

New records of 13 rotifers including *Bryceella perpusilla* Wilts *et al.*, 2010 and *Philodina lepta* Wulfert, 1951 from Korea

Min Ok Song*

Department of Biology, Gangneung-Wonju National University, Gangwon-do 25457, Republic of Korea

*Correspondent: rotisong@gmail.com, minsong@gwnu.ac.kr

Rotifers collected from various terrestrial and aquatic habitats such as mosses on trees or rocks, tree barks, wet mosses and wet leaf litter at streams, and dry leaf litter at four different locations in Korea, were investigated. Thirteen species belonging to nine genera in five families of monogonont and bdelloid rotifers were identified: *Bryceella perpusilla* Wilts, Martinez Arbizu and Ahlrichs, 2010, *Collotheca ornata* (Ehrenberg, 1830), *Habrotrocha flava* Bryce, 1915, *H. pusilla* (Bryce, 1893), *Macrotrachela aculeata* Milne, 1886, *M. plicata* (Bryce, 1892), *Mniobia montium* Murray, 1911, *M. tentans* Donner, 1949, *Notommata cyrtopus* Gosse, 1886, *Philodina lepta* Wulfert, 1951, *P. tranquilla* Wulfert, 1942, *Pleuretra hystrix* Bartoš, 1950 and *Proalinopsis caudatus* (Collins, 1873). All these rotifers are new to Korea, and *B. perpusilla*, *H. flava*, *M. montium*, *P. caudatus*, *P. hystrix* and *P. lepta* are new to Asia as well. Of interest, the present study is the first to record *B. perpusilla* outside its type locality. In addition, *P. lepta* has previously been recorded from only three European countries.

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

© 2017 National Institute of Biological Resources
DOI:10.12651/JSR.2017.6(S).037

INTRODUCTION

A taxonomic study of rotifers collected from various terrestrial as well as aquatic habitats at four different locations during 2016 yielded 13 new Korean records. Among these new Korean records, six species were new records for Asia as well. In addition, the genus *Proalinopsis* Weber, 1918 is new to the Korean fauna. The genus *Proalinopsis* is one of four genera in the family Proalidae Harring and Myers, 1924. Currently, six species have been described in the genus *Proalinopsis* (De Smet, 1996; Jersabek and Leitner, 2013).

Notably, the new Asian records included two species with limited distributions such as *B. perpusilla* and *P. lepta*. *Bryceella perpusilla* was found in Northwest Germany in 2008 and described by Wilts *et al.* (2010). It was rediscovered in Korea eight years later in this study. In the genus *Bryceella* Remane, 1929, only three species, *B. perpusilla*, *B. stylata* (Milne, 1886) and *B. tenella* (Bryce, 1897) have been described, and all of them have been reported from Korea, including the present study (Song and Jin, 2000; Song, 2015). *Philodina lepta* has been reported only from Rumania and Poland after its description from the Czech Republic by Wulfert (1951)

(Donner, 1965). The present study is the first record of *Philodina lepta* outside Europe as well as the fourth overall.

Here diagnostic characteristics are provided for each new Korean record. Illustrations and photomicrographs are added for the species with limited distributions.

MATERIALS AND METHODS

Samples were collected from various terrestrial and aquatic habitats such as mosses on trees or rocks, dry leaf litter, tree barks, wet mosses and wet leaf litter at streams at four different locations in Korea from May 7, 2016 to Sep. 25, 2016. The rotifers were isolated from samples according to previously described methods (Song, 2014; Song and Lee, 2017). All of the living rotifers were examined and identified under a light microscope with a magnification of $\times 400$ to $\times 600$. The photography and motion records of living specimens were performed using an Infinity 2 digital camera (Lumenera Corporation, ON, Canada). The photographs and computer-grabbed images of motion records were used for illustrations. Measurements were made by using Photo-

shop CS3. The specimens were killed with head, foot, and toes extended, by using the boiling water fixation method (Edmondson, 1959) instead of narcotization as previously described (Song and Min, 2015). For preparation of permanent mounts, the method of Stemberger (1979) was used as previously mentioned (Song and Lee, 2017).

The classification scheme is based on those of Melone and Ricci (1995) for bdelloids, and De Smet (1997) as well as Nogrady and Pourriot (1995) for monogononts.

RESULTS AND DISCUSSION

Phylum Rotifera Cuvier, 1817
 Class Eurotatoria De Ridder, 1957
 Subclass Monogononta Plate, 1889
 Superorder Gnesiotrocha Kutikova, 1970
 Order Collotheceae Haring, 1913
 Family Collotheceidae Haring, 1913
 Genus *Collothea* Haring, 1913

1. *Collothea ornata* (Ehrenberg, 1830)

Floscularia ornata Ehrenberg, 1830, p. 65; Ehrenberg, 1832, p. 125; Weber, 1898, pp. 274-276, pl. 10, figs. 6-8.

Collothea ornata: Koste, 1978, p. 591, T. 226: 2a-d; Meksuwan *et al.*, 2013, p. 15, figs. 3c, 4b.

Material examined. One specimen found in wet mosses alongside a stream in Daegwallyeong, Pyeongchang-gun, Gangwon-do, 37°41'19.7"N 128°45'39.0"E, 5 June 2016.

Diagnosis. Lorica absent. Corona funnel-shaped with 5 knobbed lobes; dorsal knob biggest; each knob bearing very long cilia; without cilia between knobs. Trophi unciniate. Foot stalk-like. Toes absent.

Measurements. Infundbulum width 54 µm. Body length 150 µm.

Remarks. This species is presumably cosmopolitan because it has been reported from East Africa, North America, Hawaii, Europe and Asia. In Asia, it has been recorded from Cambodia (Segers *et al.*, 2010), India (Banik *et al.*, 2009), Iran (Kordbacheh and Rahimian, 2012), Thailand (Meksuwan *et al.*, 2013), Vietnam (Trinh Dang *et al.*, 2013), Mongolia (Jersabek and Bolortsetseg, 2010) and Japan (Sudzuki, 1964).

World distribution. Cosmopolitan.

Deposition. Deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (ZII YIV0000001543).

Superorder Pseudotrocha Kutikova, 1970
 Order Ploima Hudson and Gosse, 1886

Family Proalidae Haring and Myers, 1924
 Genus *Bryceella* Remane, 1929

2. *Bryceella perpusilla* Wilts, Martinez Arbizu and Ahlrichs, 2010 (Fig. 1)

Bryceella perpusilla Wilts, Martinez Arbizu and Ahlrichs, 2010, pp. 474-478, figs. 1-4.

Material examined. Two specimens found in mosses and tree bark around Sangwonsa, Odaesan, Jinbu-myeon, Pyeongchang-gun, Gangwon-do, 37°47'18.5"N 128°33'50.6"E, 25 Sept. 2016.

Diagnosis. Corona ventral and with two short apical styli. Rostrum triangular. Foot about 1/5 of total length and with two pseudosegments. Toes shorter than second foot pseudosegment; thin and curved outwardly. Vitellarium with four nuclei. Inner margins of right ramus with three and left ramus with two cone-shaped projections anteriorly; right uncus 6-toothed and left uncus 5-toothed; manubria long and slender.

Measurements. Total body length 127 µm. Greatest trunk width 33 µm. Foot length 21 µm.

Remarks. According to Wilts *et al.* (2010), *B. perpusilla* might be one of the smallest rotifers because the body lengths of the type specimens were just 50-80 µm. The Korean specimens were larger than the type specimens as described above.

