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Three new records of bdelloid rotifers from Korea

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A taxonomic study on bdelloid rotifers collected from various terrestrial habitats such as mosses, mushrooms and tree barks at two different locations in Korea resulted in three new Korean records belonging to three genera in two families, Habrotrochidae and Philodinidae, of bdelloid rotifers: *Habrotrocha minima* De Koning, 1947, *Mniobia barbatula* Donner, 1950 and *Scepanotrocha parva* Schulte, 1954. These three new records are rare species with poorly known distributions, and this study is only the second or third report since their original descriptions. In the genus *Scepanotrocha* Bryce, 1910, 11 taxa are known to the world, and in Korea, three species including *S. parva* have been recorded so far. A taxonomic key to the *Scepanotrocha* species reported from Korea to date is provided here. In addition, partial sequences of mitochondrial cytochrome c oxidase subunit 1 gene (CO1) for *Mniobia barbatula* and *Scepanotrocha parva* are presented.

Keywords: Bdelloidea, Korea, new records, taxonomy, terrestrial habitats

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Introduction

Bdelloids sorted out from various terrestrial habitats such as mosses, mushrooms and tree barks were taxonomically investigated from May 20, 2023 to May 11, 2024. Three species belonging to three genera in two families, Habrotrochidae and Philodinidae, were identified: *Habrotrocha minima*, *Mniobia barbatula* and *Scepanotrocha parva*. These three bdelloids are rare species with poorly known distributions, and new to Asia as well. *Habrotrocha minima* has previously been reported only from Austria (Donner, 1962) and Czech Republic (Devetter *et al*., 2020) since the description from the Netherlands by De Koning (1947). *Mniobia barbatula* has been recorded from only two countries, Czech Republic (Devetter *et al*., 2020) and Italy (Melone *et al*., 1998), after the description from Austria by Donner (1950). *Scepanotrocha parva* was reported only from Czech Republic (Devetter *et al*., 2020) after description from Germany (Schulte, 1954). In the genus *Scepanotrocha*, 11 taxa have been described so far (Jersabek and Leitner, 2013), and the main diagnostic characteristic of this genus is the upper lip that is usually expanded like a hood and covers the corona fully or partially (Donner, 1965). In Korea, *Scepanotrocha corniculata* Bryce, 1910 and *S. simplex* De Koning, 1947 were reported before *S. parva* (Song and Lee, 2021). In *Scepanotrocha corniculata* and *S. parva*, the hood covers corona completely, while the hood covers slightly more than half of corona in *S. simplex* (Schulte, 1954; Song and Lee, 2021).

The result of the present study increased the number of Korean bdelloids records to 160 taxa, of which 122 at species-level and 38 at subspecies-level (Song and Lee, 2020a; 2020b; 2021; 2022; 2023; 2024). Here diagnostic characteristics, illustrations and photomicrographs are presented for each new Korean record. Partial sequences of mitochondrial cytochrome c oxidase subunit 1 gene (CO1) for *Mniobia barbatula* and *Scepanotrocha parva* are presented as well.

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Materials and Methods

The samples were collected from mosses, mushrooms and tree barks at two different locations in Korea, from May 20, 2023 to May 11, 2024. The identified species as well as detailed habitat information and sampling dates for each locality are listed in Table 1.

The bdelloid specimens were sorted out from samples conforming to a previously described method (Song, 2014). All of the living bdelloids were examined and identified under a light microscope with a magnification of ×400 to ×600. The photography and motion records of living specimens were done with an Infinity 2 digital camera (Lumenera Corporation, ON, Canada). The photographs were used for illustrations. Measurements were performed using GIMP 2.8 (the GNU Image Manipulation Program). The boiling water fixation method (Edmondson, 1959) was used to kill specimens with head, foot, and toes extended as previously described (Song and Min, 2015). The method of Stemberger (1979) was employed for the preparation of permanent mounts.

The classification scheme is accordant with those of Melone and Ricci (1995) and Segers (2002). The scheme of measurements is partially referred to Iakovenko *et al*. (2013).

