrated. Endopod small, with two distal setae and one tiny spine.

First pleopod absent (Figure 1A).

**Uropod** (Figure 5A, B) with load-shaped sympod bearing seven spines on inner margin. distal-most spine significantly thicker than others decreasing slightly in size distally. Endopod 21.7% as long as sympod length, drawn into spur, with two setae on the outer basis of spur. Exopod longer than endopod, 47.0% as long as sympod, with one outer seta, two terminal setae and one inner medial seta. Inner seta strong, longer and thicker than outer terminal seta.

**Pleotelson** (Figure 5B) without seta.

Anal operculum protruded.

Furcal rami (Figure 5B) nearly square, with two distal spines and four additional spines on inner margin, dorsally with two plumose setae of different length, and ventrally with furcal organ.

**Description of adult female (allotype)**

Female differing from male in protruded and undulated inner margin of the protopod of thoracopod VI and in the form of thoracopod VIII. Because of the failure of the preparation of thoracopod VI, the corresponding figure is not provided. Body length 1.15 mm (other females: 1.13 mm). Thoracopod VIII (Figure 3E) in form of two radicles distally lobed slightly.
*Nipponbathynella donggangensis* sp. nov.  
(Figures 6–10)

**Etymology**  
The species name is derived from a stream (Donggang, a tributary of The Han-River) where the species was collected.

Figure 6. *Nipponbathynella donggangensis* sp. nov. (♀: holotype). (A) general habitus; (B) antennule (dorsal); (C) antenna (dorsal); (D) labrum (ventral); (E) mandible (ventral). Scale bars = 0.05 mm (unless otherwise specified).
Figure 7. *Nipponbathynella donggangensis* sp. nov. (♀: holotype). (A) Maxillule (ventral); (B) maxilla (ventro-lateral); (C) maxilla (ventral); (D) thoracopod I (frontal); (E) thoracopod II (frontal). Scale bars = 0.05 mm.
Figure 8. *Nipponbathynella donggangensis* sp. nov. (♀: holotype). (A) Thoracopod III (frontal); (B) thoracopod IV (frontal); (C) thoracopod V (frontal); (D) thoracopod VIII (ventral). Scale bars = 0.05 mm.

Material examined

Type material

*Holotype.* Female, dissected on six slides. South Korea, Kangwon-Do (province), Jeongseon-Gun (county), Jeongseon-Eup (town), A gravel bank of Donggang (37° 22′49.3″ N 128°39′24.9″ E), 24 May 2014 (J.-L. Cho and J.-G. Park) (NIBR IV0000267099).

*Allotype.* Male, dissected on six slides, same data as holotype (NIBR IV0000267100). No paratype.
Description of adult female (holotype)

Body (Figure 6A). Elongated and cylindrical, length 1.38 mm, approximately 12 times as long as wide. Head as long as wide, slightly shorter than anterior three thoracic segments combined.

Antennule (Figure 6B) six-segmented. First segment with one seta on inner distal margin, with two simple dorsal setae and each one plumose seta dorso-laterally,
laterally and ventro-laterally. Second segment with one group of four plumose setae, with one simple seta on inner distal margin and with one ventral seta inner laterally. Third segment with two lateral setae, one seta on inner distal margin and with one ventral seta inner laterally. Inner flagellum of third segment with three simple setae. Fourth segment with one stub seta and one plumose seta on dorsal margin, and with

Figure 10. *Nipponbathynella donggangensis* sp. nov. (♀: holotype). (A) Pleotelson, uropod and furcal rami (lateral); (B) uropod (inner lateral); (C) pleotelson and furcal rami (dorsal). Scale bars = 0.05 mm.
two stub setae and two plumose setae on outer distal apophysis being slightly protruded. Fifth segment with a medial group of two inner setae, one dorsal aesthetasc and one dorsal simple seta, and distally with three setae, two dorsal aesthetascs, one dorsal seta and one lateral aesthetasc. Sixth segment as large as one half of the fifth segment, with three subterminal aesthetascs and four simple setae.

**Antenna (Figure 6C)** two-segmented, as long as the length of the first antennular segment. Proximal segment without setae, distal segment with two simple terminal setae and one subterminal seta.

