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New record of two spirotrichous ciliate species (Protozoa, Ciliophora) collected from coasts of South Korea

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Two newly recorded ciliates, *Aspidisca major* (Madsen, 1931) Kahl, 1932 and *Metaurostylopsis rubra* Song and Wilbert, 2002, were collected from eastern and southern coasts of South Korea, respectively. The morphology of these two species were studied based on observations of protargol-stained specimens. The morphological characteristics of the two species are as follows: (1) *Aspidisca major* is characterized by a size of 76−78 × 42−49 μm after protargol impregnation, two distinct macronuclei, seven frontoventral cirri in "*polystyla*-arrangement", and dorsal kinety 1 extends to posterior end of dorsal kinety 2; and (2) *Metaurostylopsis rubra* is characterized by a size of 68−77 × 49−58 μm size after protargol impregnation, brick-reddish body color, and large number of marginal rows. In the present study, we provide a brief diagnosis, remarks, and photomicrographs.

Keywords: *Aspidisca major*, marine ciliates, *Metaurostylopsis rubra*, taxonomy

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Introduction

The genera *Aspidisca* Ehrenberg, 1830 and *Metaurostylopsis* Song *et al*., 2001 are widely distributed globally in marine ecosystems. Up to date, about 60 nominal *Aspidisca* species and eight *Metaurostylopsis* species have been recorded (Wu and Curds, 1979; Fernandez-Leborans de Zaldumbide, 1987; Valbonesi, 1996; Berger, 2001; Song and Wilbert, 2002; Lei *et al*., 2005; Shao *et al*., 2008a; 2008b; Jankowski, 2009; Shen *et al*., 2010; Chen *et al*., 2011; Jung *et al*., 2011; Jiang *et al*., 2013; Lu *et al*., 2016; Song *et al*., 2020; Zheng *et al*., 2022; Choi *et al*., 2024). According to the National Institution of Biological Resources (2023), only 11 *Aspidisca* species (*A. aculeata* (Ehrenberg, 1838) Kahl, 1932; *A. cicada* (Müller, 1786) Claparède and Lachmann, 1858; *A. dentata* Kahl, 1928; *A. hexeris* Quennerstedt, 1869; *A. leptaspis* Fresenius, 1865; *A. lynceus* (Müller, 1773) Ehrenberg, 1830; *A. orthopogon* Deroux and Tuffrau, 1965; *A. polypoda* (Dujardin, 1841) Kahl, 1932; *A. polystyla* Stein, 1859; *A. steini* (Buddenbrock, 1920) Kahl, 1932; and *A. turrita* (Ehrenberg, 1838) Claparède and Lachmann, 1858) and only 4 *Metaurostylopsis* species (*M. cheni* Chen *et al*., 2011; *M. marina* (Kahl, 1932) Song *et al*., 2001; *M. salina* Lei *et al*., 2005; and *M. struederkypkeae* Shao *et al*., 2008) have been recorded in South Korea, indicating undersampling of the Korean ciliate fauna (Shin and Kim, 1988; Lei *et al*., 2005; Li *et al*., 2010; Park *et al*., 2012; Kim *et al*., 2016; Kim and Jung, 2018; Kim *et al*., 2018; 2020; Choi *et al*., 2020; Choi *et al*., 2023). Therefore, this study aims to further explore the diversity and distribution of these genera in Korean marine environments.

During a field survey, we identified two species, 1) *Aspidisca major* (Madsen, 1931) Kahl, 1932; and 2) *Metaurostylopsis rubra* Song and Wilbert, 2002, previously unrecorded in Korea. In this paper, we provide brief diagnosis, remarks, photomicrographs, and information about collection sites and conditions.

Materials and Methods

The detailed information about collection sites and conditions are provided in 'Material examined' section for each species. After gently stirring up surface marine water, samples were collected with bottom sediments. All samples were transferred to the laboratory and kept in Plant culture dishes at room temperature (ca. 20°C) with 1−3 autoclaved rice grains. The morphology of each species was studied using a stereomicroscope (SZ11; Olympus, Tokyo, Japan), and photomicrographs were captured

using a digital camera (DP74; Olympus). The protargol powder was synthesized using the method of Pan *et al.* (2013) and Kim and Jung (2017). The protargol-impregnated specimens were prepared using the 'procedure A' method of Foissner (2014). The differential through-focal images of the protargol-impregnated specimens were merged using Helicon Focus ver. 8.1.0 software (Helicon-Soft Ltd, Kharkiv, Ukraine). The basic terminology and taxonomic classification mainly followed Lynn (2008), Song *et al.* (2001), and Wu and Curds (1979).

