

Five new records of monogonont rotifers 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 Duung and Gyeongpo wetlands in Korea were investigated. Five species belonging to five genera in four families of monogonont rotifers were identified: *Cephalodella ventripes* (Dixon-Nuttall), *Dicranophorus grandis* (Ehrenberg), *Lecane undulata* Hauer, *Taphrocampa selenura* Gosse, and *Testudinella emarginula* (Stenroos). All these species are new to the Korean fauna, even though they have very wide or cosmopolitan distributions. The present study is the first report on the genus *Taphrocampa* Gosse from Korea. The taxonomy and distribution of each new Korean record are briefly discussed here. The diagnostic characteristics, photomicrographs and the deposition of voucher specimen are provided for each new Korean record.

Keywords: Korea, monogonont rotifers, new records, wetlands

© 2018 National Institute of Biological Resources
DOI:10.12651/JSR.2018.7.4.333

INTRODUCTION

A taxonomic study of rotifers collected from Duung (30 April 2017) and Gyeongpo (15 October 2017) wetlands yielded five new Korean records of monogonont rotifers. These five new Korean records belong to five genera in four families, *Cephalodella* Bory de St. Vincent, 1826, *Dicranophorus* Nitzsch, 1827, *Lecane* Nitzsch, 1827, *Taphrocampa* Gosse, 1851, and *Testudinella* Bory de St. Vincent, 1826. The genus *Taphrocampa* is new to the Korean fauna.

Although the five Korean new records are probably cosmopolitan or cosmopolitan (Jersabek and Leitner, 2013), they are still new to Korea. This implies that further taxonomic studies on monogonont rotifers are required in Korea. Since Song and Kim (1989) began taxonomic studies of Korean monogononts, 36 species/subspecies have been reported to date (Song, 2015; 2017). The result of the present study brought the record of Korean monogononts to 41 species/subspecies, which were studied taxonomically. Since 115 species/subspecies of monogononts were reported as parts of ecological surveys before Song and Kim (1989) (Song, 1989), a total of 156 species/subspecies of monogononts has been recorded from Korea so far. Considering that more than 2,000 species of monogononts have been described globally to date, the Korean record covers only about 8% of world records of monogononts, clearly showing the urgent need for more taxonomic studies of rotifers in Korea.

Here the taxonomy and distribution of each new Korean

record are briefly discussed. The diagnostic characteristics and photomicrographs are provided for each rotifer.

MATERIALS AND METHODS

Samples were collected from Duung and Gyeongpo wetlands on April 30 and October 15, 2017, respectively. The rotifers were isolated from samples according to previously described methods (Song, 2014; Song and Lee, 2017). All of the living or fixed rotifers were examined and identified under a light microscope with a magnification of $\times 400$ to $\times 600$. The photography and motion records of specimens were performed using an Infinity 2 digital camera (Lumenera Corporation, ON, Canada). Measurements were made by using GIMP 2.8 (the GNU Image Manipulation Program). The specimens, except *Lecane* and *Testudinella* species, were fixed 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 De Smet (1997) and Nogrady and Pourriot (1995).

