

New records of three lecanid rotifers (Rotifera: Monogononta: Lecanidae) from Korea

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In this study, three lecanid rotifer species were newly recorded in Korea: *Lecane inermis* (Bryce, 1892), *L. furcata* (Murray, 1913), and *L. nana* (Murray, 1913). Most of the lecanid rotifers recorded in Korea have been collected from stagnant water, and *Lecane furcata* and *L. nana* were collected from a reservoir. In contrast, *L. inermis* was found in a soil sample. *Lecane inermis* is the first illoricated lecanid species reported in Korea. This species is distinguished from other illoricated species by its toes with relatively long claws. *Lecane furcata* is the most common lecanid rotifer in submerged vegetation. The morphological characteristics of its lorica are similar to many other lecanid rotifers, but it can be distinguished by its completely fused toes with a terminal fissure, an absence of antero-lateral spines, and the ratio of lorica/toe length. *Lecane nana* is most similar to *L. tryphema* Haring & Myers, 1926, but can be distinguished by the toe tips curved outwards. The three species in this study are considered to have a cosmopolitan distribution and have been recorded in many Asian countries. In this paper, we describe the morphological characteristics of the three lecanid species with trophi structures observed by scanning electron microscope.

Keywords: cosmopolitan, *Lecane*, monogonont rotifers, new record, South Korea

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INTRODUCTION

The genus *Lecane* Nitzsch, 1827 is one of the largest genera within the phylum Rotifera Cuvier, 1817, comprising approximately 200 species (Segers, 2007; Jersabek and Leitner, 2013). Lecanid rotifers inhabit the substratum of diverse environments, ranging from freshwater to saline water (Segers, 1996; Jersabek, 2010). In addition to these various aquatic environments, lecanids are also found in the water film of mosses and lichens, and even dry sediments in the dormant state (Wallace *et al.*, 2006).

Lecanid rotifers generally have a hard lorica and can produce resting eggs for cyclical parthenogenesis. Due to these two characteristics, lecanid rotifers can tolerate harsh environments, such as water films or dry sediments. These characteristics also facilitate the effective dispersal of the lecanid rotifers via wind or animal vectors, such as birds and humans (Segers, 1996; 2008).

In Korea, lecanid rotifers were first reported by Hada (1936), who recorded the two species *Lecane luna* (Müller, 1776) and *L. lunaris* (Ehrenberg, 1832). Since then, 33 lecanid species have been recorded in Korea (Chung *et al.*, 1991; Cho, 1993; Kim, 2017; National Institute of Biological Resources and Ministry of Environment, 2020),

collected primarily from stagnant waters, such as lakes, reservoirs, and ponds. However, given that species of lecanid are also found water films and dry sediments, it is anticipated that more lecanid species will be collected from various environments in Korea.

In this study, we identified three lecanid species previously unrecorded in Korea: *Lecane inermis* (Bryce, 1892), *L. furcata* (Murray, 1913), and *L. nana* (Murray, 1913). These three species are considered cosmopolitan species (Segers, 1996) and have previously been recorded in a number of other Asian countries: Cambodia (Meas and Sor, 2014), China (Wang, 1961), India (Sharma and Sharma, 2019), Laos (Meas and Sor, 2014), Japan (Sudzuki, 1964), Mongolia (Jersabek, 2010), Thailand (Sanoamuang *et al.*, 1995), and Vietnam (Zhdanova, 2011). In this paper, we provide the redescrptions of these three newly recorded lecanid species and present the findings of scanning electron microscopy examinations of the trophi structures.

MATERIALS AND METHODS

Of the three lecanid species, *Lecane furcata* and *L.*

nana were collected from the Araetkol Reservoir in Yeongwol-gun using a 50 µm plankton net, whereas *L. inermis* was collected from a soil sample. The net-tow samples were fixed in situ with formalin at a final concentration of 4%. To collect rotifers from the terrestrial environment, soil samples were transferred to the laboratory and air-dried for two weeks. After being completely dried, the soil samples were rewetted with mineral water and stored in an 18°C incubator for several days. Rotifers in the soil samples were isolated using a Pasteur pipette and transferred to new Petri dishes. For morphological study, the rotifers were fixed in formalin (final conc. of 4%). Given that *L. inermis* has a soft lorica, we also examined live specimens of this species.

All specimens were observed under an SZX12 stereo microscope (Olympus, Japan) and a DM2500 optical microscope (Leica, Germany). The trophi of rotifers were examined by scanning electron microscopy (SEM), following the preparation of samples using the procedure described by De Smet (1998). SEM was performed using SU8010 and S-4200 scanning electron microscope (Hitachi, Japan), operating at an accelerating voltage of 10–15 kV. Morphological classification followed that of Koste and Voigt (1978), Koste and Shiel (1990), Segers (1995), and Jersabek and Leitner (2013). All examined specimens were deposited at the Nakdonggang National Institute of Biological Resources (NNIBR).