**Labrum (Figure 6D)** flat, with eight median teeth of more or less similar size flanked by one (left) or two (right) lateral teeth. Inner surface concave, with two pairs of nipple-like lateral protrusions and with ctenidia and three tiny projections in middle region.

**Mandible (Figure 6E)** with incisor process of three teeth. Tooth of ventral edge triangular. Spine row consisting of four spines. Palp of one segment, with one apical seta not exceeding incisor process in length.

**Maxillule (Figure 7A)** two-segmented. Proximal segment with three setae and one tiny seta on inner distal margin. Distal segment with two terminal spines, with four spines on inner edge, and with three simple setae on outer distal margin. Most distal spine with six dentils.

**Maxilla (Figure 7B, C)** four-segmented, setal formula 2-5-10-7.

**Thoracopods I–VII (Figures 7D, E, 8A–C, 9A, B)** increasing in size up to thoracopod III, thoracopods III–VII similar in size. Protopod of thoracopod VI protruding and with distal opening. Thoracopods II–VII each bearing one epipod on protopod. Basis of thoracopods I–VII with one seta each. Exopod of thoracopod I one-segmented with one medial seta on ventral margin. Exopod of thoracopods II–VII two-segmented. Exopod of thoracopods II and III with one medial seta on ventral margin of proximal segment. Endopods of thoracopods I–VII four-segmented, setal formulae:

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

**Thoracopod VIII (Figure 8D)** in form of two radicles.

First pleopod absent (Figure 6A).

**Uropod (Figure 10A, B)** with load-shaped sympod bearing 11 spines on inner margin. Most distal spine significantly thicker than others decreasing slightly in size distally. Endopod 21.3% as long as sympod length, drawn into spur, with two setae on the outer basis of spur. Exopod longer than endopod, 55.2% as long as sympod, with one outer seta, two terminal setae and one inner medial seta. Inner seta strong, longer and thicker than outer terminal seta.

**Pleotelson (Figure 10A, C)** without seta.

Anal operculum protruded.

**Furcal rami (Figure 10C)** longer than wide, with two distal spines and five (right) or six (left) spines on inner margin, and dorsally with two plumose setae of different length and ventrally with furcal organ.
Description of adult male (allotype)
Male differing from female in smooth inner margin of protopod of thoracopod VI and in form of thoracopod VIII. Body length 1.35 mm. Thoracopod VIII (Figure 9C, D) bell-shaped tilting backwards in lateral view, 1.3 times longer than wide. Protopod massive, with penial region of three lobes: frontal lobe with seven spinules; dentate lobe with 13 teeth; inner lobe spinulated, in form of bur. Epipod small, round distal end not reaching penial region. Basis nearly trapezoid, without distal spur, with one seta. Exopod one-third as long as basis, longer than wide, one-lobed and smooth. Endopod longer than wide, with two distal setae.

*Nipponbathynella wanjuensis* sp. nov.
(Figures 11–14)

Etymology
The specific name is derived from the county (Wanju-Gun; gun means county) where the species was collected

Material examined

Type material
*Holotype.* Male, dissected on six slides. South Korea, Jeollabuk-Do (province), Wanju-Gun (county), Yongjin-Myeon (town), Gueok-Ri (village). A sand bank of Mankyeonggang (35°52'21.1 ''N, 127°9'36.4'' E). 14 March 2014 (J.-L. Cho and J.-G. Park) (NIBR IV0000267101). No allotype and paratype.

Description of adult male (holotype)

Body (Figure 11A). Elongated and cylindrical, length 1.85 mm, approximately 10 times as long as wide. Head as long as wide, shorter than anterior three thoracic segments combined.

Antennule (Figure 11B) six-segmented. First segment with one seta on inner distal margin, with two simple dorsal setae and with each one plumose seta dorso-laterally and ventro-laterally. Second segment with one group of four plumose setae, with one simple seta on inner distal margin. Third segment with two lateral setae, one seta on inner distal margin and with one ventral seta inner laterally. 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 being slightly protruded. Fifth segment with a medial group of two inner setae, one dorsal aesthetasc and one dorsal simple seta, and distally with three setae, two dorsal aesthetascs, one dorsal seta and one lateral aesthetasc. Sixth segment as large as one half of the fifth segment, with three subterminal aesthetascs and four simple setae.