RESULTS AND DISCUSSION

Phylum Rotifera Cuvier, 1817 율형동물문

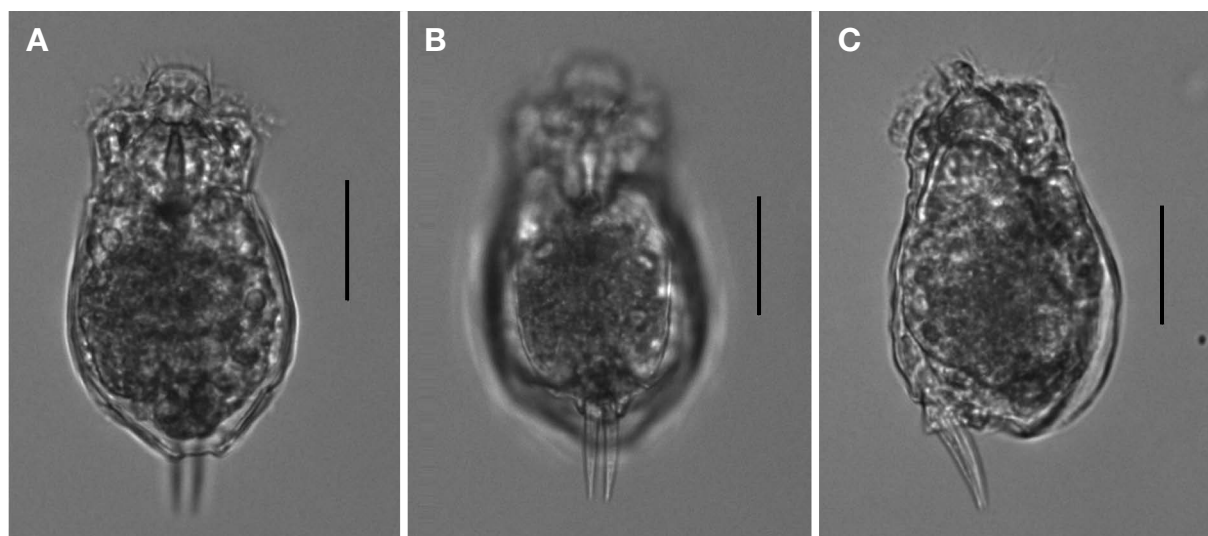


Fig. 1. *Cephalodella ventripes* (Dixon-Nuttall, 1901). A. dorsal view; B. ventral view; C. lateral view (Scales: A-C = 25 μ m).

Class Eurotatoria De Ridder, 1957 진운충강
Subclass Monogononta Plate, 1889 단소아강
Superorder Pseudotrocha Kutikova, 1970
위섬모관상목
Order Ploima Hudson and Gosse, 1886 유영목
Family Notommatidae Remane, 1933 몽치윤충과
Genus *Cephalodella* Bory de St. Vincent, 1826
거두윤충속

1. *Cephalodella ventripes* (Dixon-Nuttall, 1901) (Fig. 1)
복족거두윤충 (신칭)

Diaschiza ventripes Dixon-Nuttall, 1901, pp. 25-26, pl. 2, figs. 1-3.

Cephalodella ventripes: Haring and Myers, 1924, p. 484, pl. 28, fig. 5; Nogrady and Pourriot, 1995, pp. 139-140, fig. 188.

Material examined. Three specimens found in Gyeongpo wetland area, Gangneung-si, Gangwon-do, 37°47'19.9"N, 128°53'49.8"E, 15 Oct. 2017.

Diagnosis. Body short, chunky, convex dorsally and oval in dorsal view. Plates and sulci of lorica distinct. End of dorsal lorica protruding beyond distal end of foot pseudosegment. Foot small and ventral. Toes short, about 1/5 of total body length and slightly curved forward. Trophi type A. Fulcrum spatulated distally. Double cervical eyes.

Measurements. Total body length 95.5-104 μ m. Toe length 22-23 μ m. Trophi length 27 μ m.

Remarks. This species is usually found in the littoral periphyton of most standing fresh waters. It is occasionally found in athalassic saline and coastal brackish waters (Jersabek and Leitner, 2013). The Korean specimens were found at Gyeongpo wetland area, which is brackish.

This species is cosmopolitan and has been reported in

Asia from Cambodia (Min *et al.*, 2011), India (Sharma and Sharma, 2005), Iran (Kordbacheh and Rahimian, 2012), and Thailand (Sanoamuang *et al.*, 1995).

World distribution. Cosmopolitan.

Deposition. Deposited in the collection of the Nakdong-gang National Institute of Biological Resources, Sangjusi, Gyeongsangbuk-do, Korea (NNIBR2018113IV954, NNIBR2018113IV955, NNIBR2018113IV957).

Genus *Taphrocampa* Gosse, 1851 주름관윤충 (신칭)

2. *Taphrocampa selenura* Gosse, 1887 (Fig. 2)
반원발톱주름관윤충 (신칭)

Taphrocampa selenura Gosse, 1887, p. 1, pl. 1, fig. 1; Weber, 1898, pp. 436-437, pl. 17, figs. 14-15; Haring and Myers, 1924, pp. 454-456, pl. 24, figs. 5-9; Nogrady and Pourriot, 1995, pp. 150-152, fig. 203.