Results and Discussion

Phylum Ciliophora Doflein, 1901
Class Spirotrichea Bütschli, 1889
Order Euplotida Small and Lynn, 1985
Suborder Euplotina Jankowski, 1979
Family Aspidiscidae Ehrenberg, 1830
Genus *Aspidisca* Ehrenberg, 1830

1. *Aspidisca major* (Madsen, 1931) Kahl, 1932 (Fig. 1)

Material examined. Marine water (salinity 37.8‰, temperature 18.3°C) collected from Sodol beach, Jumun-ri, Jumunjin-eup, Gangneung-si, Gangwon-do, Korea (37° 54′24.6″N, 128°49′41.7″E) on May 15, 2023.

Diagnosis. Size 76−78 × 42−49 μm after protargol impregnation (n = 3); body bean-shaped; cortex rigid; peristomial spur and projections along left margin on ventral side lacking (Fig. 1A); anterior adoral zone of membranelles (AZM1) about 4 μm long with 4 membranelles, posterior adoral zone of membranelles (AZM2) about 24 μm long after protargol impregnation and with 15−18 membranelles; invariably seven frontoventral cirri in "*polystyla*-arrangement"; five transverse cirri, cilia of each transverse cirrus not separated (Fig. 1A); four dorsal kineties with 25−28, 18−22, 19−23, and 22−24 dikinetids in dorsal kineties 1−4, respectively (Fig. 1B); dorsal kinety 1 distinctly curved to right posteriorly and ends near posterior end of dorsal kinety 2 (Fig. 1C); two ellipsoid macronuclei, micronucleus not observed (Fig. 1D).

Distribution. Germany, South Korea

Remarks. The Korean population of *Aspidisca major* corresponds with the German population redescribed by Kahl (1932) in all available aspects. *Aspidisca major* is a special species among the congeners in having two macronuclei (Fig. 1D). Because of this feature, *A. major*, *A. binucleata* Kahl, 1932, *A. fusca* Kahl, 1928, and *A. mutans* Kahl, 1932 can be easily distinguished from other members of the genus *Aspidisca*. However, *A. major* differs from *A. binucleata* in the number of frontoventral cirri (7 vs. 9). *Aspidisca mutans* differs from *A. major* by the number of frontoventral cirri (12 vs. 7) and the number of transverse cirri (7 vs. 5) (Kahl, 1932). *Aspidisca fusca* differs from *A. major* by the presence of a peristomial spur