This species is distinguished from other congeners by the very small size, the slender body outline, the short apical styli, the triangular rostrum, the outward curving, blunt and rod-shaped toes, the four-nucleated vitellarium (york gland), the slender manubria and the caudally directed alulae (Wilts *et al.*, 2010). In the Korean specimens, rostrum was rather round than triangular in the frontal view.

B. perpusilla was found in terrestrial mosses in North-west Germany in 2008. Eight years later, it was rediscovered in mosses and tree barks around Sangwonsa, Odaesan in Korea, which was the second record of this species.

World distribution. Germany and Korea.

Deposition. Deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (ZII YIV0000004842, ZIIYGR0000000008).

Genus *Proalinopsis* Weber, 1918

3. *Proalinopsis caudatus* (Collins, 1873) (Fig. 2)

Notommata caudata Collins, 1873, p. 11, figs. 8a, b.

Proalinopsis caudatus: Weber and Montet, 1918, pp. 98-99; Haring and Myers, 1922, pp. 608-610, pl. 52, figs. 1-5; Koste, 1978, p. 267, T. 87: 4a-f, T. 88: 3a-m; Koste and Shiel, 1990, p. 131, figs. 1: 3a-e; De Smet, 1996, pp. 19-20, figs. 40-46, pl. 4: figs. 1-6.

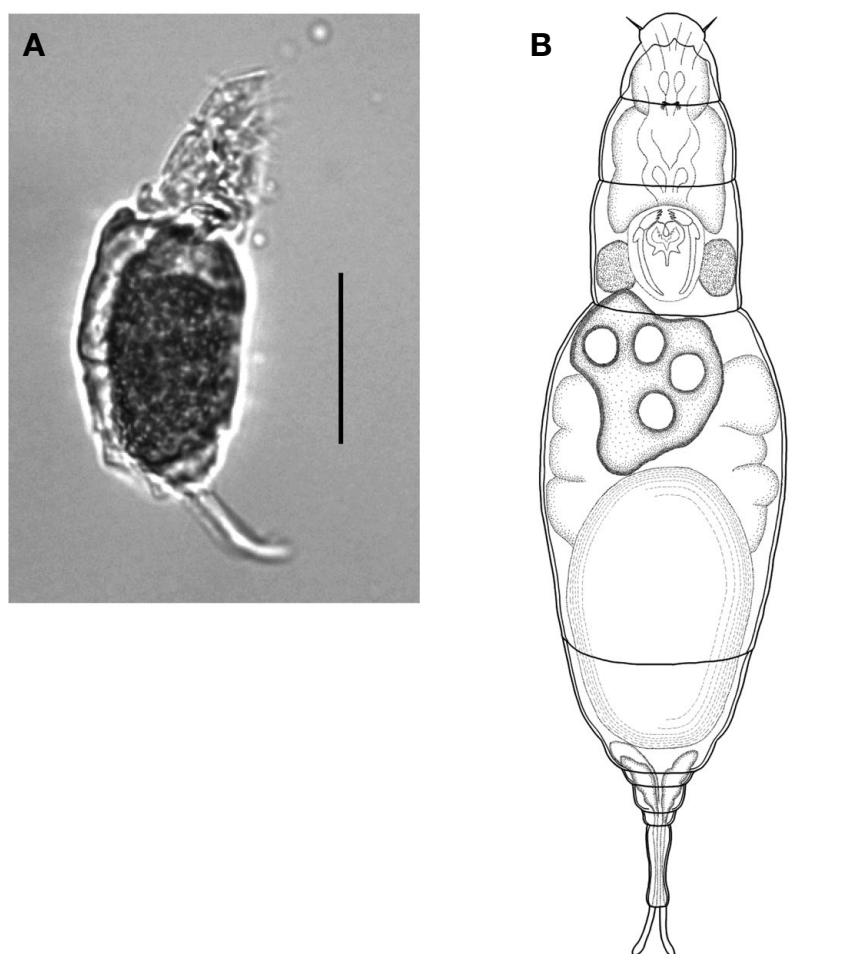


Fig. 1. *Bryceella perpusilla* Wilts, Martinez Arbizu and Ahlrichs, 2010. A. creeping, lateral view; B. creeping, dorsal view (Scales: A, B = 25 μ m).

Material examined. Two specimens found in wet leaf litter alongside a stream at Gyeryongsan, Gongju-si, Chungcheongnam-do, 36°20'47.7"N 127°12'22.9"E, 7 May 2016.

Diagnosis. Body spindle-shaped and slender. Cuticle delicate. Head offset by transverse fold. Corona oblique. Foot with 2-4 pseudosegments and about 1/7-1/5 of total length. Posterodorsal part of first foot pseudosegment with a short cylindrical projection bearing a long seta. Trophi virgate. Unci with 7-8 large and clubbed teeth.

Measurements. Total body length 204 μ m. Greatest trunk width 59 μ m. Foot length 28 μ m. Toe length 18 μ m.

Remarks. Even though this species has a wide distribution, it is new to Asian fauna.

The genus *Proalinopsis* Weber, 1918 is new to the Korean fauna. In *Proalinopsis*, only six species have been described to date globally (De Smet, 1996; Jersabek and Leitner, 2013).

World distribution. Probably cosmopolitan (De Smet,

1996).

Deposition. Deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (ZII YIV0000001553, ZIIYGR0000000005).

Family Notommataidae Hudson and Gosse, 1886

Genus *Notommata* Ehrenberg, 1830

4. *Notommata cyrtopus* Gosse, 1886

Notommata cyrtopus Gosse, Hudson and Gosse, 1886, v. 2, p. 22, pl. 17, fig. 7; Harring and Myers, 1922, pp. 582-584, pl. 49, figs. 5-8; Koste, 1978, pp. 330-331, T. 106: 8a-h, T. 107: 12a-d; Nogrady and Pourriot, 1995, pp. 181-183, fig. 230.

Material examined. One specimen found in wet leaf litter at a stream near Gyeryongsan, Gongju-si, Chungcheongnam-do, 36°20'47.7"N 127°12'22.9"E, 7 May 2016.