Material examined. One specimen found in Gyeongpo wetland area, Gangneung-si, Gangwon-do, 37°47'19.9"N, 128°53'49.8"E, 15 Oct. 2017.

Diagnosis. Body vermiform, plicated like accordion and tapering slightly to foot. Corona oblique with auricles. Foot covered by broad and long tail; tail much longer than foot; tail separated from trunk by indentation. Toes long, slender and bow-shaped in dorsal view. Trophi asymmetrical; right ramus with eight teeth, while left ramus with one tooth, lamella, and then two teeth; left uncus with two teeth, while right uncus with three teeth.

Measurements. Total body length 138 μ m. Toe length 13.2 μ m.

Remarks. In the genus *Taphrocampa* Gosse, 1851, only three valid species are recognized, *T. clavigera* Stokes, 1896, *T. annulosa* Gosse, 1851, and *T. selenura* Gosse,

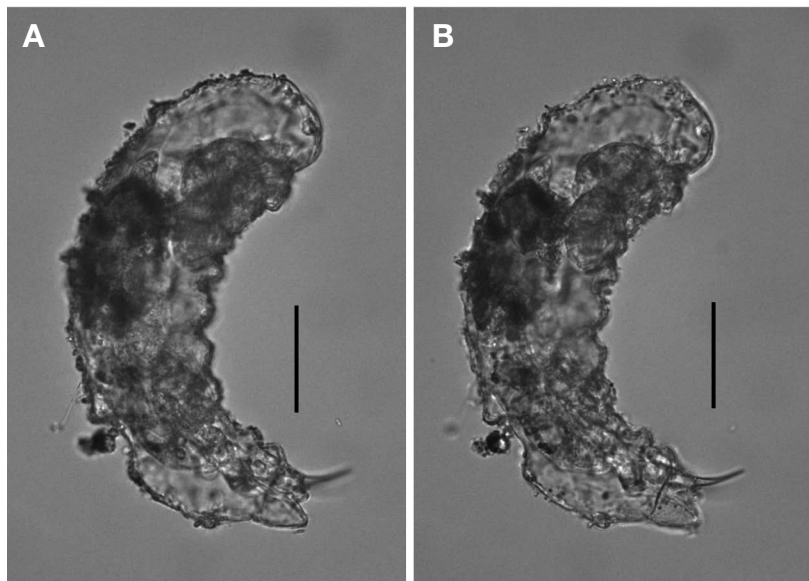


Fig. 2. *Taphrocampa selenura* Gosse, 1887. A, B. lateral view (Scales: A, B = 25 μ m).