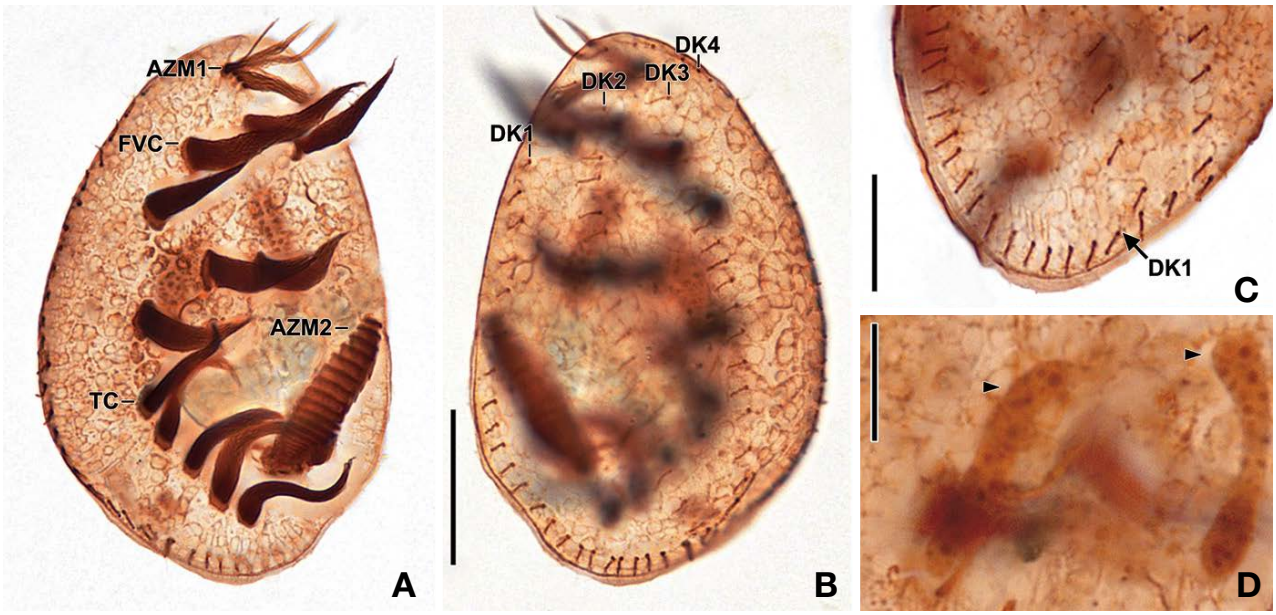

Fig. 1. *Aspidisca major* after protargol impregnation (A−D). A, B. Ventral (A) and dorsal (B) view, showing the body shape, anterior and posterior portion of adoral zone of membranelles, the transverse cirri, the frontoventral cirri in "*polystyla*-arrangement", and dorsal kineties 1−4. C. Dorsal view showing the arrangement of dorsal kineties. Dorsal kinety 1 curved posteriorly and extends to posterior end of dorsal kinety 2. D. Two ellipsoidal macronuclei (arrowheads). AZM1 and 2, anterior and posterior adoral zone of membranelles; DK1−4, dorsal kineties 1−4; FVC, frontoventral cirri; TC, transverse cirri. Scale bars = 20 μm (A, B); 10 μm (C, D).