Antenna (Figure 11C) two-segmented, as long as the length of the first antennular segment. Proximal segment without setae, distal segment with two simple terminal setae and one subterminal seta.
Labrum (Figure 11D) flat, with 10 median teeth of more or less similar size flanked by three (left) or four (right) lateral teeth. Inner surface concave, with two pairs of nipple-like lateral protrusions and with ctenidia and one tiny projection in middle region.
Mandible (Figure 11E) with incisor process of three teeth. Tooth of ventral edge triangular. Spine row consisting of four spines. Palp of one segment, with one apical seta not exceeding incisor process in length.

Figure 12. *Nipponbathynella wanjuensis* sp. nov. (♂: holotype). (A) Maxilla (dorsal); (B) thoracopod I (frontal); (C) left thoracopod II (frontal); (D) ornaments of right thoracopod II (frontal); (E) thoracopod III (frontal). Scale bars = 0.05 mm.
Maxillule (Figure 11F) two-segmented. Proximal segment with four setae on inner distal margin. Distal segment with two terminal spines, with three spines and one small spine on inner edge, and with three simple setae on outer distal margin. Distalmost spine with two dentils.
Maxilla (Figure 12A) four-segmented, setal formula 2-4-9-7.

Thoracopods I–VII (Figures 12B–E, 13A–C, 14A) increasing in size up to thoracopod III, thoracopods III–VII similar in size. Thoracopods II–VII each bearing one epipod on protopod. Basis of thoracopods I–VII with one seta each. Exopod of
Thoracopod I one-segmented with one medial seta on ventral margin. Exopod of thoracopods II–VII two-segmented. Endopods of thoracopods I–VII four-segmented, setal formulae:

Thoracopod I $2 + 0/1 + 1/0 + 1/3(1)$
Thoracopods II $0 + 0/2(1)+1/0 + 1/2(0)$.
Thoracopods III–VII $0 + 0/1 + 1/0 + 1/2(0)$.

Thoracopod VIII (Figure 14B) bell-shaped tilting backwards in lateral view, 1.2 times longer than wide. Protopod massive, with penial region of three lobes: frontal lobe smooth and with undulated margin; dentate lobe with 14 teeth; inner lobe spinulated, in form of bur. Epipod long, round distal end reaching penial region. Basis nearly trapezoid, without distal spur, with one seta. Exopod one-third as long as basis, longer than wide, one-lobed and smooth. Endopod longer than wide, with one distal seta.
First pleopod absent (Figure 11A).
Uropod (Figure 14C, E) with load-shaped sympod bearing 14 spines on inner margin. Most distal spine significantly thicker than others decreasing in size distally. Endopod 23.1% as long as sympod length, drawn into spur, with two setae on the outer basis of spur. Inner margin of spur serrated. Exopod longer than endopod, 39.1% as long as sympod, with one outer seta, two terminal setae and one inner medial seta. Inner seta strong, longer and thicker than outer terminal seta.
Pleotelson (Figure 14E) without seta.
Anal operculum slightly protruded.
Furcal rami (Figure 14D) nearly square, with two distal spines and nine additional spines on inner margin, and dorsally with two plumose setae of different length and ventrally with furcal organ.
Female unkonwn.

*Nipponbathynella shigaensis* sp. nov.  
(Figures 15–19)

**Etymology**
The species name is derived from the province, Shiga-Ken (Ken means prefecture), where the species was collected.

**Material examined**

**Type material**
*Holotype.* Male, dissected on seven slides. Japan, Shiga-Ken (prefecture), Takashima-Shi (city), Imazu-Cho (commune), Hamabun, Imazu Beach, Groundwater 35–02, 4 October 2011 (M.J. Grygier and M. Matsuda) (LBM1430005567).

*Allotype.* Female, dissected on six slides, same data as of holotype (LBM1430005568).