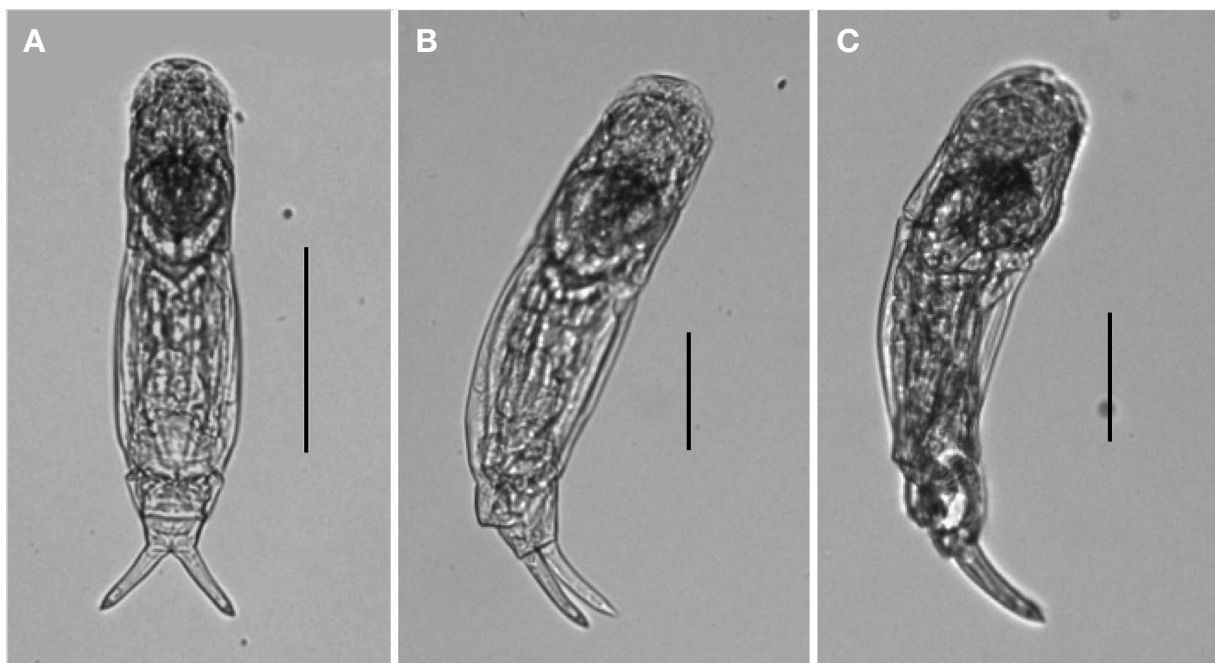


Fig. 3. *Dicranophorus grandis* (Ehrenberg, 1832). A. dorsal view; B. dorsolateral view; C. lateral view (Scales: A = 100 μ m; B, C = 50 μ m).

1887. *Taphrocampa* species are easily recognized by their oblique corona with auricles and vermiform bodies which are stretchable and plicated like an accordion. The present study is the first report on the species as well as the genus *Taphrocampa* from Korea. In Asia, this species has previously been reported from Cambodia (Meas and Sor, 2014), India (Segers *et al.*, 1994), Japan (Sudzuki, 1975) and Laos (Segers and Sanoamuang, 2007).

World distribution. Probably cosmopolitan.

Deposition. Deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (FKR UIV0000000916).

Family Dicranophoridae Harring, 1913 돼지코윤충과
Genus *Dicranophorus* Nitzsch, 1827 돼지코윤충속

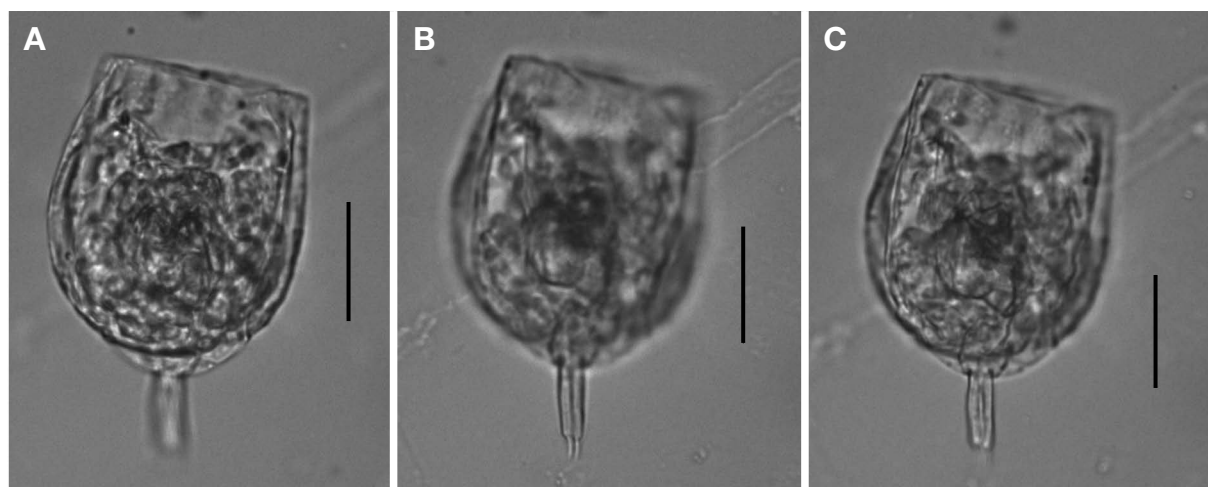


Fig. 4. *Lecane undulata* Hauer, 1938. A. dorsal view; B, C. ventral view (Scales: A-C = 25 μ m).