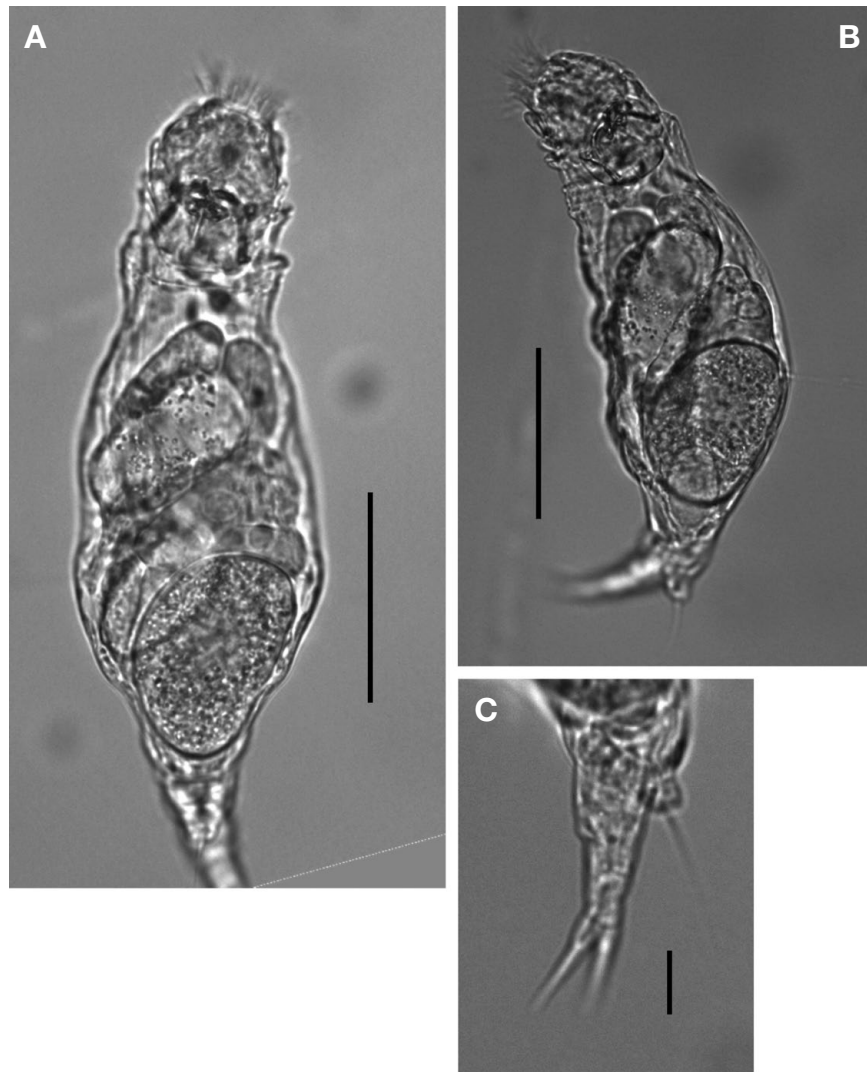


Fig. 2. *Proalinopsis caudatus* (Collins, 1873). A. creeping, dorsal view; B. creeping, lateral view; C. foot and toes, dorsolateral view (Scales: A, B = 50 μ m; C = 10 μ m).

Diagnosis. Body stout and without a tail. Corona ventral. Each side of head with a small auricle anterolaterally. Foot with two joints and ending in two slender and outcurved toes. Rami triangular with an inner ventral projection and well-developed sharp alula.

Measurements. Total body length 140 μ m. Greatest trunk width 53 μ m. Toe length 18 μ m.

Remarks. Though this species is cosmopolitan, it has been reported from only four Asian regions such as Laos (Segers and Sanoamuang, 2007), Mongolia (Jersabek and Bolortsetseg, 2010), Pakistan (Ejaz *et al.*, 2015) and an Asian region of Turkey (Bekleyen *et al.*, 2011).

World distribution. Cosmopolitan.

Deposition. In a permanent slide, deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (ZIIYIV0000001549).

Subclass Bdelloidea Hudson, 1884
Order Philodinida Melone and Ricci, 1995
Family Habrotrochidae Bryce, 1910
Genus *Habrotrocha* Bryce, 1910

5. *Habrotrocha flava* Bryce, 1915 (Fig. 3)

Habrotrocha flava Bryce, 1915, pp. 639-640, pl. 38, fig. 3; Bartoš, 1951, p. 306, figs. 14E, F; Donner, 1965, p. 81, figs. 61e-f.

Material examined. One specimen found in wet leaf litter alongside a stream at Daegwallyeong, Pyeongchang-gun, Gangwon-do, 37°41'19.7"N 128°45'39.0"E, 5 June 2016.

Diagnosis. Corona slightly wider than cingulum and as wide as cingulum pad. Disc retractor prominent and

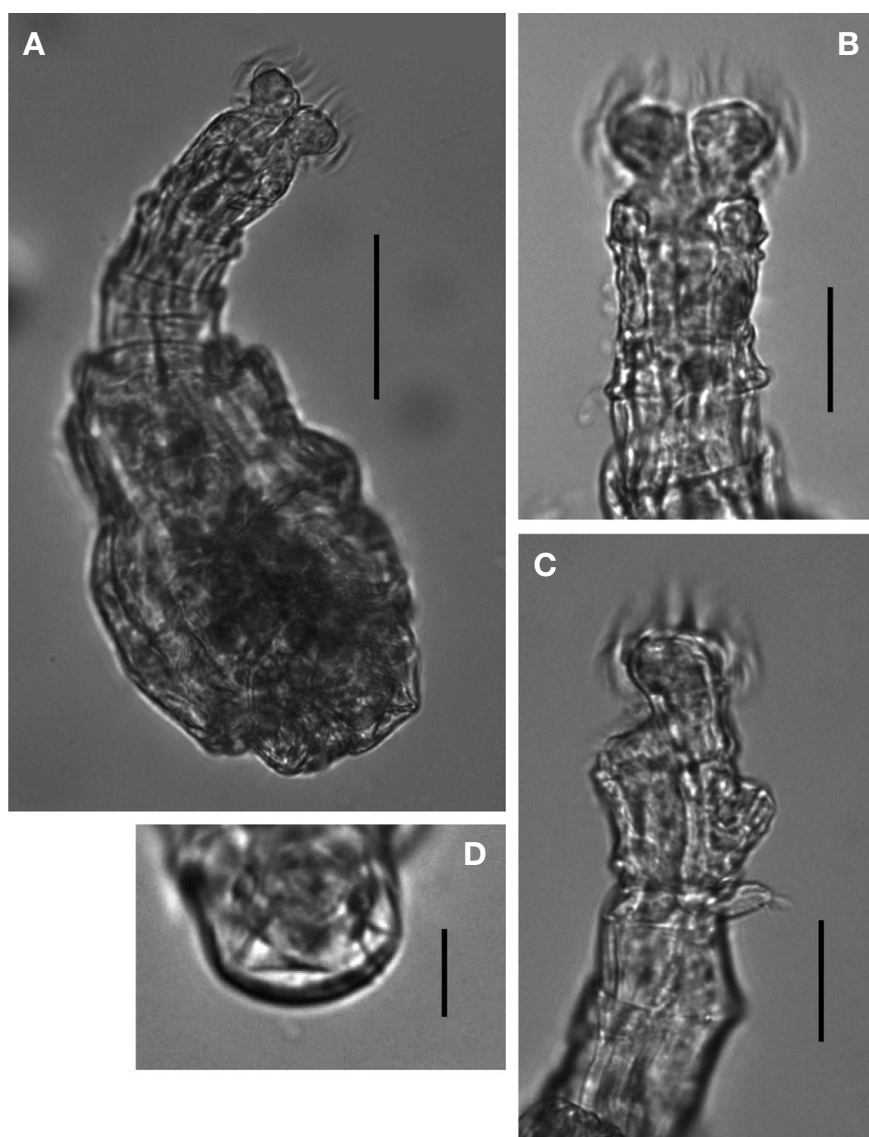


Fig. 3. *Habrotrocha flava* Bryce, 1915. A. feeding, dorsal view; B. feeding, ventral view; C. feeding, lateral view; D. spurs, ventral view (Scales: A = 50 μ m; B, C = 25 μ m; D = 10 μ m).

V-shaped with convex sides. Sulcus very narrow. Upper lip arched and much lower than trochal discs. Head and neck long. Pharyngeal tube long with loops and twice as long as trophi length. Lateral margins of antenna pseudosegment swollen. Teeth 7/7. Spurs conical, very short and with wide interspace.

Measurements. Total body length in feeding 230 μ m. Total body length in creeping 305 μ m. Corona width 31 μ m. Cingulum width 26 μ m. Cingulum pad width 32 μ m. Spur length 5 μ m.

Remarks. This species is similar to *H. flaviformis* De Koning, 1947; however, these two species can be distinguished by the following characteristics: (1) the head and neck of *H. flaviformis* are much longer than those

of *H. flava*, (2) the pharyngeal tube of *H. flaviformis* is three times as long as its trophi length, while that of *H. flava* is about twice its trophi length, and (3) the teeth formula of *H. flaviformis* is 5/5, while that of *H. flava* is 7/7.