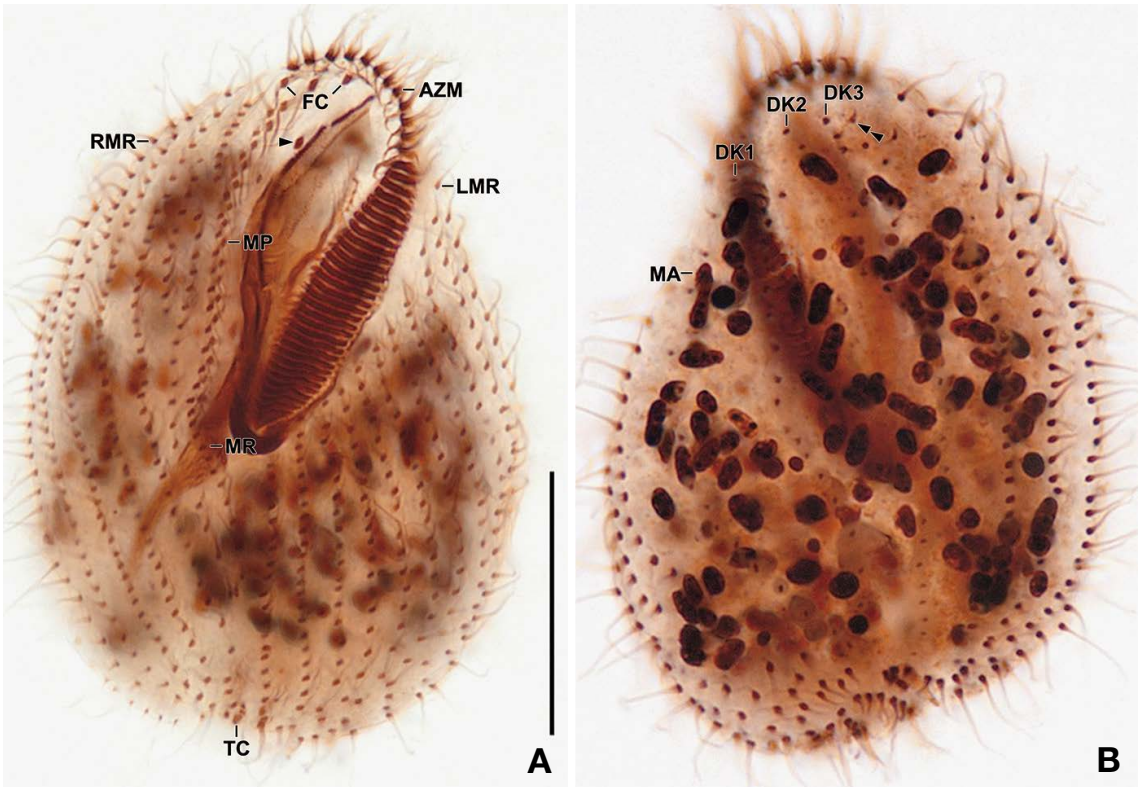

Fig. 2. *Metaurostylopsis rubra* after protargol impregnation (A, B). A. Ventral view showing the body shape, adoral zone of membranelles, frontal and transverse cirri, midventral pairs and row, and left and right marginal rows. Arrowhead denotes one buccal cirrus. B. Dorsal view showing the dorsal kineties 1–3 and macronuclear nodules. Double arrowhead denotes fragment-like kineties anterior to the leftmost right marginal row. AZM, adoral zone of membranelles; DK1–3, dorsal kineties 1–3; FC, frontal cirri; LMR, left marginal rows; MA, macronuclear nodules, MP, midventral pairs; MR, midventral row; RMR, right marginal rows; TC, transverse cirri. Scale bar = 30 μm.

(present vs. absent) (Wu and Curds, 1979). Considering the arrangement of frontoventral cirri, number of membranelles in AZM1 and the presence of peristomial spur, the Korean population of *A. major* is similar to *A. steini* however, they differ mainly in the number of macronuclei (two vs. one) and larger body size (76–78 × 42–49 μm vs. 20–35 × 15–27 μm) (Wu and Curds, 1979; Song and Wilbert, 1997).

Voucher slides. Two slides with protargol-impregnated specimens were deposited at the National Marine Biodiversity Institute of Korea (MABIK PR00045067, MABIK PR00045068).

Order Urostylida Jankowski, 1979
Family Urostylidae Bütschli, 1889
Genus *Metaurostylopsis* Song, Petz and Warren, 2001

2. *Metaurostylopsis rubra* Song and Wilbert, 2002 (Fig. 2)

Material examined. Marine water (salinity 36.1‰, temperature 16.8°C) collected from Sanyang-eup, Tongyeong-si, Gyeongsangnam-do, South Korea (34°49′16″ N, 128°26′27″E) on April 17, 2023.

Diagnosis. Size 68–77 × 49–58 μm after protargol impregnation (n = 3); body oval to ellipsoidal with brick-reddish color; body flexible and slightly contractile; adoral zone of membranelles occupies about 50% of body length; 36–44 adoral membranelles; 1 buccal cirrus; 3 frontal, 8–9 frontoterminal, and 5–6 transverse cirri; 13–16 midventral pairs and a midventral row with about 8–12 cirri, extending to the midline of body; 10–12 left and 6–7 right marginal rows (Fig. 2A); three dorsal kineties (Fig. 2B); and about 70 macronuclear nodules.

Distribution. Antarctic, South Korea

Remarks. The Korean population of *Metaurostylopsis rubra* is similar to the type population of *M. rubra* described by Song and Wilbert (2002) in most features except for the slightly non-overlapping number of midventral pairs (13–16 vs. 8–11) and left marginal rows (10–12 vs. 6–9) (Song and Wilbert, 2002). *Metaurostylopsis rubra* can be easily distinguished from other congeners by the cell color and the number of midventral pairs and left marginal rows (Fig. 2A). Since the number of living

cells were not enough to examine in detail, we cannot determine whether the reddish color of the cells is due to the reddish cytoplasm or the cortical granules. Among the congeners, there is no species with more than six right marginal rows (Song *et al*., 2020). Also, only two species, *M. struederkypkeae* and *M. parastruederkypkeae* Lu *et al*., 2016, have reddish body color like *M. rubra*, but they differ from the present Korean population by the number of right marginal rows (3 vs. 3–5 vs. 6–7) (Shao *et al*., 2008b; Lu *et al*., 2016; Song *et al*., 2020).

Voucher slides. Two slides with protargol-impregnated specimens were deposited at the National Marine Biodiversity Institute of Korea (MABIK PR00045065, MABIK PR00045066).

Conflicts of Interest

The author of this paper has no affiliation with any interests and is solely responsible for the paper.

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