DNA was extracted from one specimen of each new record using Extract-N-Amp^{TM} Tissue PCR Kit (Sigma-Aldrich, MO, USA) following the manufacturer's instructions. Partial mitochondrial cytochrome c oxidase subunit 1 gene (CO1) was amplified following the procedures described in Iakovenko *et al*. (2013) with some modifications (Song and Lee, 2020a). Sequencing was outsourced to Macrogen (Seoul, South Korea) using universal primers LCO1490 and HCO2198 (Folmer *et al*., 1994). The forward and reverse sequences were assembled using ClustalW program implemented in MEGAX (https://www.megasoftware.net/).

Results and Discussion

Phylum Rotifera Cuvier, 1817
Class Eurotatoria De Ridder, 1957
Subclass Bdelloidea Hudson, 1884
Order Philodinida Melone and Ricci, 1995
Family Habrotrochidae Bryce, 1910
Genus *Habrotrocha* Bryce, 1910

1. *Habrotrocha minima* De Koning, 1947

꼬마협관윤충 (신칭)

Habrotrocha minima De Koning, 1947, p. 191, pl. 3, figs. 12a–d.

Material examined. One specimen found from mushrooms, mosses and tree barks at Daegwallyeong Guksaseonghwangdang, Hoenggye-ri, Daegwallyeong-myeon, Pyeongchang-gun, Gangwon-do, 37°41′41.12″N, 128°45′15.27″E, 20 May, 2023.

Diagnosis. Rostrum round. Corona much narrower than cingulum; the ratio of corona width to cingulum width about 1 : 1.43. Upper lip slightly concave and with low arch medially; lower than sulcus base. Sulcus very narrow; narrower than 1/5 of pedicel width. Disc retractor shallow U-shaped, narrow and much higher than upper lip. Pedicel short. Cingulum pad rather long, round anterolaterally and cylindrical posteriorly. Foot very short and about 1/10 of total length in creeping. Spurs short and with narrow interspace; interspace much narrower than spur base width.

Measurements. Total length in feeding 142–148 μm. Total length in creeping 202 μm. Rostrum width in creeping 14 μm. Corona width 15–16 μm. Cingulum width 20–22 μm. Cingulum pad width 21–23 μm. Greatest trunk width in creeping 36 μm. Spur length 3 μm.

Remarks. *Habrotrocha minima* can be distinguished from the other *Habrotrocha* species by the narrow corona, lowly arched median lobe of upper lip and narrow sulcus.

Table 1. List of species and sampling localities.

Species	Habitat	Locality[a]	Previous world records
**Habrotrocha minima* De Koning, 1947	mushrooms, mosses and tree barks	1	Austria (Donner, 1962), Czech Republic (Devetter *et al*., 2020), the Netherlands (De Koning, 1947)
**Mniobia barbatula* Donner, 1950	mosses and tree barks	2	Austria (Donner, 1950), Czech Republic (Devetter *et al*., 2020), Italy (Melone *et al*., 1998)
**Scepanotrocha parva* Schulte, 1954	mosses and tree barks	1	Czech Republic (Devetter *et al*., 2020), Germany (Schulte, 1954)

*New to Asia.
[a]1 = Daegwallyeong Guksaseonghwangdang, Hoenggye-ri, Daegwallyeong-myeon, Pyeongchang-gun, Gangwon-do, 37°41′41.12″N/128°45′15.27″E, 20 May, 2023; 2 = Daegwallyeong Guksaseonghwangdang (near parking area), Hoenggye-ri, Daegwallyeong-myeon, Pyeongchang-gun, Gangwon-do, 37°41′46.9″N/128°45′13.5″E, 11 May, 2024.