The characteristics of the Korean specimen are consistent with the original description except that the interspace between spurs is very narrow in the Korean specimen, while it is wide and convex in the type specimens.

This species has been reported from several countries in Europe, New Zealand and North America. The present study is the first Asian record of this species.

World distribution. Europe, New Zealand, North America (Donner, 1965; Jersabek and Leitner, 2013) and

Korea.

Deposition. In a permanent slide, deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (ZIIYIV0000001545).

6. *Habrotrocha pusilla* (Bryce, 1893)

Callidina pusilla Bryce, 1893, p. 201, fig. 2.

Habrotrocha pusilla: Donner, 1970, p. 517, Abb. 2g, Abb. 3f.

Material examined. One specimen found in wet leaf litter from Daegwallyeong, Pyeongchang-gun, Gangwon-do, 37°41'19.7"N 128°45'39.0"E, 5 June 2016.

Diagnosis. Corona slightly narrower than cingulum. Pedicel very short. Sulcus very narrow. Upper lip slightly arched and rimmed. Cingulum somewhat expanded laterally. Cingulum pad angular medially. Lateral margin of antenna pseudosegment swollen. Teeth 6/6. Spurs short and conical. Egg oval.

Measurements. Total body length in feeding 214 µm. Antenna pseudosegment width 27 µm. Corona width 25 µm. Cingulum width 26 µm. Cingulum pad width 29 µm.

Remarks. *Habrotrocha pusilla* lives in a net made of mucus and debris. *Habrotrocha pusilla* differs from *H. pusilla textrix* in the following characteristics: (1) the rim of upper lip is wider in *H. pusilla textrix*, (2) each anterolateral corner of cingulum is somewhat expanded in *H. pusilla*, (3) the cingulum pad of *H. pusilla* is angular medially, while that of *H. pusilla textrix* is round medially, and (4) the lateral margin of antenna pseudosegment is swollen and round in *H. pusilla*.

The dental formula of the Korean specimen is 6/6 while that of the type specimen was 4/3. *Habrotrocha pusilla* is probably cosmopolitan because it has been reported from Central Africa, Europe, New Zealand, North America, Pacific islands (Donner, 1965), Brazil (Koste, 2000), and South Africa (Koste, 1996).

Kaya (2013) reported this species from Erzurum (eastern part of Turkey), which was the first Asian record of it.

World distribution. Probably cosmopolitan.

Deposition. In a permanent slide, deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (ZIIYIV0000004841).

Family Philodinidae Ehrenberg, 1838

Genus *Macrotrachela* Milne, 1886

7. *Macrotrachela aculeata* Milne, 1886

Macrotrachela aculeata Milne, 1886, p. 138, pl. 1, fig. 6;

Donner, 1965, p. 111, figs. 83d-h; Koste *et al.*, 1993, p. 142, Abb. 32.

Callidina aculeata: Murray, 1911a, pp. 10-11, pl. 1, figs. 4-6c; Murray, 1911c, pp. 7-8, pl. 1, fig. 4.

Material examined. Two specimens found in dry leaf litter from Juwangsang, Cheongsong-gun, Gyeongsangbuk-do, 36°23'23.6"N 129°10'00.1"E, 17 Aug. 2016.

Diagnosis. Each trunk pseudosegments with transverse row of spines posterodorsally as well as posterolaterally; each spine short and at the end of longitudinal fold except those on the first and the last two trunk pseudosegments. First foot pseudosegment with a hump dorsally. Spurs narrow, tapering and with narrow interspace.

Measurements. Total body length in creeping 240 µm. Greatest trunk width in creeping 61 µm. Spur length 8 µm.

Remarks. This species is easily recognized by the transverse rows of short spines on each posterodorsal as well as posterolateral margins of trunk pseudosegments. It is presumably cosmopolitan because it has been recorded from many European countries, South and Central Africa, North America and the Arctic. Its first Asian record was from the eastern part of Turkey (Erzurum) by Kaya (2013).

World distribution. The Arctic (Kaya *et al.*, 2010), Czech Republic, England, Hungary, Ireland, North America, South and Central Africa, Spain, Turkey (Donner, 1965), Jamaica (Koste *et al.*, 1993).

Deposition. Deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (ZIIYIV0000004840, ZIIYGR0000000007).

8. *Macrotrachela plicata* (Bryce, 1892)

Callidina plicata Bryce, 1892, pp. 21-22, pl. 2, fig. 1;

Murray, 1908, pp. 196-197, pl. 2, figs. 14, 15.

Macrotrachela plicata: Montet, 1915, pp. 290-291, pl. 10, figs. 19a-b; Donner, 1965, p. 141, figs. 105a-l; Donner, 1971, p. 371, Abb. 4e-g.

Material examined. Two specimens found in wet leaf litter from Daegwallyeong, Pyeongchang-gun, Gangwon-do, 37°41'19.7"N 128°45'39.0"E, 5 June 2016.

Diagnosis. Corona wider than cingulum. Sulcus narrower than a half of pedicel width. Upper lip bilobed medially and as high as trochal discs. Disc retractor with a round projection medially. Teeth 2 + 1/1 + 2. Trunk, rump, foot and spurs very finely granulated. Preanal pseudosegment with round lateral margins. Lateral margin of anal pseudosegment swollen posteriorly.

Measurements. Total body length in feeding 279 µm. Greatest trunk width in feeding 78 µm. Corona width 50 µm. Cingulum pad width 40 µm. Spur length 11 µm.

Remarks. The disc retractor of this species has a round projection medially, which is observed between median lobes of the upper lip and has been incorrectly identified as a small obtuse process on the median notch of the upper lip. The longitudinal folds on the trunk are strong and finely granulated.

This species is cosmopolitan (Donner, 1965) and has been reported from the eastern part of Turkey (Erzurum) by Kaya (2013), which was the first Asian record of it.

World distribution. Cosmopolitan.

Deposition. Deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (ZII YIV0000004839, ZIIYGR0000000006).

Genus *Mniobia* Bryce, 1910

9. *Mniobia montium* Murray, 1911 (Fig. 4)

Mniobia montium Murray, 1911b, pp. 291-292, pl. 8, figs. 14a, b; Donner, 1965, pp. 246-247, fig. 181a-e.

Material examined. One specimen found in mosses and tree bark around Sangwonsa, Odaesan, Jinbu-myeon, Pyeongchang-gun, Gangwon-do, 37°47'18.5"N 128°33'50.6"E, 25 Sept. 2016.

Diagnosis. Corona as wide as cingulum pad, and slightly narrower than cingulum. Lateral margins of cingulum somewhat extended. Upper lip bell-shaped and with

shallow median notch; much lower than trochal discs. Sulcus very narrow. Pedicel long. Spurs conical, tapering to blunt ends and with narrow interspace.

Measurements. Total body length in feeding 226 μm . Total body length in creeping 260 μm . Greatest trunk width in creeping 34 μm . Corona width 25 μm . Cingulum width 28 μm . Cingulum pad width 26 μm . Spur length 5 μm .

Remarks. The characteristics of the Korean specimen coincide well with those in the original description except that sulcus is much narrower than that of the type specimen.

The shape of median notch of upper lip is variable from simple slit to U-shaped depression. In the Korean specimen, the median notch was a shallow V-shaped depression.

This species is rare and has been reported from Austria, Germany and Iceland after its description from Canada. The present study is the first Asian record of this species.