RESULTS AND DISCUSSION

Phylum Rotifera Cuvier, 1817 유행동물문
Class Eurotatoria De Ridder, 1957 진운충강
Subclass Monogononta Plate, 1889 단소아강
Order Ploima Hudson & Gosse, 1886 유명목
Family Lecanidae Remane, 1933 술잔운충과
Genus *Lecane* Nitzsch, 1827 술잔운충속

1. *Lecane inermis* (Bryce, 1892) (Fig. 1)

Distyla inermis Bryce, 1892, p. 274; Montet, 1915, p. 336.

Cathypna inermis Murray, 1913a, p. 556–557; Weber & Montet, 1918, p. 187.

Lecane inermis: Harring, 1913, p. 61; Kutikova, 1970, p. 451; Koste & Voigt, 1978, p. 219; Koste & Shiel, 1990, p. 25; Segers, 1995, p. 36.

Lecane amorpha Harring, 1914, p. 544.

Lecane supinoi Manfredi, 1929, p. 3–5.

Material examined. Soil sample from Jangbang-ri, Hanlim-myeon, Gimhae-si, Gyeongsangnam-do, Korea, 35°19'01.4"N, 128°48'10.6"E. Collected by Kyu-Seok Chae on 13 May 2020 (NNIBRIV50291).

Description. Body soft and illoricated. Dorsal and ventral

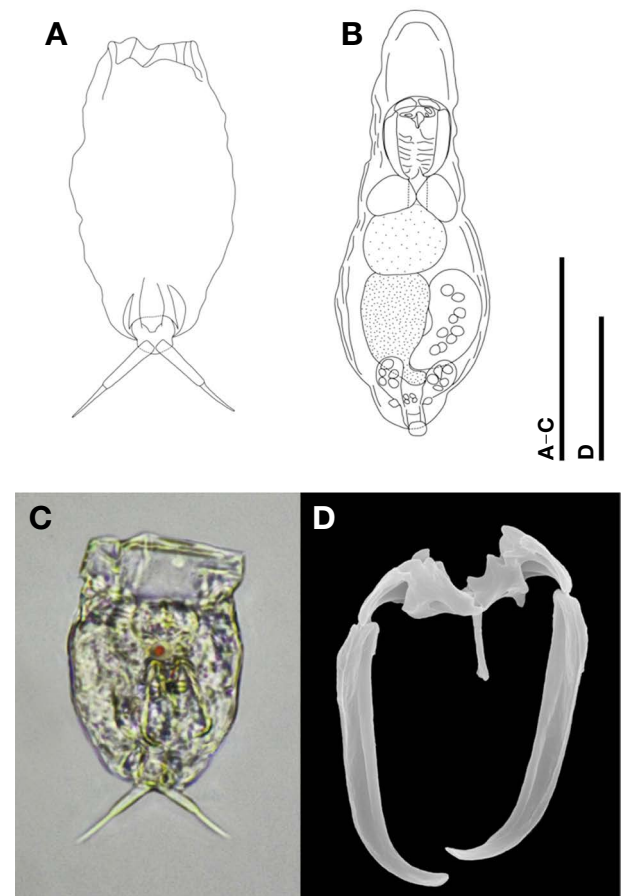


Fig. 1. *Lecane inermis*. A, B. Line drawing of preserved specimen. C. photograph of preserved specimen. D. trophi. Scale bars: A–C = 50 µm, D = 10 µm.

plate hard to distinguish. Anterior margin of lorica irregular. Lorica length 65.0–67.5 µm and lorica width 37.5–40.0 µm. Prepedal folds narrow and elongated. Foot plate round, with rectangular foot pseudosegment. Foot pseudosegment slightly protruded outward. Toes with long, flexible claws. Toe 7.5 µm in length, claws 5.0 µm (Fig. 1A, C). One red eye located at front end of mastax. Stomach large, connect to mastax by thick, distinctive esophagus. One pair of large gastric gland located between mastax and stomach. Vitellarium with nine spherical nuclei (Fig. 1B). Trophi malleate type. Fulcrum short and thin in ventral view. Right rami with alula. Each uncus with two teeth. Manubria long, terminal end curved interiorly (Fig. 1D).

Distribution. Cosmopolitan.