3. *Dicranophorus grandis* (Ehrenberg, 1832) (Fig. 3)

큰돼지코윤충 (신칭)

Diglena grandis Ehrenberg, 1832, p. 137.

Dicranophorus grandis: Harring, 1913, p. 36; Koste, 1978, p. 468, pl. 170, figs. 1a-c; De Smet, 1997, pp. 67-68, figs. 139-144; Koste and Zhuge, 1998, pp. 200-202, figs. 14a-c.

Material examined. One specimen found in Duung wetland, Sindu-ri, Wonbuk-myeon, Taean-gun, Chungcheongnam-do, 36°50'10.1"N 126°11'45.5"E, 30 April 2017.

Diagnosis. Two small black eye spots. Head about 1/3 of total length. Rostrum short, round anteriorly and decurved. Trunk with lateral sulci. Foot short, truncated cone-shaped and composed of one pseudosegment. Toes stout, 1/4-1/5 of total length, slightly tapering then abruptly tapering to tips at about 1/5 or 1/6 of toe length distally. Base of rami with triangular alula. Inner margin of rami with 7-9 shearing teeth.

Measurements. Total body length 269 μ m. Toe length 46.5 μ m. Trophi length 55.3 μ m.

Remarks. Among the species of genus *Dicranophorus* Nitzsch, 1827, only two species, *Dicranophorus epicharis* Harring and Myers, 1928 and *Dicranophorus forcipatus* (Müller, 1786) have been reported from Korea before the present study (Song and Jin, 2000; Song and Kim, 1989).

Even though *D. grandis* is probably cosmopolitan because it has been reported from Europe, Africa, Eastern Mediterranean, America, and Australia (De Smet, 1997; Jersabek and Leitner, 2013), it is new to Korea. In Asia, *D. grandis* has been recorded from China (Zhuge *et al.*, 1998), Thailand (Sa-Ardrit *et al.*, 2013), and Vietnam (Trinh Dang *et al.*, 2015).

World distribution. Africa, America, Australia, Eastern

Mediterranean, Europe.

Deposition. Deposited in the collection of the Nakdong-gang National Institute of Biological Resources, Sangjusi, Gyeongsangbuk-do, Korea (NNIBRIV7).

Family Lecanidae Lemane, 1933 술잔윤충과

Genus *Lecane* Nitzsch, 1827 술잔윤충속

4. *Lecane undulata* Hauer, 1938 (Fig. 4)

물결술잔윤충 (신칭)

Lecane undulata Hauer, 1938, p. 526, figs. 49a-c; Segers, 1995, pp. 129-130, figs. 322-326.

Lecane inopinata undulata: Koste and Tobias, 1990, p. 99, fig. 13b.

Material examined. One specimen found in Gyeongpo wetland area, Gangneung-si, Gangwon-do, 37°47'19.9"N, 128°53'49.8"E, 15 Oct. 2017.

Diagnosis. Dorsal plate anteriorly narrower and medially wider than ventral plate. Dorsal plate shorter than ventral plate. Ventral plate longer than wide. Anterior margins rather straight. Without any processes anterolaterally. Lateral sulci deep. Foot pseudosegment not projecting. Prepedal fold oval. Coxal plates rounded. Toes fused basally and bearing completely separated short claws.

Measurements. Dorsal plate length 62 μ m. Dorsal plate width 55 μ m. Ventral plate length 64 μ m. Ventral plate width 46 μ m. Toe length 17 μ m. Claw length 5 μ m.

Remarks. *Lecane undulata* is very similar to *L. inopinata* Harring and Myers, 1926; however, the toes are fused over about 40-70 % of their length in *L. inopinata*, while they are fused only basally in *L. undulata*.