*Paratypes.* One female and one juvenile each kept as a whole specimen in a slide, same data as holotype (LBM1430005569, LBM1430005570).
Figure 15. *Nipponbathynella shigaensis* sp. nov. (♂: holotype). (A) general habitus; (B) antennule (dorsal); (C) antenna (dorsal); (D) labrum (ventral); (E) mandible (ventral); (F) maxillule (dorsal); (G) maxilla (dorsal). Scale bars = 0.05 mm (unless otherwise specified).
Description of adult male (holotype)

Body (Figure 15A). Elongated and cylindrical, length 1.50 mm, approximately 10 times as long as wide. Head as long as wide, shorter than anterior three thoracic segments combined.
Antennule (Figure 15B) six-segmented. First segment with one seta on inner distal margin, with two simple dorsal setae and each one plumose seta dorso-laterally, laterally and ventro-laterally. Second segment with one group of four plumose setae, with one simple seta on inner distal margin and inner laterally with one ventral seta. Third segment with two lateral setae, one seta on inner distal margin and inner laterally with one ventral 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 being slightly protruded. Fifth segment with a medial group of two inner setae, one dorsal aesthetasc and one dorsal simple seta, and distally with three setae, two dorsal aesthetascs, one dorsal seta and one lateral aesthetasc. Sixth segment as large as one half of the fifth segment, with three subterminal aesthetascs and four simple setae.

Antenna (Figure 15C) two-segmented, as long as the length of the first antennular segment. Proximal segment without setae, distal segment with two simple terminal setae and one plumose seta.

Labrum (Figure 15D) flat, with 11 median teeth of more or less similar size flanked by three lateral teeth, lateral-most teeth with tiny terminal spinule. Inner surface concave, with two pairs of nipple-like lateral protrusions and with ctenidia and tiny projection in middle region.

Mandible (Figure 15E) with incisor process of three teeth. Tooth of ventral edge triangular. Spine row consisting of four spines. Palp of one segment, with one apical seta not exceeding incisor process in length.

Maxillule (Figure 15F) two-segmented. Proximal segment with four setae on inner distal margin and with two medial rows of ctenidia. Distal segment with two terminal spines, with four spines and one small spine on inner edge, and with three simple setae on outer distal margin.
Maxilla (Figure 15G) four-segmented, setal formula 2-4-9-7. Thoracopods I–VII (Figures 16A–D, 17A–D) increasing in size up to thoracopod IV, thoracopods IV–VII similar in size. Thoracopods II–VII each bearing one epipod on protopod. Basis of thoracopods I–VII with one seta each. Basis of thoracopods II–VII with long and strong hairs along outer margin. Exopod of thoracopod I
one-segmented with one medial seta on ventral margin. Exopod of thoracopods II–VII two-segmented. Endopods of thoracopods I–VII four-segmented, setal formulae:

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

Thoracopod VIII (Figure 18A, B) bell-shaped and tilting backwards in lateral view, 1.2 times longer than wide. Protopod massive, with penial region of two smooth lobes, inner lobe absent. Epipod narrow and elongated, distal end barely reaching penial region. Basis nearly trapezoid, without distal spur, with one seta. Exopod half as long as basis, longer than wide, one-lobed and smooth. Endopod longer than wide, with two distal setae of different sizes.  
First pleopod absent (Figure 15A).  
Uropod (Figure 19B, C) with load-shaped sympod bearing 13 spines on inner margin. Proximal-most spine smaller than remaining ones decreasing slightly in size distally. Distal-most spine thicker and longer than others. Endopod 24% as long as sympod length, drawn into spur, with two setae on the outer basis of spur. Exopod longer than endopod, 46% as long as sympod, with one outer seta, two terminal setae and one inner seta. Inner seta nearly subterminal, strong, thicker and slightly shorter than inner terminal seta. Outer terminal seta nearly subterminal. All setae and spines on uropod barbed.  
Pleotelson (Figure 19C, D) without seta.  
Anal operculum protruded.  
Furcal rami (Figure 19C, D) approximately 1.2 times longer than wide, with two distal spines and six (right) or seven (left) additional spines on inner margin, and dorsally with one plumose seta and one simple seta and ventrally with furcal organ.