World distribution. Austria (Donner, 1965), Canada (Murray, 1911b), Germany (Jersabek and Leitner, 2013),

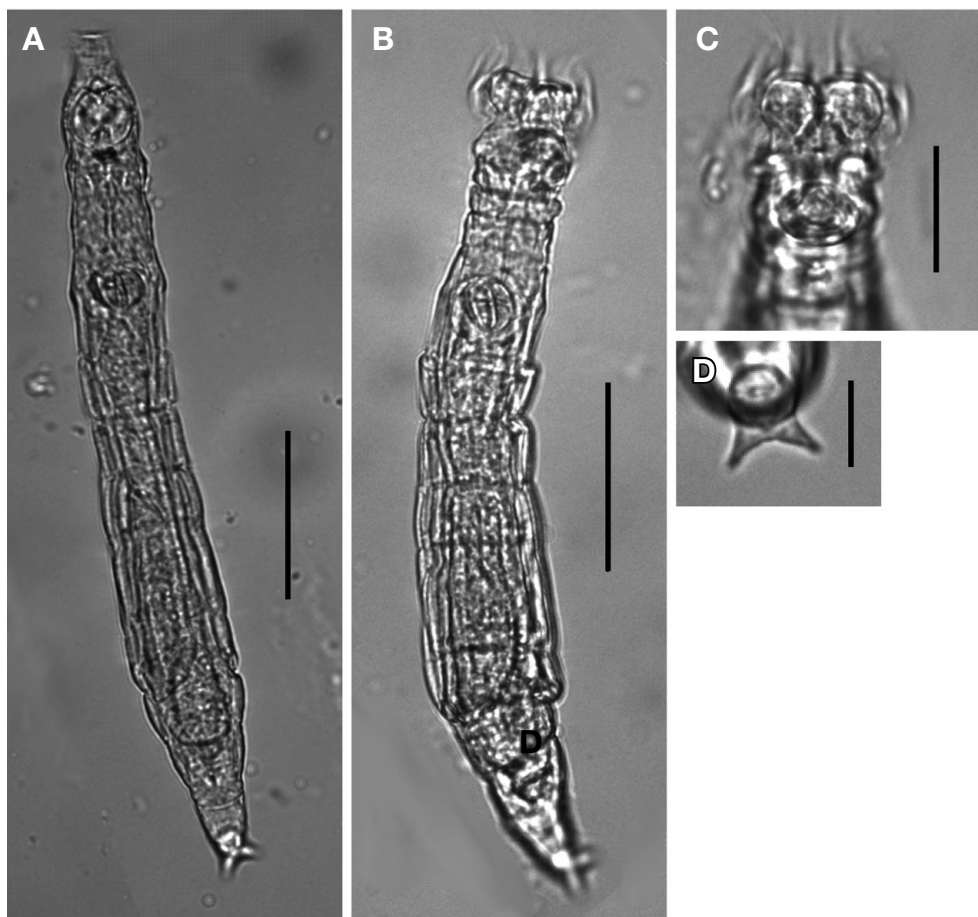


Fig. 4. *Mniobia montium* Murray, 1911. A. creeping, dorsal view; B. feeding, dorsal view; C. feeding head and neck, dorsal view; D. spurs, ventral view (Scales: A, B = 50 μm ; C = 25 μm ; D = 10 μm).

Iceland (Lindegaard, 1979) and Korea.

Deposition. In a permanent slide, deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (ZIIYIV0000004849).

10. *Mniobia tentans* Donner, 1949

Mniobia tentans Donner, 1949, pp. 126-128, Abb. 8; Donner, 1965, p.250, 252, fig. 185; Donner, 1971, pp. 374-375, Abb. 4i.

Material examined. Three specimens found in wet mosses at a stream around Gyeryongsan, Gongju-si, Chungcheongnam-do, 36°20'47.7"N 127°12'22.9"E, 7 May 2016.

Diagnosis. Body reddish and very finely stippled. Corona much wider than cingulum width. Upper lip arched, bilobed medially and much lower than trochal discs; a depression between two lobes much narrower than each lobe's width. Sulcus somewhat narrower than pedicel width. First foot pseudosegment with a hump dorsally.

Measurements. Greatest trunk width in feeding 84 µm. Corona width 77 µm. Cingulum width 59 µm. Cingulum pad width 58 µm. Spur length 10 µm.

Remarks. This species has been reported from Europe (Donner, 1965; Devetter, 2007; Schöll and Devetter, 2013) and the Arctic (Kaya *et al.*, 2010) since its description from Austria. In Asia, it was recorded from Tibet by Gong (1983) (reviewed in Zhuge *et al.*, 1998).

The morphology of the Korean specimens is most similar to that of var. 4 in Donner (1971) in the following characteristics: (1) the corona is much wider than cingulum, (2) lateral margins of cingulum pads are rather parallel medially, and abruptly tapering posteriorly, and (3) the first foot pseudosegment has a hump dorsally.

World distribution. Europe, the Arctic, Tibet and Korea.

Deposition. Deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (ZIIYIV0000001546, ZIIYIV0000001547, ZIIYGR000000002).

Genus *Philodina* Ehrenberg, 1830

11. *Philodina lepta* Wulfert, 1951 (Fig. 5)

Philodina lepta: Donner, 1965, p. 227, figs. 164h-i.

Material examined. One specimen found in wet leaf litter and wet mosses around Sangwonsa, Odaesan, Jinbu-myeon, Pyeongchang-gun, Gangwon-do, 37°47'18.5" N 128°33'50.6"E, 25 Sept. 2016.

Diagnosis. Corona slightly wider than cingulum. Trochal discs rather inclined toward sulcus. Sulcus much narrower than pedicel width. Pedicel rather long. Upper

lip rimmed, arched and trilobed medially; slightly higher than sulcus base. Cingulum pad slightly narrower than cingulum. Spurs finger-shaped and with acute points; interspace much wider than spur base width.

Measurements. Total length in feeding 161 µm. Corona width 37 µm. Cingulum width 34 µm.

Remarks. The characteristics of the Korean specimen agree well with those in the original description.

This species is rather rare and has been recorded only from three European countries including its type country, Czech Republic (Donner, 1965). The present study is the first record of this species outside Europe.

World distribution. Czech Republic, Rumania, Poland and Korea.

Deposition. In a permanent slide, deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (ZIIYIV0000004844).

12. *Philodina tranquilla* Wulfert, 1942

Philodina tranquilla Wulfert, 1942, pp. 195-196, Abb. 5a-d; Donner, 1965, p. 211, fig. 155e.

Material examined. Two specimens found in wet mosses at a stream around Daegwallyeong, Pyeongchang-gun, Gangwon-do, 37°41'19.7"N 128°45'39.0"E, 5 June 2016.

Diagnosis. Two orange eyes. Corona slightly wider than cingulum pad. Upper lip arched and much lower than trochal discs; bilobed medially and with a wide depression between lobes. Sulcus as wide as pedicel width and convex medially. Teeth 2 + 1/1 + 2. Spurs plump proximally and abruptly tapering to blunt ends from the middle part.

Measurements. Total length in feeding 125 µm. Greatest trunk width in feeding 60 µm. Corona width 41 µm. Cingulum width 37 µm. Spur length 5 µm.

Remarks. This species is similar to *Philodina acuticornis odiosa* Milne, 1916, but it can be distinguished from the latter by the following characteristics: (1) the corona of *P. tranquilla* is slightly wider than cingulum pad, while that of the latter is much wider than cingulum pad, and (2) the dorsal toes of *P. acuticornis odiosa* are always extended a little even during feeding, while those of *P. tranquilla* are not.