Lecane undulata is probably cosmopolitan because it has been reported from seven out of the eight large biogeographical regions (Palearctic, Afrotropical, Oriental,

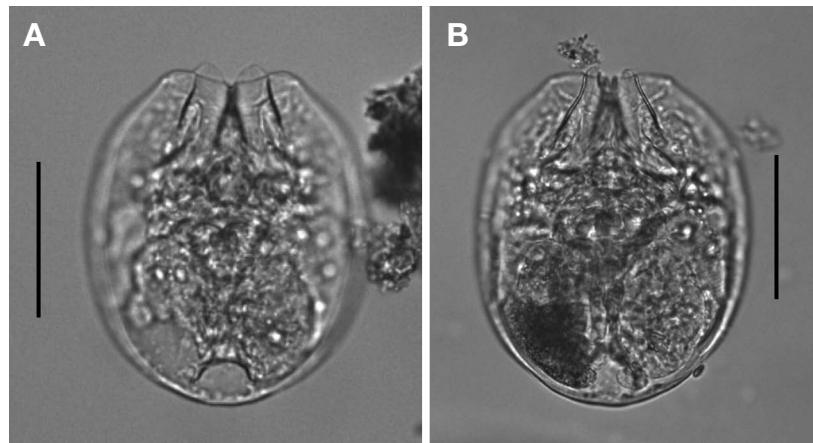


Fig. 5. *Testudinella emarginula* (Stenroos, 1898). A. ventral view; B. dorsal view (Scales: A = 25 μ m; B = 50 μ m).

Nearctic, Neotropical, Australian, and Pacific) (Segers, 2007; Jersabek and Leitner, 2013). This species is still new to the Korean fauna, and has been reported from China (Huang *et al.*, 2017), India (Sharma, 2014), Laos (Segers and Sanoamuang, 2007), Thailand (Sanoamuang *et al.*, 1995; Chittapun, 2011), and Vietnam (Trinh Dang *et al.*, 2015) in Asia.

World distribution. Probably cosmopolitan.

Deposition. Deposited in the collection of the National Institute of Biological Resources, Incheon, Korea (FKR UIV0000000703).

Superorder Gnesiotrocha Kutikova, 1970

참섬모관상목

Order Flosculariacea Remane, 1933 소화윤충목

Family Testudinellidae Bartoš, 1959 접시윤충과

Genus *Testudinella* Bory de St. Vincent, 1826

접시윤충속

5. *Testudinella emarginula* (Stenroos, 1898) (Fig. 5)

빛살주름접시윤충 (신칭)

Pterodina emarginula Stenroos, 1898, pp. 168-169, pl. 2, figs. 31-32; Von Hofsten, 1923, pp. 868-869, fig. 11.

Testudinella incisa emarginula: Koste, Janetzky and Vareschi, 1993, p. 137, figs. 27a-b.

Testudinella emarginula: Carlin, 1939, pp. 32-34, fig. 9a.

Material examined. Five specimens in Gyeongpo wetland area, Gangneung-si, Gangwon-do, 37°47'19.9"N, 128°53'49.8"E, 15 Oct. 2017.

Diagnosis. Lorica dorsoventrally flattened and slightly elliptical. Anterodorsal margin slightly bilobed and with inverted V-shaped fold medially; two parallel oblique folds outside median fold. Anteroventral margin bilobed medially and median lobes protruding beyond anterodorsal margin. Foot opening at posterior part of ventral plate.

Cross section boomerang-shaped; convex dorsally and concave ventrally.

Measurement. Lorica length 55.7-119.7 μ m. Lorica width 46.4-95.5 μ m. Foot opening width 8.6-18.9 μ m.

Remarks. *Testudinella emarginula* is periphytic and epibenthic in stagnant and running freshwater, and in paddy fields, athalassic saline and coastal brackish waters. The Korean specimens were found at Gyeongpo wetland area, which is brackish.

Even though this species is cosmopolitan, it is new to the Korean fauna. In Asia, it has been reported from India (Sharma, 2014), Laos (Segers and Sanoamuang, 2007), Pakistan (Ejaz *et al.*, 2017), and Thailand (Segers *et al.*, 2004; Chittapun *et al.*, 2007).

Distribution. Cosmopolitan.

Deposition. Deposited in the collection of the Nakdong-gang National Institute of Biological Resources, Sangju-si, Gyeongsangbuk-do, Korea (NNIBR2018113IV956, NNIBR2018113IV959, NNIBR2018113IV960).

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 (NIBR201701201) as well as a grant from Nakdong-gang National Institute of Biological Resources (NNIBR), funded by the Ministry of Environment (MOE) of the Republic of Korea as a part of "A Survey of Invertebrate Species in Korea".