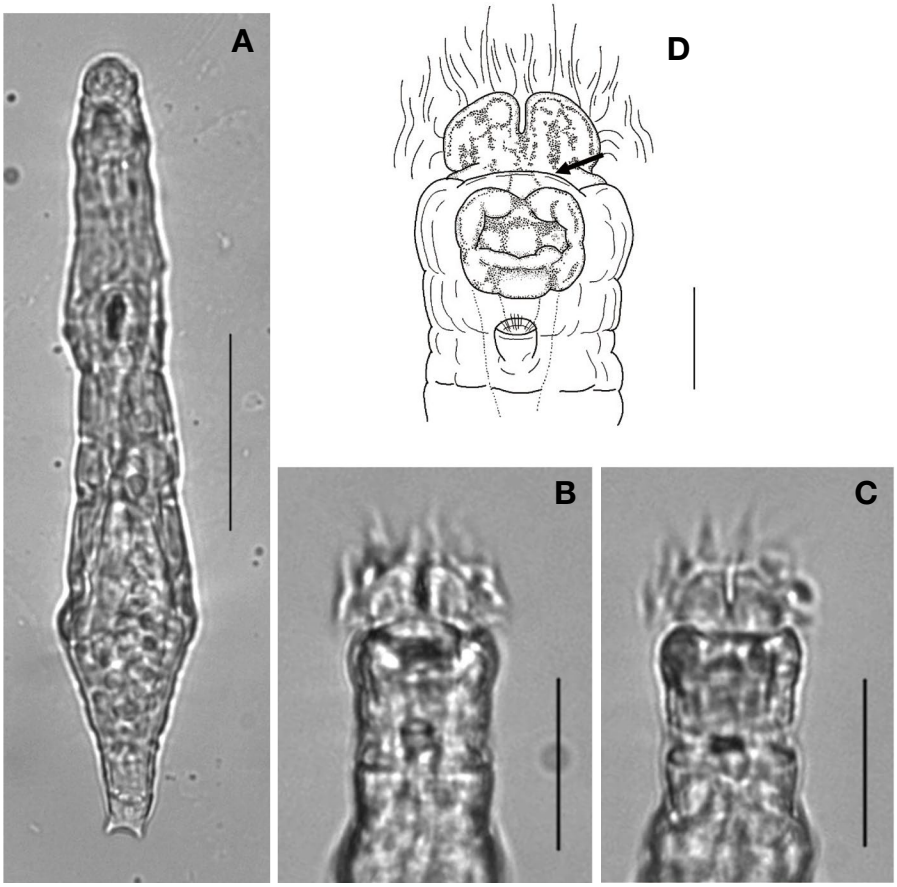

Fig. 1. *Habrotrocha minima* De Koning, 1947: A. creeping, dorsal view; B, C. feeding head and neck, dorsal view; D. feeding head, dorsal view (an arrow pointing at the upper lip) (Scales: A = 50 μm; B, C = 25 μm; D = 10 μm).

The characteristics of the Korean specimen agree well with the original description except the morphology of upper lip and the ratio of cingulum to cingulum pad. The upper lip is slightly arched in the original description, while that of the Korean specimen was rather concave and with low and arched median lobe. The cingulum of the type specimens was much wider than cingulum pad, while that of the Korean specimen was slightly narrower than cingulum pad. The shape of the feeding head of the Korean specimen was more close to that of the Austrian specimens reported by Donner (1962).

This species is rather rare and has been reported only from Austria (Donner, 1962) and Czech Republic (Devetter *et al*., 2020) since the description from the Netherlands by De Koning (1947). Devetter *et al*. (2020) reported this species only in the species list. New to Asia.

World distribution. Austria, Czech Republic, the Netherlands and Korea.

Deposition. Deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (NIBR IV0000910356).

Genus *Scepanotrocha* Bryce, 1910

Key to the species of *Scepanotrocha* reported from Korea

1. Hood with a shallow median notch; without any process medially; with a bird-beak like process laterally ····· *S. corniculata**
– Hood without a median notch; with a small and low process medially; with or without a lateral expansion or process ····· 2
2. Hood covering slightly more than half of corona; much narrower than corona; without any lateral expansion ····· *S. simplex**
– Hood covering corona completely; slightly wider than corona; with a trapezoidal flap-shaped lateral expansion ····· *S. parva*

(* in Song and Lee, 2021)

2. *Scepanotrocha parva* Schulte, 1954
작은두건관윤충 (신칭)

Scepanotrocha parva Schulte, 1954, pp. 601–602, figs. 25a–d.