This species is rather rare and has been reported from Japan and New Zealand after its description from Germany. The first Asian record of this species was from Japan by Hayashi *et al.* (1998).

World distribution. Japan (Hayashi *et al.*, 1998), Germany (Wulfert, 1942), New Zealand (Haigh, 1963) and Korea.

Deposition. Deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (ZIIYIV0000004845, ZIIYGR0000000009).

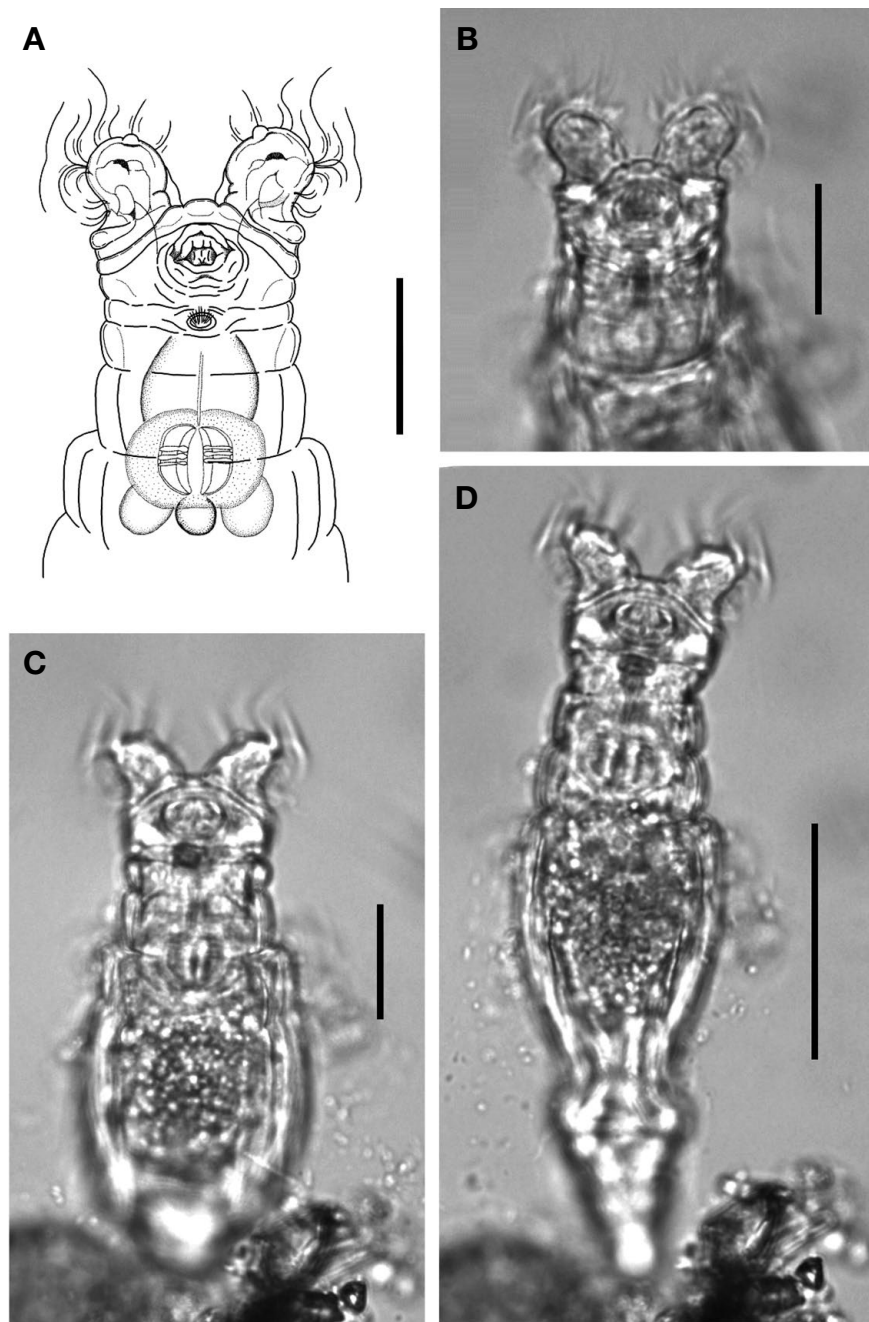


Fig. 5. *Philodina lepta* Wulfert, 1951. A. feeding head and neck, dorsal view; B. feeding head and neck, dorsal view; C. feeding, dorsal view; D. feeding, dorsal view (Scales: A-C = 25 μ m; D = 50 μ m).

Genus *Pleuretra* Bryce, 1910

13. *Pleuretra hystrix* Bartoš, 1950 (Fig. 6)

Pleuretra hystrix Bartoš, 1950, p. 290, figs. 1A-C; Donner, 1965, pp. 192-193, figs. 139a-c; Fontaneto and Melone, 2003, pp. 154-155, figs. 1-13.

Philodina brycei (Weber) var.: Murray, 1908, p. 192, fig. 13.

Material examined. Two specimens found in wet mosses at a stream around Daegwallyeong, Pyeongchang-gun, Gangwon-do, 37°41'19.7"N 128°45'39.0"E, 5 June 2016.

Diagnosis. Corona much wider than cingulum. Sulcus slightly narrower than pedicel width. Pedicel long. Upper lip arched and as high as sulcus base. Trunk integument rather stiff, highly granulated and with 10 promi-