REFERENCES

Carlin, B. 1939. Über die Rotatorien einiger Seen bei Anebo-da. Meddelanden Från Lunds Universitets Limnologiska

- Institution 2:1-68.
- Chittapun, S. 2011. Fire and recovery of resting egg bank: an experimental study in paddy fields in Pathum Thani province, Thailand. *Hydrobiologia* 662:163-170.
- Chittapun, S., P. Pholpunthin and H. Segers. 2007. Diversity of rotifer fauna from five coastal peat swamps on Phuket Island, Southern Thailand. *Science Asia* 33:383-387.
- De Smet, W.H. 1997. Rotifera Volume 5: The Dicranophoridae (Monogononta). SPB Academic Publishing bv, Amsterdam. pp. 1-325.
- Dixon-Nuttall, F.R. 1901. On *Diaschiza ventripes*-A new rotifer. *The Journal of the Quekett Microscopical Club* 8:25-28.
- Edmondson, W.T. 1959. Rotifera. In: W.T. Edmondson (ed.), *Fresh-water Biology* (2nd ed.), John Wiley & Sons, Inc., New York. pp. 420-494.
- Ehrenberg, C.G. 1832. Über die Entwicklung und Lebensdauer der Infusionsthier; nebst ferneren Beiträgen zu einer Vergleichung ihrer organischen Systeme. *Abhandlungen der königlichen Akademie der Wissenschaften zu Berlin (für 1831)*:1-154.
- Ejaz, M., M.J. Yousaf, A. Maqbool, A. Hussain and A.Q.K. Sulehria. 2017. Species diversity and community assemblage of planktonic rotifers in Pipnakh Pond, Gujranwala, Pakistan. *BIOLOGIA (PAKISTAN)* 63:151-160.
- Gosse, P.H. 1887. Twenty-four new species of Rotifera. *Journal of the Royal Microscopical Society* 7:1-7.
- Harring, H.K. 1913. Synopsis of the Rotatoria. *Bulletin of the United States National Museum* 81:7-226.
- Harring, H.K. and F.J. Myers. 1924. The rotifer fauna of Wisconsin. II. A revision of the notommatid rotifers, exclusive of the Dicranophorinae. *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters* 21:416-549.
- Hauer, J. 1938. Die Rotatorien von Sumatra, Java und Bali nach den Ergebnissen der Deutschen Limnologischen Sunda-Expedition. *Archiv für Hydrobiologie, Supplement* 15:507-602.
- Huang, F., Q. Wu, B. Han and Q. Lin. 2017. Species diversity and distribution of Lecanidae on Hainan Island, China. *Biodiversity Science* 25:430-436.
- Jersabek, C.D. and M.F. Leitner. 2013. The Rotifer World Catalog. World Wide Web electronic publication [Available from <http://www.rotifera.hausdernatur.at/>, accessed 21 September 2018]
- 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. and W. Tobias. 1990. Zur Kenntnis der Rädertierfauna des Kinda-Stausees in Zentral-Burma (Aschelminthes: Rotatoria). *Osnabrücker Naturwissenschaftliche Mitteilungen* 16:83-110.
- Koste, W. and Y. Zhuge. 1998. Zur Kenntnis der Rotatorienfauna (Rotifera) der Insel Hainan, China. Teil II. *Osnabrücker Naturwissenschaftliche Mitteilungen* 24:183-222.
- Koste, W., W. Janetzky and E. Vareschi. 1993. Zur Kenntnis der limnischen Rotatorienfauna Jamaikas (Rotatoria: Aschelminthes). Teil I. *Osnabrücker Naturwissenschaftliche Mitteilungen* 19:103-149.
- Meas, S. and R. Sor. 2014. New Records of Rotifer Fauna in the Upper Cambodian Mekong River Basin. *International Journal of Environmental and Rural Development* 5:7-13.
- Min, M., K.Y.W. Ken and S. Meas. 2011. Rotifer fauna in pond samples from the upper Cambodian Mekong River Basin. *Cambodian Journal of Natural History* 1:14-22.
- Nogrady, T. and R. Pourriot. 1995. Rotifera Volume 3: The Notommatidae and the Scaridiidae. SPB Academic Publishing bv, Amsterdam. pp. 1-229, 239-248.