Remarks. *Lecane inermis* had previously been recorded in a number of Asian countries: Cambodia (Meas and Sor, 2014), China (Wang, 1961), India (Sharma and Sharma, 2019), Laos (Meas and Sor, 2014), and Thailand (Sanoamuang *et al.*, 1995). The external morphology of the Korean *L. inermis* is similar to that described by Segers

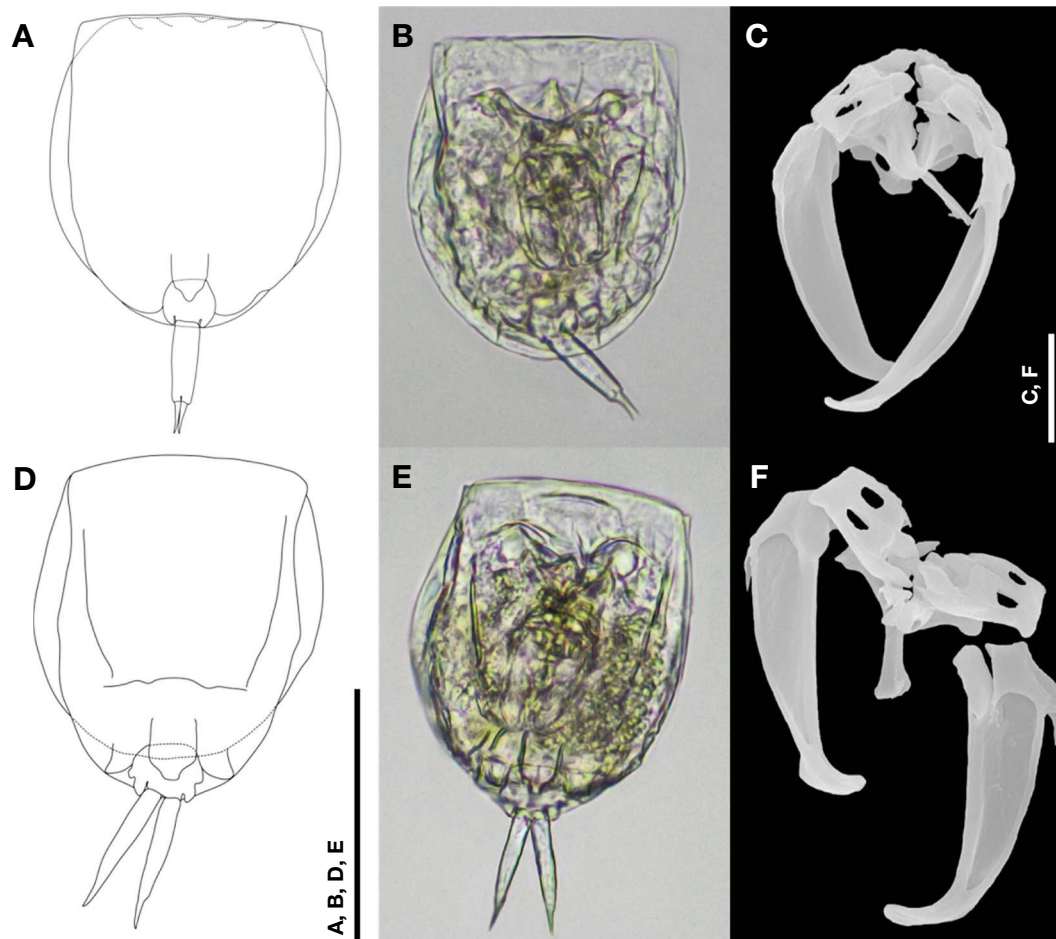


Fig. 2. A–C. *Lecane furcata*. A. Line drawing of preserved specimen. B. photograph of preserved specimen. C. trophi. D–F. *Lecane nana*. D. Line drawing of preserved specimen. E. photograph of preserved specimen. F. trophi. Scale bars: A, B, D, E = 50 μm , C, F = 10 μm .

(1995), whereas SEM image of the trophi correspond to that of the Italian specimen observed by Fontaneto and Melone (2003). This species is one of the 14 illoricated species within the genus *Lecane*, namely, *L. agilis* (Bryce, 1892); *L. bifurcata* (Bryce, 1892); *L. boorali* Koste & Shiel, 1983; *L. broaensis* Segers & Dumont, 1995; *L. calcaria* Harring & Myers, 1926; *L. clara* (Bryce, 1892); *L. elegans* Harring, 1914; *L. inermis* (Bryce, 1892); *L. margalefi* De Manuel, 1994; *L. niothis* Harring & Myers, 1926; *L. palinacis* Harring & Myers, 1926; *L. pumila* (Rousselet, 1906); *L. rhacois* Harring & Myers, 1926; and *L. solfatar* (Hauer, 1938) (Jersabek and Leitner, 2013; Segers, 1995). Of these illoricated species, *L. inermis* is most similar to *L. elegans* Harring, 1914 and *L. margalefi* De Manuel, 1994. This species, however, can be distinguished from these two congeners, by its toes with relatively long claws (Segers, 1995).

2. *Lecane furcata* (Murray, 1913) (Fig. 2A–C)

Monostyla furcata Murray, 1913b, p. 358–359; Koste &

Shiel, 1990, p. 8.