Description of adult female (allotype)
The female differs from the male in the inner margin of the protopod of the thoracopod VI and in the form of the thoracopod VIII. Body length 1.55 mm (other females: 1.50 mm). Inner margin of the protopod of the thoracopod VI (Figure 17C) undulated and with opening of oviduct. Thoracopod VIII (Figure 19A) in form of two radicles bearing one tiny spine distally

Discussion
The four new species are assigned to Nipponbathynella based on the following character combination:

(1) six-segmented antennule with a group of setae on the medial edge of the fifth segment;
(2) two-segmented antenna;
(3) molar process of mandible having four stout spines;
(4) massive male thoracopod VIII with prominent penial region;
(5) female thoracopod VIII as radicle-like process directing backwards;
(6) absence of the first pleopod and seta of the pleotelson.

Intraspecific differences within the genus are summarized in Table 1. This table does not consider N. miurai because of its insufficient taxonomic description, which is only available in the original description of the species (Ueno 1952).
Table 1. Morphological differences among the six species of *Nipponbathynella* (*Nipponbathynella miurai* is not considered).

|                  | *N. uozumii* | *N. pectina* | *N. leesookyangae* | *N. donggangensis* | *N. wanjuensis* | *N. shigaensis* |
|------------------|--------------|--------------|--------------------|--------------------|----------------|----------------|
| Body (mm)        | 1.24 (holotype: ♂); 1.35 (allotype: ♀) | 2.57 (holotype: ♂); 2.32 (allotype: ♀) | 1.20 (holotype: ♂); 1.15 (allotype: ♀) | 1.38 (holotype: ♂); 1.35 (allotype: ♀) | 1.85 (holotype: ♂); 1.50 (allotype: ♀) | 1.50 (holotype: ♂); 1.55 (allotype: ♀) |
| Antennules       |               |              |                    |                    |                |                |
| plumose setae/first segment | ?         | dorso-lateral, lateral | dorso-lateral, lateral ventro-lateral | dorso-lateral, lateral | dorso-lateral, lateral | dorso-lateral, lateral ventro-lateral |
| second segment   | ?            | with ventral seta | with ventral seta | with ventral seta | without ventral seta | with ventral seta |
| fifth segment    | ?            | 2 simple seta + 1 aesthetasc | 3 simple seta + 1 aesthetasc | 3 simple seta + 1 aesthetasc | 3 simple seta + 1 aesthetasc | 3 simple seta + 1 aesthetasc |
| Antenna          | outer seta plumose | outer seta simple | outer seta simple | outer seta simple | outer seta simple | outer seta simple |
| Labrum           |               |              |                    |                    |                |                |
| No. of teeth     | 16           | 8 + 2        | 8 + 2              | 8 + 3              | 10 + 7         | 11 + 6         |
| Ventral surface  | ?            | concave      | convex             | concave            | concave        | concave        |
| Maxillule        |               |              |                    |                    |                |                |
| No. of setae on proximal segment | 3     | 4             | 3                  | 3 + 1 tiny seta | 4              | 4              |
| No. of spines on distal segment | 7 | 7 including tiny proximal spine | 6 including tiny proximal spine | 6 | 6 including small proximal spine | 7 including seta-like proximal spine |
| Distal spine     | smooth       | smooth       | smooth             | dentate with 6 dentils | dentate with 2 dentils | dentate with 1 dentil |
| Maxilla          | ?            | 2-4-7-7      | 2-4-9-7            | 2-5-10-7           | 2-4-10-7       | 2-4-9-7        |

(Continued)
Table 1. (Continued).