- Sa-Ardrit, P., P. Pholpunthin and H. Segers. 2013. A checklist of the freshwater rotifer fauna of Thailand (Rotifera, Monogononta, Bdelloidea). *Journal of Limnology* 72:361-375.
- Sanoamuang, L., H. Segers and H.J. Dumont. 1995. Additions to the rotifer fauna of south-east Asia: new and rare species from north-east Thailand. *Hydrobiologia* 313/314: 35-45.
- Segers, H. 1995. Rotifera, Volume 2: The Lecanidae (Monogononta). SPB Academic Publishing bv, The Hague. pp. 1-226.
- Segers, H. 2007. Annotated checklist of the rotifers (Phylum Rotifera), with notes on nomenclature, taxonomy and distribution. *Zootaxa* 1564:1-104.
- 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.
- Segers, H., S.S.S. Sarma, F.K. Kakkassery and C.K.G. Nayar. 1994. New records of Rotifera from India. *Hydrobiologia* 287:251-258.
- Segers, H., W. Kotethip and L. Sanoamuang. 2004. Biodiversity of freshwater microfauna in the floodplain of the River Mun, Northeast Thailand: the Rotifera monogononta. *Hydrobiologia* 515:1-9.
- Sharma, B.K. 2014. Rotifers (Rotifera: Eurotatoria) from wetlands of Majuli- the largest river island, the Brahmaputra river basin of upper Assam, northeast India. *Check List* 10:292-298.
- Sharma, B.K. and S. Sharma. 2005. Biodiversity of freshwater rotifers (Rotifera, Eurotatoria) from North-Eastern India. *Mitteilungen aus dem Zoologischen Museum in Berlin* 1: 81-88.
- Song, M.O. 1989. List of Korean species of freshwater Rotifera. *The Korean Journal of Systematic Zoology* 5:257-268.
- 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. 2017. New records of 13 rotifers including *Bryceella perpusilla* Wilts *et al.*, 2010 and *Philodina lepta* Wulfert, 1951 from Korea. *Journal of Species Research* 6:26-37.
- Song, M.O. and C.-H. Lee. 2017. A new and five rare bdelloids from Korea. *Zootaxa* 4242:529-547.
- Song, M.O. and D.-H. Jin. 2000. Rotifer fauna of natal streams of chum salmon (Oshipcheon). *Journal of Fisheries Science and Technology* 3:71-77.
- Song, M.O. and G.-S. Min. 2015. A new species and ten new records of bdelloid rotifers from Korea. *Zootaxa* 3964: 211-227.
- Song, M.O. and H.S. Kim. 1989. Monogonont rotifers (Monogononta: Rotifera) inhabiting several lowland swamps in Kyongsangnam-do, Korea. *The Korean Journal of Systematic Zoology* 5:139-157.
- Stemberger, R.S. 1979. *A Guide to Rotifers of the Laurentian Great Lakes*. US Environmental Protection Agency, Cincinnati, Ohio. pp. 1-185.
- Stenroos, K.E. 1898. Das Thierleben im Nurmijärvi-See. *Acta Societatis pro Fauna et Flora Fennica* 17:1-259.
- Sudzuki, M. 1975. List of Rotifera and Gastrotricha from garden ponds of Tokyo 1974-'75 and some notes on *Rhinalglena*, *Fadeewella*, *Neogosseia*, etc. *Proceedings of the Japanese Society of Systematic Zoology* 11:5-12.
- Trinh Dang, M., H. Segers and L. Sanoamuang. 2015. Psammion rotifers in Central Vietnam, with the descriptions of three new species (Rotifera: Monogononta). *Zootaxa* 4018: 249-265.
- Von Hofsten, N. 1923. Rotatorien der nordschwedischen Hochgebirge. *Naturwissenschaftliche Untersuchung des Sarekgebirges* 4:829-896.
- Weber, E.F. 1898. Faune Rotatorienne du bassin du Léman. *Revue Suisse de Zoologie* 5:263-785.
- 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: September 21, 2018

Revised: October 15, 2018

Accepted: October 16, 2018