Monostyla ovalis Jakubski, 1914, p. 34.

Monostyla tethis Harring & Myers, 1926, p. 405.

Monostyla elachis Harring & Myers, 1926, p. 406.

Monostyla mologensis Bogoslovsky, 1935, p. 110.

Lecane furcata: Edmondson, 1936, p. 215; Kutikova, 1970, p. 480; Koste & Voigt, 1978, p. 242; Segers, 1995, p. 157.

Lecane vanoyei De Ridder, 1960, p. 173.

Material examined. Reservoir in Yeongdeok-ri, Bukmyeon, Yeongwol-gun, Gangwon-do, Korea, 37°17'05.6"N, 128°26'09.9"E. Collected by Hee-Min Yang on 20 Jun 2019 (NNIBRIV50292).

Description. Hard lorica. Anterior margin of lorica straight. Antero-lateral corner angulate. Dorsal plate narrower than ventral plate anteriorly, wider in middle. Length of dorsal and ventral plate similar. Lorica 62.5–65.0 μm in length. Width of dorsal lorica 57.5–60.0 μm , ventral lorica 50.0–52.5 μm . Prepedal folds long and

narrow. Foot plate wide and foot pseudosegment squircle. Foot pseudosegment not protruded from foot plate. Toe single with terminal fissure. Toe length 20.0 μm (Fig. 2A, B). Trophi malleate. Upper part of manubria thick, tapering narrow toward the end. The end of manubria curved inwards. Fulcrum short and thin in ventral view (Fig. 2C).

Distribution. Cosmopolitan.

Remarks. *Lecane furcata* is a cosmopolitan species and the most common lecanid rotifer found in submerged vegetation (Segers, 1995). External characteristics of the lorica of *L. furcata* are similar to those of the following lecanid rotifers: *L. acanthinula* (Hauer, 1938); *L. brazilensis* Segers, 1993; *L. dumonti* Segers, 1993; *L. inconspicua* Segers & Dumont, 1993; *L. inopinata* Harring & Myers, 1926; *L. rugosa* (Harring, 1914); and *L. undulata* Hauer, 1938 (Segers, 1995). *Lecane furcata* can, however, be distinguished from these species in that it has completely fused toe with a terminal fissure, an absence of antero-lateral spines, and by the ratio of the lorica/toe length.

3. *Lecane nana* (Murray, 1913) (Fig. 2D–F)

Cathypna nana Murray, 1913b, p. 353.

Lecane nana: Harring, 1914, p. 536; Harring & Myers, 1926, p. 375; Kutikova, 1970, p. 460; Koste & Shiel, 1990, p. 27; Segers, 1995, p. 42, 44.

Material examined. Reservoir in Yeongdeok-ri, Bukmyeon, Yeongwol-gun, Gangwon-do, Korea, 37°17'05.6"N, 128°26'09.9"E. Collected by Hee-Min Yang on 20 Jun 2019 (NNIBRIV50293).

Description. Lorica stiff. Anterior margin straight or slightly convex. Antero-lateral corner angulate. Width of ventral plate convex in middle and getting narrow toward the posterior end. Dorsal plate anteriorly as wide as ventral plate, wider in the middle. Length of dorsal plate shorter than ventral plate. Dorsal lorica 60.0–62.5 μm in length, 58.0–60.0 μm in width. Ventral lorica 65.0–70.0 μm in length, 54.5–56.5 μm in width. Incomplete longitudinal and transverse fold in ventral plate. Prepedal folds narrow with median projection posteriorly. Foot pseudosegment squircle shaped, with bulge in middle and slightly protruded from foot plate. Toes completely separated. Tip of toes sharp and curved outwards. Toe 26 μm in length (Fig. 2D, E). Trophi malleate. Fulcrum short and stubbed. Unci square shaped with two big teeth. Manubria thick, rapidly tapering to the end. Tip of manubria with distinctly curved end (Fig. 2F).

Distribution. Cosmopolitan.

Remarks. *Lecane nana* is a cosmopolitan species that has previously been recorded in a number of Asian counties: Cambodia (Meas and Sanoamuang, 2010), China (Huang *et al.*, 2017), India (Sharma, 1978), Japan

(Sudzuki, 1964), Mongolia (Jersabek, 2010), Thailand (Sanoamuang *et al.*, 1995), and Vietnam (Zhdanova, 2011). It can be distinguished from other lecanid species by the following characteristics: (1) two separated toes with a curved terminal end, (2) an anterior margin of the dorsal and ventral lorica that is coincident and straight, and (3) incomplete transverse and longitudinal folds on the ventral plate. This species is most similar to *L. tryphema* Harring & Myers, 1926, but can be distinguished from the former by its toe tips curved outwards.

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