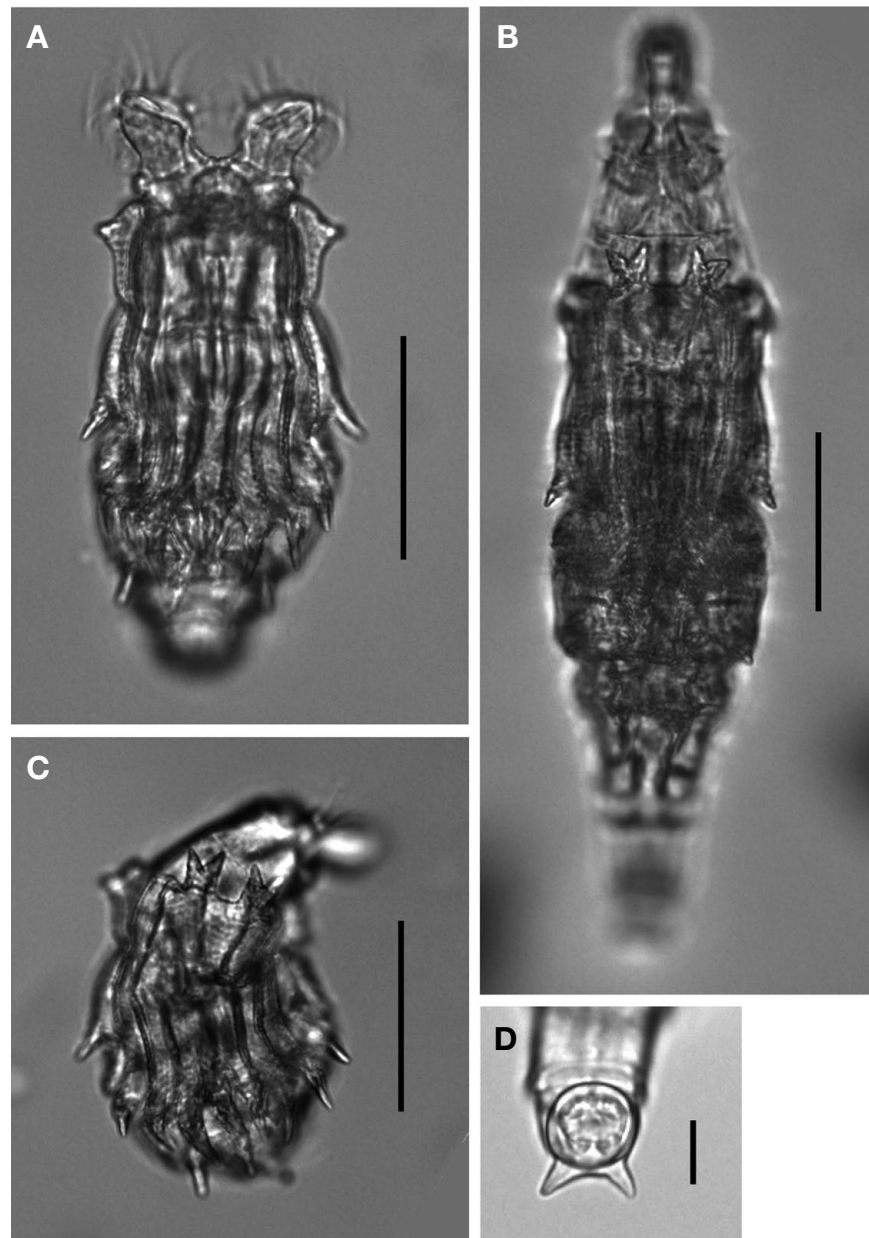


Fig. 6. *Pleuretra hystrix* Bartoš, 1950. A. feeding, dorsal view; B. creeping, dorsal view; C. creeping, dorsal view; D. spurs and toes, ventral view (Scales: A-C = 50 μ m; D = 20 μ m).

ment longitudinal ridges; each ridge ending in an acute spine in the middle of trunk. Anterodorsal margin of the first trunk pseudosegment with a pair of bifurcated projections, which flanking a dorsal antenna.

Measurements. Total length in feeding 130 μ m. Total length in creeping 260 μ m. Greatest trunk width in creeping 60 μ m. Corona width 44 μ m. Cingulum width 36 μ m. Sulcus width 12 μ m. Spur length 6 μ m.

Remarks. This species is easily recognized by a pair of bifurcated projections on anterodorsal margin of the first trunk pseudosegment. The characteristics of the Korean

specimens agree well with those in the original description.

Fontaneto and Melone (2003) rediscovered this species in the western Italian Alps about 50 years after the original description by Bartoš (1950), and redescribed this species in detail using scanning electron micrographs, confirming the validity of it. In their faunistic survey on the global distribution of bdelloids, Fontaneto *et al.* (2007) suggested *P. hystrix* as Alpine endemic because it had been found only in the Alpine regions of Switzerland and Italy until then. Recently, its distribu-

tion has been expanded to Canada and the Arctic region by Kaya *et al.* (2010). This species was rediscovered from Korea in 2016 (current study), which was the first observation of this species in Asia.

World distribution. The Arctic, Canada, Italy, Switzerland and Korea.

Deposition. Deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (ZIIY IV0000001552, ZIIYGR0000000004).

ACKNOWLEDGEMENTS

This work was supported by a grant from the National Institute of Biological Resources (NIBR), funded by the Ministry of Environment (MOE) of the Republic of Korea (NIBR201601201).

REFERENCES

- Banik, S., S. Abir, S. Kar and N. Chakrabarty. 2009. New reports of some rotifer species from freshwater wetland ecosystem of Tripura, India. *Proceedings of Workshop on Aquaculture Biotechnology for Women for Rural Development*: 42-63.
- Bartoš, E. 1950. Additions to knowledge of moss-dwelling fauna of Switzerland. *Hydrobiologia* 2:285-295.
- Bartoš, E. 1951. The Czechoslovak Rotatoria of the order Bdelloidea. *Vestník Československé Zoologické Společnosti* 15:241-500.
- Bekleyen, A., B. Gokot and M. Varol. 2011. Thirty-four new records and the diversity of the Rotifera in the Turkish part of the Tigris River watershed, with remarks on biogeographically interesting taxa. *Scientific Research and Essays* 6:6270-6284.
- Bryce, D. 1892. On the macrotrachelous Callidinae. *Journal of the Quekett Microscopical Club* ser. 2:15-23.
- Bryce, D. 1893. On two new species of macrotrachelous Callidinae. *Journal of the Quekett Microscopical Club* ser. 2:196-201.
- Bryce, D. 1915. On five species of genus *Habrotracha*. *Journal of the Quekett Microscopical Club* ser. 2:631-642.
- Collins, F. 1873. New species of Rotatoria. *Science Gossip*, London 8:9-11.
- De Smet, W.H. 1996. Rotifera. Volume 4: The Proalidae (Monogononta). SPB Academic Publishing, pp. 1-102.
- De Smet, W.H. 1997. Rotifera Volume 5: The Dicanophoridae (Monogononta). SPB Academic Publishing, pp. 1-325.
- Devetter, M. 2007. Soil rotifers (Rotifera) of the Kokořínsko Protected Landscape Area. *Biologia*, Bratislava 62:222-224.
- Donner, J. 1949. Rotatorien der Humusböden. *Österreichische Zoologische Zeitschrift*, Wien II:117-151.
- Donner, J. 1965. Ordnung Bdelloidea (Rotatoria, Rädertiere). Akademie-Verl., Berlin, pp. 1-297.
- Donner, J. 1970. Rotatorien aus einigen Böden und Moosen Spaniens und seiner Inseln. *Revue d'Écologie et de Biologie du Sol* T. 7:501-532.
- Donner, J. 1971. Rotatorien aus einigen Auböden der Donau, aus ostmediterranen Böden und aus Kiew. *Archiv für Hydrobiologie, Beihefte* 36:352-376.
- Edmondson, W.T. 1959. Rotifera. In: Edmondson, W.T. (Ed.) *Fresh-water Biology*, 2nd ed. John Wiley & Sons, Inc., New York, USA, pp. 420-494.
- Ehrenberg, C.G. 1830. Organisation, Systematik und geographisches Verhältnis der Infusionsthierchen. Zwei Vorträge in der Akademie der Wissenschaften zu Berlin gehalten in den Jahren 1828 und 1830. *Druckerei der königlichen Akademie der Wissenschaften, Berlin*, pp. 108.
- Ehrenberg, C.G. 1832. Über die Entwicklung und Lebensdauer der Infusionsthierchen; nebst ferneren Beiträgen zu einer Vergleichung ihrer organischen Systeme. *Abhandlungen der königlichen Akademie der Wissenschaften zu Berlin (für 1831)*: 1-154.
- Ejaz, M., A.Q.K. Sulehria, A. Maqbool, A. Hussain and M.J. Yousaf. 2015. Seasonal diversity of Rotifers in a pond (Aroop Village). *Biologia (Pakistan)* 61:17-24.
- Fontaneto, D., E.A. Herniou, T.G. Barraclough and C. Ricci. 2007. On the global distribution of microscopic animals: New worldwide data on bdelloid rotifers. *Zoological Studies* 46:336-346.
- Fontaneto, D. and G. Melone. 2003. Redescription of *Pleuretra hystrix*, an endemic alpine bdelloid rotifer. *Hydrobiologia* 497:153-160.
- Haigh, S.B. 1963. The bdelloid rotifers of New Zealand. *Journal of the Quekett Microscopical Club* 29:161-170.
- Harring, H.K. and F.J. Myers. 1922. The rotifer fauna of Wisconsin. *Transactions of the Wisconsin Academy of Sciences, Arts and Letters* 20:553-662.
- Hayashi, N., K. Kuniyasu, Y. Inamori and R. Sudo. 1998. Effect of Environmental Factors on Growth Characteristics of Rotatoria. *Japanese Journal of Water Treatment Biology* 34:205-213 (in Japanese).
- Hudson, C.T. and P.H. Gosse. 1886. The Rotifera or wheel-animalcules, both British and foreign. Longmans, Green, and Co., London. Vol. 1: VI+128 pp., Vol. 2: 144 pp.
- Jersabek, C.D. and E. Bolortsetseg. 2010. Mongolian rotifers (Rotifera, Monogononta) - a checklist with annotations on global distribution and autecology. *Proceedings of the Academy of Natural Sciences of Philadelphia* 159:119-168.
- Jersabek, C.D. and M.F. Leitner. 2013. The Rotifer World Catalog. World Wide Web electronic publication. *Journal Volume*: Pages [Available from <http://www.rotifera.hausdennatur.at/>. accessed 10 Jan. 2017].
- Kaya, M. 2013. Terrestrial bdelloid rotifers from Erzurum (eastern part of Turkey). *Turkish Journal of Zoology* 37:

- 413-418.
- Kaya, M., W.H. De Smet and D. Fontaneto. 2010. Survey of moss-dwelling bdelloid rotifers from middle Arctic Spitsbergen (Svalbard). *Polar Biology* 33:833-842.
- Kordbacheh, A. and H. Rahimian. 2012. Annotated Checklist of Rotifers of Tehran Province, Iran, with Notes on New Records. *Progress in Biological Sciences* 2:59-67.
- Koste, W. 1978. Die Rädertiere Mitteleuropas. Überordnung Monogononta. Begründet von M. Voigt. pp. I. Textbd. VIII+pp. 1-673; II. Tafelbd. II+pp. 1-476.
- Koste, W. 1996. On soil Rotatoria from a Lithotelma near Halali Lodge in Etosha National Park in N-Namibia, South Africa. *International Review of Hydrobiology* 81: 353-365.
- Koste, W. 2000. Study of the Rotatoria-fauna of the littoral of the Rio Branco, south of Boa Vista, Northern Brazil. *International Review of Hydrobiology* 85:433-469.
- Koste, W., W. Janetzky and E. Vareschi. 1993. Zur Kenntnis der limnischen Rotatorienfauna Jamaikas (Rotatoria: Aschelminthes). Teil I. *Osnabrücker Naturwissenschaftliche Mitteilungen* 19:103-149.
- Koste, W. and R.J. Shiel. 1990. Rotifera from Australian inland waters. VI. Proalidae, Lindiidae (Rotifera: Monogononta). *Transactions of the Royal Society of South Australia* 114:129-143.
- Lindegaard, C. 1979. The invertebrate fauna of Lake Mývatn, Iceland. *Oikos* 32:151-161.
- Meksuwan, P., P. Pholpunthin and H. Segers. 2013. The Collotheceidae (Rotifera, Collotheceacea) of Thailand, with the description of a new species and an illustrated key to the Southeast Asian fauna. *ZooKeys* 315:1-16.
- Melone, G. and C. Ricci. 1995. Rotatory apparatus in Bdelloids. *Hydrobiologia* 313/314:91-98.
- Milne, W. 1886. On the defectiveness of the eye-spot as a means of generic distinction in the Philodinidae, with a description of two other Rotifera. *Proceedings of the Philosophical Society of Glasgow* 17: 134-145.
- Montet, G. 1915. Contribution à l'étude des Rotateurs du bassin du Léman. *Revue Suisse de Zoologie* 23: 251-360.
- Murray, J. 1908. Scottish rotifers, collected by the Lake Survey (Supplement). *Transactions of the Royal Society of Edinburgh* 46:189-201.
- Murray, J. 1911a. Bdelloid Rotifera of South Africa. *Annals of the Transvaal Museum. Annale van die Transvaal Museum* 3:1-19.
- Murray, J. 1911b. Canadian Rotifera: Collected by the Shackleton Antarctic Expedition, 1909. *Journal of the Royal Microscopical Society* 31:285-297.
- Murray, J. 1911c. Clare Island Survey, Vol. 52: Rotifera Bdelloidea. *Proceedings of the Royal Irish Academy* 31B:1-20.
- Nogrady, T. and R. Pourriot. 1995. Rotifera Volume 3: The Notommatidae and the Scaridiidae. SPB Academic Publishing, pp. 1-229, 239-248.
- Schöll, K. and M. Devetter. 2013. Soil rotifers new to Hungary from the Gemenc floodplain (Duna-Dráva National Park, Hungary). *Turkish Journal of Zoology* 37:406-412.
- Segers, H., P. Meksuwan and L. Sanoamuang. 2010. New records of sessile rotifers (Phylum Rotifera: Flosculariacea, Collotheceacea) from Southeast Asia. *Belgian Journal of Zoology* 140:235-240.
- Segers, H. and L. Sanoamuang. 2007. Note on a highly diverse rotifer assemblage (Rotifera: Monogononta) in a Laotian rice paddy and adjacent pond. *International Review of Hydrobiology* 92:640-646.
- Song, M.O. 2014. Eight new records of monogonont and bdelloid rotifers from Korea. *Journal of Species Research* 3:53-62.
- Song, M.O. 2015. New Records of One Monogonont and 5 Bdelloid Rotifers from Korea. *Korean Journal of Environmental Biology* 33:140-147.
- Song, M.O. and D.-H. Jin. 2000. Rotifer fauna of natal streams of chum salmon (Oshipechon). *Journal of Fisheries Science and Technology* 3:71-77.
- Song, M.O. and C.-H. Lee. 2017. A new and five rare bdelloids from Korea. *Zootaxa* 4242:529-547.
- Song, M.O. and G.-S. Min. 2015. A new species and ten new records of bdelloid rotifers from Korea. *Zootaxa* 3964: 211-227.
- Stemberger, R.S. 1979. A Guide to Rotifers of the Laurentian Great Lakes. US Environmental Protection Agency, Cincinnati, Ohio, pp. 1-185.
- Sudzuki, M. 1964. New systematical approach to the Japanese planktonic rotatoria. *Hydrobiologia* 23:1-124.
- Trinh Dang, M., H. Segers and L. Sanoamuang. 2013. Rotifers from Thuy Tien lake and Nhu Y river in central Vietnam, with a description of *Ploesoma asiaticum* new species (Rotifera: Monogononta). *Journal of Limnology* 72:376-386.
- Weber, E.F. 1898. Faune Rotatorienne du bassin du Léman. *Revue Suisse de Zoologie* 5:263-785.
- Weber, E.F. and G. Montet. 1918. Rotateurs. *Museum d'Histoire Naturelle de Geneve, Geneve*, pp. XII+335.
- Wilts, E.F., P.M. Arbizu and W.H. Ahlrichs. 2010. Description of *Bryceella perpusilla* n. sp. (Monogononta: Proalidae), a new rotifer species from terrestrial mosses, with notes on the ground plan of *Bryceella* Remane, 1929. *International Review of Hydrobiology* 95:471-481.
- Wulfert, K. 1942. Neue Rotatorienarten aus deutschen Mineralquellen. *Zoologischer Anzeiger* 137:187-200.
- Zhuge, Y., X. Huang and W. Koste. 1998. Rotifera recorded from China, 1893-1997, with remarks on their composition and distribution. *International Review of Hydrobiology* 3:217-232.

Submitted: August 16, 2017

Revised: September 18, 2017

Accepted: September 18, 2017