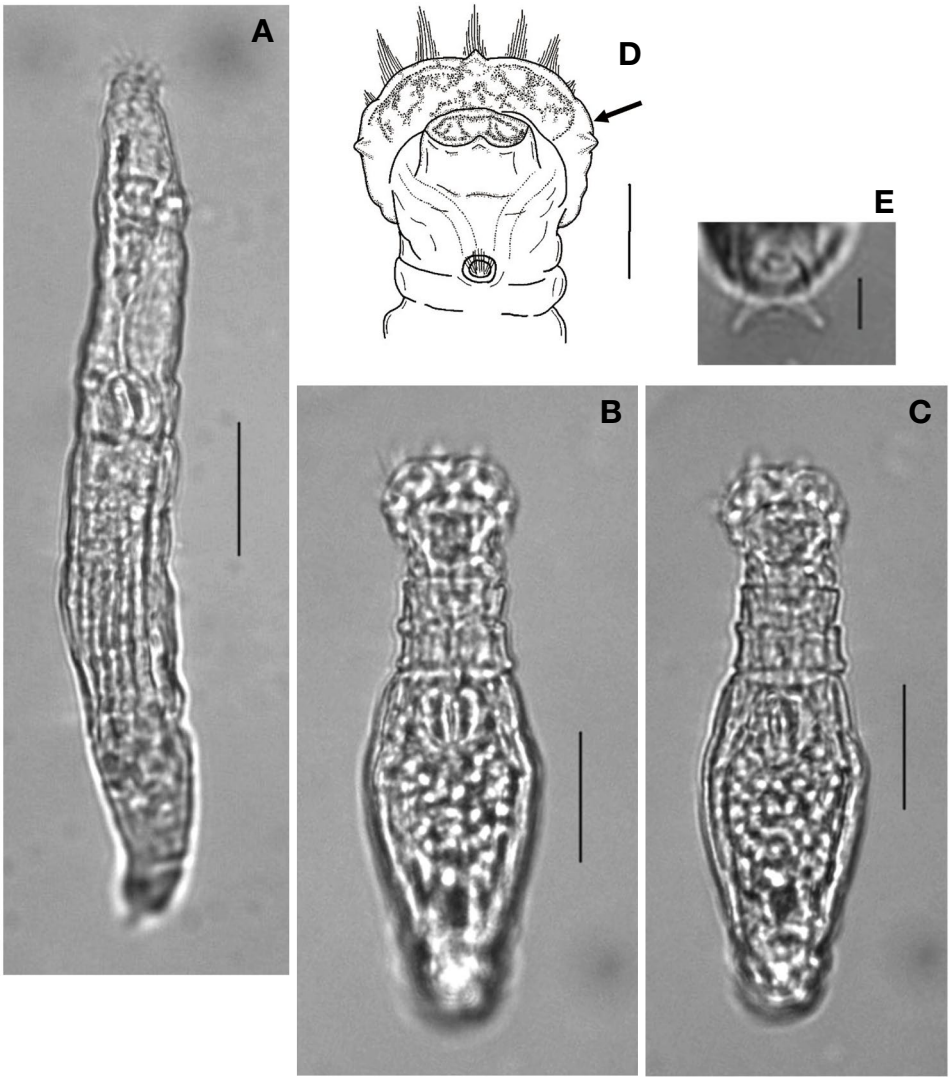

Fig. 2. *Scepanotrocha parva* Schulte, 1954: A. creeping, dorsolateral view; B, C. feeding, dorsal view; D. feeding head and neck, dorsal view (an arrow pointing at the trapezoidal flap-shaped lateral expansion of hood); E. spurs, ventral view (Scales: A–C = 25 μm; D = 10 μm; E = 5 μm).

Material examined. Three specimens sorted out from mosses and tree barks at Daegwallyeong Guksaseong-hwangdang, Hoenggye-ri, Daegwallyeong-myeon, Pyeongchang-gun, Gangwon-do, 37°41′41.12″N, 128°45′15.27″E, on 20 May, 2023.