| Thoracopods                     | I–VII                | Exopod of thoracopod I | Male thoracopod VIII |
|--------------------------------|----------------------|-------------------------|----------------------|
| Outer margin of basipod        | smooth               | smooth                  | smooth               |
| with 2 distal setae            | with 2 distal setae  | with 2 distal setae    | with 2 distal setae  |
| Exopod of thoracopod I         |                      |                         |                      |
| Male thoracopod VIII           |                      |                         |                      |
| Dentate lobe                   | ?                    | Numerous teeth          | 9                    |
| Inner lobe                     | ?                    | bur-like                | 14 bur-like          |
| epipod                         | conical with         | small and triangular    | conical with wide    |
| narrow base                    | with 1 seta          | with 1 seta             | base                 |
| basipod                        | without setae        | with 3 spinules         | smooth               |
| exopod                         | ?                    |                          | with 1 seta          |
| endopod                        | 2 setae              | 2 setae                 | 1 seta               |
| Uropod                         | rod-shaped           | rod-shaped              | 2 setae              |
| sympod                         | 13 spines            | 26 spines               | 14 spines            |
| endopod                        | spur with 3 additional spines | spur without additional spines
| exopod                         |                       |                         |                       |
| position of inner seta         | inner seta absent    | 2/3 exopodal height     | nearly sub-terminal  |
| Furcal ramus                   | 9 spines             | 21 spines               | 6 spines             |
|                                |                      |                         | 7, 8 spines          |
|                                |                      |                         | 11 spines            |
|                                |                      |                         | 8, 9 spines          |

With strong hairs
The body size of *Nipponbathynella* ranges from 1.15 mm (female of *N. leesookyungae* sp. nov.) to 2.57 mm (male of *N. pectina* Cho et al., 2008). However, there seems to be no correlation between the body size and the armature of appendages. For example, the antennule has three prominent characters (the number of plumose setae on the first segment, the presence/absence of ventral seta on the second segment and the number of simple setae on the medial edge of the fifth segment), but none seems to correlate with the animal size: the number of plumose setae on the first segment is either two or three. A higher number is present in three species with a relatively smaller body size (*N. leesookyungae*, *N. donggangensis* and *N. shigaensis*), whereas two plumose setae are present in two species with a larger body size (*N. pectina* and *N. wanjuensis*). It is also remarkable, that *N. wanjuensis* is the only species lacking the ventral seta on the second antennular segment, whereas *N. pectina* exhibits two (instead three in other species) simple setae on the medial edge of the fifth segment. As for the antenna, there is no remarkable variation among the species except that the outer seta on the distal segment is plumose in *N. shigaensis* and, according to the figure of the original description (Morimoto 2002, fig 2, p. 20), also in *N. uozumii*.

Ornaments of the mouthparts are also seemingly independent of species body size. The number of teeth of the labrum can be 10 (in *N. pectina* and *N. leesookyungae*), 11 (in *N. donggangensis*), 16 (*N. uozumii*), or 17 (in *N. wanjuensis* and *N. shigaensis*). In addition, the ventral surface of the labrum is convex in *N. leesookyungae*, but concave in the remaining species. The mandible does not vary significantly, but there are notable species-specific variations in the maxillule, which is known to be a rather conservative appendage in many genera (e.g. *Atopobathynella* Schminke 1973; *Hexabathynella*, 1972; *Kimberleybathynella* Cho et al. 2005). For example, the proximal segment carries four setae in *N. pectina*, *N. wanjuensis* and *N. shigaensis*, as in most parabathynellids, but three setae and one tiny seta in *N. donggangensis*, and only three setae in *N. leesookyungae* (apparently also in *N. uozumii*). The number of spines (and setae) on the inner margin of the distal segment can be either six (*N. leesookyungae*, *N. donggangensis* and *N. wanjuensis*) or seven (*N. uozumii*, *N. pectina* and *N. shigaensis*). Moreover, the distal spine is smooth in *N. uozumii*, *N. pectina* and *N. leesookyungae*, but dentate with different number of dentils in *N. donggangensis* (6), *N. wanjuensis* (2) and *N. shigaensis* (1). For *N. uozumii*, Morimoto (2002) reports three-segmented maxilla carrying three setae each on the proximal and second endites, and a total of 13 setae including three aesthetascs on the distal endite. With the exception of this species, which needs re-examination, and *N. donggangensis*, all other species of the genus display four-segment maxilla with the setal formula of 2-4-n-7 (n: variation in the number of setae on the third endite). *Nipponbathynella donggangensis* has one additional medial seta on the second endite.