Diagnosis. Rostrum short and round. Rostral lamella bilobed. Upper lip expanded to hood-shaped membrane with a trapezoidal flap-shaped lateral expansion; anterior margin of hood bilobed and with a low triangular process medially; hood slightly higher than trochal discs. Corona narrower than hood. Pedicel short. Pharyngeal tube as long as trophi. Foot very short; about 1/11 of total length in creeping. Spurs narrow cone-shaped and without interspace.

Measurements. Total length in feeding 97–152 μm. Total length in creeping 166–177 μm. Cingulum width 23–26 μm. Cingulum pad width 21–24 μm. Greatest trunk width in feeding 25–36 μm. Trophi length 11–12 μm. Spur length 5 μm.

Remarks. The upper lip of *Scepanotrocha parva* is expanded to a hood-shaped membrane which has a wavy anterior margin as well as a trapezoidal flap-shaped lateral expansion. Both the anterior margin and each lateral expansion of the hood have a small projection medially. The characteristics of the Korean specimens conformed to the original description except that the projection in the middle of the anterior margin of the hood was large and round in the original description, whereas it was small and pointed in the Korean specimens.

This species is very rare and the only report after description from Germany (Schulte, 1954) was Devetter *et al*. (2020), which reported it from Czech Republic in the

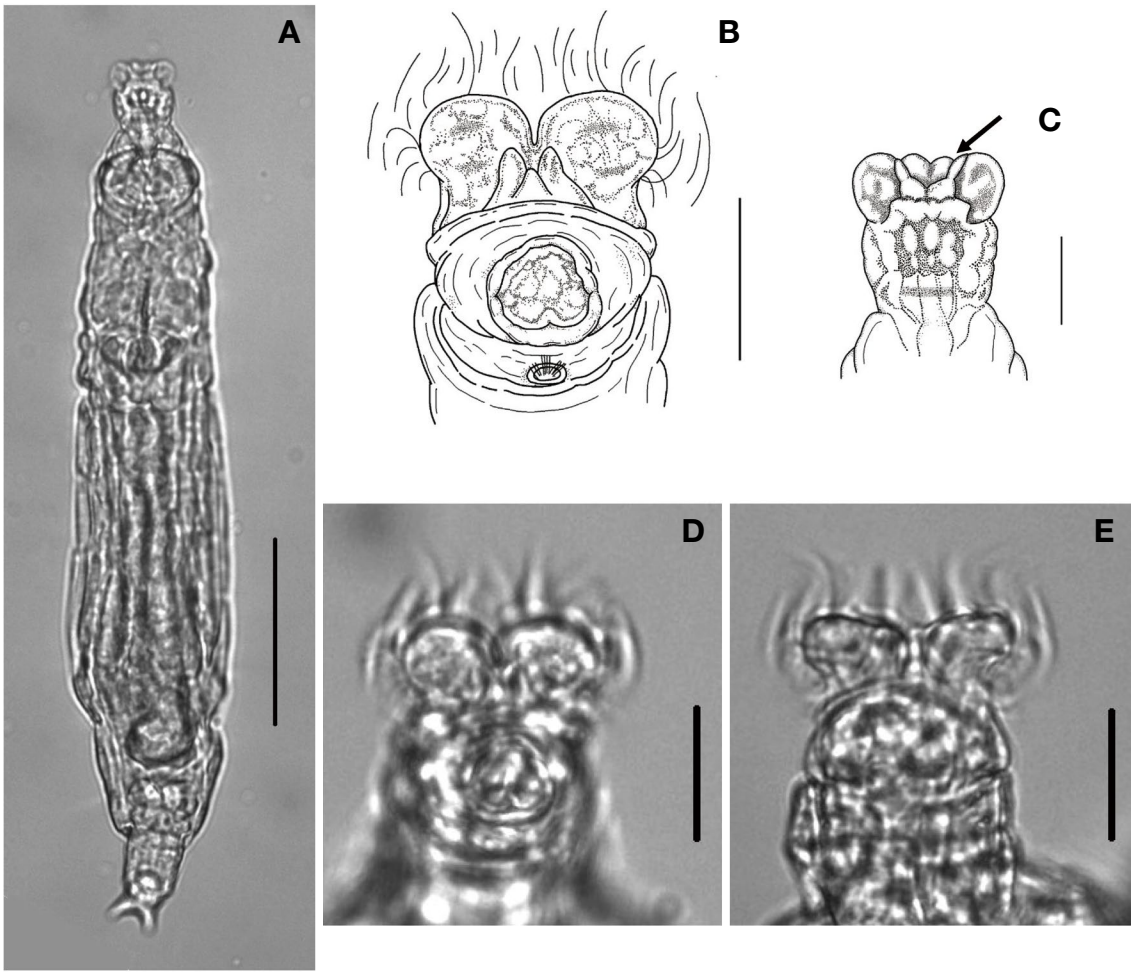

Fig. 3. *Mniobia barbatula* Donner, 1950: A. creeping, ventral view; B. feeding head, dorsal view; C. rostrum, ventral view (an arrow pointing at the tetralobed rostral lamella); D, E. feeding head and neck, dorsal view (Scales: A = 50 μm; B, D, E = 20 μm; C = 10 μm).

species list without remarks or figures. New to Asia.

Partial CO1 was amplified using DNA extracted from one specimen of *Scepanotrocha parva*. One sequence (619 bp in length) was obtained and submitted to GenBank under accession number PQ498773.

World distribution. Czech Republic, Germany and Korea.

Deposition. Deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (NIBR IV0000910357).

Family Philodinidae Ehrenberg, 1838
Genus *Mniobia* Bryce, 1910

3. *Mniobia barbatula* Donner, 1950
콧수염흡반윤충 (신칭)

Mniobia barbatula Donner, 1950, p. 334, figs. 22a–f; Melone *et al*., 1998, p. 1758, fig. 8.