Exopod on thoracopod I carries two terminal setae in *N. uozumii* and *N. pectina*, but three setae in four remaining species. Interestingly, *N. shigaensis* displays long and strong hairs along outer margin of the basis of thoracopods II–VII. As known so far, this character occurs only in Bathynellidae. With these two exceptions, the six species do not differ significantly in thoracopods I–VII. In contrast, the male thoracopod VIII contains several useful characters for species delineation. These characters are: (1) the distal surface of the penial region could be either dentate and the inner lobe is bur-like (*N. pectina*, *N. leesookyungae*, *N. donggangensis* and *N. wanjuensis*), or smooth and there is no inner lobe (*N. uozumii* and *N. shigaensis*);
except for the triangular form present in *N. pectina*, the epipod is usually conical, but its base is either narrow (*N. uozumii* and *N. shigaensis*) or wide (*N. leesookyungae, N. donggangensis* and *N. wanjuensis*); (3) the exopod is usually smooth, but could carry three spines (*N. pectina*) and even two additional teeth (*N. leesookyungae*); (4) the endopod usually carries two distal setae, but there is only one seta in *N. wanjuensis*. Note that the absence of the basipodal seta in the male thoracopod VIII of *N. uozumii* needs to be re-examined.

The uropod can also be useful for species recognition. This appendage is usually rod-shaped, or comb-shaped in *N. pectina*. The number of spines ranges from seven (*N. leesookyungae*) to 26 (*N. pectina*). With the exception of *N. uozumii*, which carries only two distal setae, the exopod carries four setae in total: two distal setae and one seta each on both inner and outer margins. The seta at inner margin is located either sub-terminally (*N. pectina, N. leesookyungae* and *N. donggangensis*) or on the two-thirds exopod height (*N. wanjuensis* and *N. shigaensis*). The endopodal spur is usually equipped with fine barbs, but is dentate in *N. donggangensis*, or even carries three additional spines on its base in *N. pectina*.

In the light of the above discussion, it appears that each of the four new species represents a lineage. *Nipponbathynella leesookyungae* is characterized by the convex ventral surface of the labrum and the rich ornamentation (with three spinules and two teeth) of the exopod of male thoracopod VIII, *N. donggangensis* by the distal spine of the distal maxillular segment with rich dentils, *N. wanjuensis* by the endopod of the male thoracopod VIII with one seta (instead of two setae) and the serrated endopodal spur of the uropod, and *N. shigaensis*, finally, by the basipod of thoracopods II–VII carrying strong hairs on its outer margin. At this stage, any detailed interpretation of their relationship is premature, at least because both *N. miurai* and *N. uozumii* are in need of revision. However, it seems, that the bur-like inner lobe of the male thoracopod VIII is a synapomorphy of *N. pectina, N. leesookyungae, N. donggangensis* and *N. wanjuensis*, which, in comparison with the Japanese species, gives them a separate evolutionary lineage.

*Nipponbathynella* displays several outstanding features that render difficult any attempt to establish its phylogenetic position among other Asian genera. Nevertheless among known Asian genera, *Arishubathynella* Park and Eun, 2012 is the most similar to *Nipponbathynella* in having (1) an antenna of few (three) segments, (2) an one-segmented exopod on the thoracopod I and a two-segmented exopod on the thoracopods II–VII, (3) a bell-shaped male thoracopod VIII and (4) a uropod with sympod carrying a large distal spine in addition to the several proximal spines of smaller size, with endopod drawn into a spur and with exopod carrying a seta, which corresponds to the seta of the inner margin in *Nipponbathynella*. The character combination on the uropod, especially along with the seta on the inner margin, is unique within the family, but turns up also in *Parabathynella* Chappuis 1926 from Europe. *Nipponbathynella* and *Parabathynella* are also the only genera, in which the female thoracopod VIII retains its segmental nature. However, the seven-segmented (instead of six-segmented) antennule, the five-segmented antenna, the two-segmented (or multi-segmented) exopod on the thoracopod I and the oval-shaped male thoracopod VIII of *Parabathynella* separate both genera, and do not support a close relationship.
Geological information
Point (*Nipponbathynella leesookyungae*): 34°46'18.0 "N, 126°42'59.3" E; Point (*Nipponbathynella donggangensis*): 37°22'49.3 "N, 128°39'24.9" E; Point (*Nipponbathynella wanjuensis*): 35°52'21.1 "N, 127°9'36.4" E

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