Material examined. Four specimens found from mosses and tree barks at Daegwallyeong Guksaseonghwangdang (near parking area), Hoenggye-ri, Daegwallyeong-myeon, Pyeongchang-gun, Gangwon-do, 37°41′46.9″N, 128°45′13.5″E, on 11 May, 2024.

Diagnosis. Rostral lamella slightly wider than rostrum width and bilobed; each lobe bilobed and inner lobe much smaller than outer lobe. Corona slightly wider than cingulum; corona as wide as cingulum pad. Upper lip arched and with a narrow and high median lobe; median lobe bilobed and with a smaller and lower lobe between them. Sulcus very narrow; much narrower than 1/2 of pedicel width. Lateral margins of cingulum pad round medially. Teeth 3/3. Trunk finely granulated. Foot very short and about 1/9 of total length in creeping. Spurs long, conical and with narrow interspace.

Measurements. Total length in creeping 209–237 μm. Rostrum width 15–16 μm. Rostral lamella width 17–18 μm. Corona width 29–33 μm. Cingulum width 28–29

μm. Cingulum pad width 31−32 μm. Greatest neck width in creeping 35−38 μm. Greatest trunk width in creeping 35−56 μm. Greatest trunk width in feeding 66 μm. Trophi length 17−19 μm. Antenna length 9−10 μm. Spur length 5−6 μm.

Remarks. *Mniobia barbatula* can be distinguished from the other *Mniobia* species by the tetralobed anterior margin of rostral lamella and the trilobed median lobe of upper lip. The characteristics of the Korean specimens agreed quite well with the original description.

This species is rather rare and has been reported from only two countries after the description from Austria by Donner (1950). In their comparative study on the trophi of bdelloids, Melone *et al*. (1998) reported this species from Italy in the species list with a scanning electron microscopy photograph of trophi. Devetter *et al*. (2020) reported it from Czech Republic in the species list without remarks or figures. New to Asia.

Partial CO1 was amplified using DNA extracted from one specimen of *Mniobia barbatula*. One sequence (614 bp in length) was obtained and submitted to GenBank under accession number PQ498739.

World distribution. Austria, Czech Republic, Italy and Korea.

Deposition. Deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (OBMV IV0000000213).

Conflicts of Interest

The authors of this paper have no affiliation with any interests and are solely responsible for the paper.

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