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Morphological reports of four ciliates (Ciliophora) from coastal marine and brackish water habitats in Korea

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Three marine and one brackish-water ciliates (*Dysteria crassipes* Claparède and Lachmann, 1859; *Gruberia calkinsi* Beltrán, 1933; *Pleuronema salmastra* Dragesco, 1986; *Zosterodasys agamaliev* Deroux, 1978) were isolated from Incheon in Korea and their morphologies were investigated using live observation and protargol impregnation.

Keywords: *Dysteria*, *Gruberia*, Korea, Morphology, *Pleuronema*, *Zosterodasys*

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Introduction

Ciliates, including free-living and symbiotic species, have adapted to diverse habitats, such as freshwater, seawater, soil, moss, and deserts (Lynn and Small, 2002; Xu *et al*., 2013; Zhang *et al*., 2013). The number of unreported species is estimated to be 27,000-40,000, but only 4,500 free-living and morphologically valid ciliate species have been identified worldwide (Foissner *et al*., 2008).

The approximately 200 ciliate species (including parasitic ciliates) identified in South Korea to date mostly belong to the class Spirotrichea (84.7%; Park, 2014). Therefore, we focused on the identification of ciliate species that belong to other classes, i.e., Phyllopharyngea, Heterotrichea, and Oligohymenophorea, instead of well-known taxa.

Materials and Methods

The four species, *Dysteria crassipes*, *Gruberia calkinsi*, *Pleuronema salmastra*, and *Zosterodasys agamaliev*, were sampled from coastal marine and brackish-water habitats, and they were maintained in petri dishes with rice grains at room temperature. We observed living specimens by using bright-field and differential interference contrast microscopy, at magnifications of ×50 to ×1,000. The infraciliature was revealed using the protocol reported by Foissner (1991). Counts and measurement of stained specimens were performed at a magnification of ×1,000 (Leica DM2500; Wetzlar, Germany). Terminology follows that of Corliss (1979), Gong and Song (2004), and Chen *et al*. (2011) for *Dysteria crassipes*; Al-Rasheid (2001) for *Gruberia calkinsi*; Corliss (1979) for *Pleuronema salmastra*; Vd'ačný and Tirjaková (2012) for *Zosterodasys agamaliev*.

Results and Discussion

Phylum Ciliophora Doflein, 1901
Class Heterotrichea Stein, 1859
Order Heterotrichida Stein, 1859
Family Spirostomidae Stein, 1867
Genus *Gruberia* Kahl, 1932

1. *Gruberia calkinsi* Beltrán, 1933 (Fig. 1A, B)

Diagnosis. Live cell 440-1,000 μm in length; anterior slightly curved, contractile, posterior narrowed in shape; peristome about 1/2-2/3 of cell in length; 36-45 somatic kineties; 273-441 adoral membranelles; macronuclei, moniliform, 9-15 in number.
Material examined. On October 24, 2014, at Seonnyeobawi Beach, the Yellow Sea, Korea (37°26′N, 126°22′E).
Voucher slides. A slide of protargol-impregnated specimens was deposited at the National Institute of Biological Resources, Korea (NIBRPR0000106616).
Remarks. In this study, the genus *Gruberia* is firstly reported from Korea. *Gruberia calkinsi* is similar to *G. beninensis* Dragesco and Dragesco-Kernéis, 1986 with

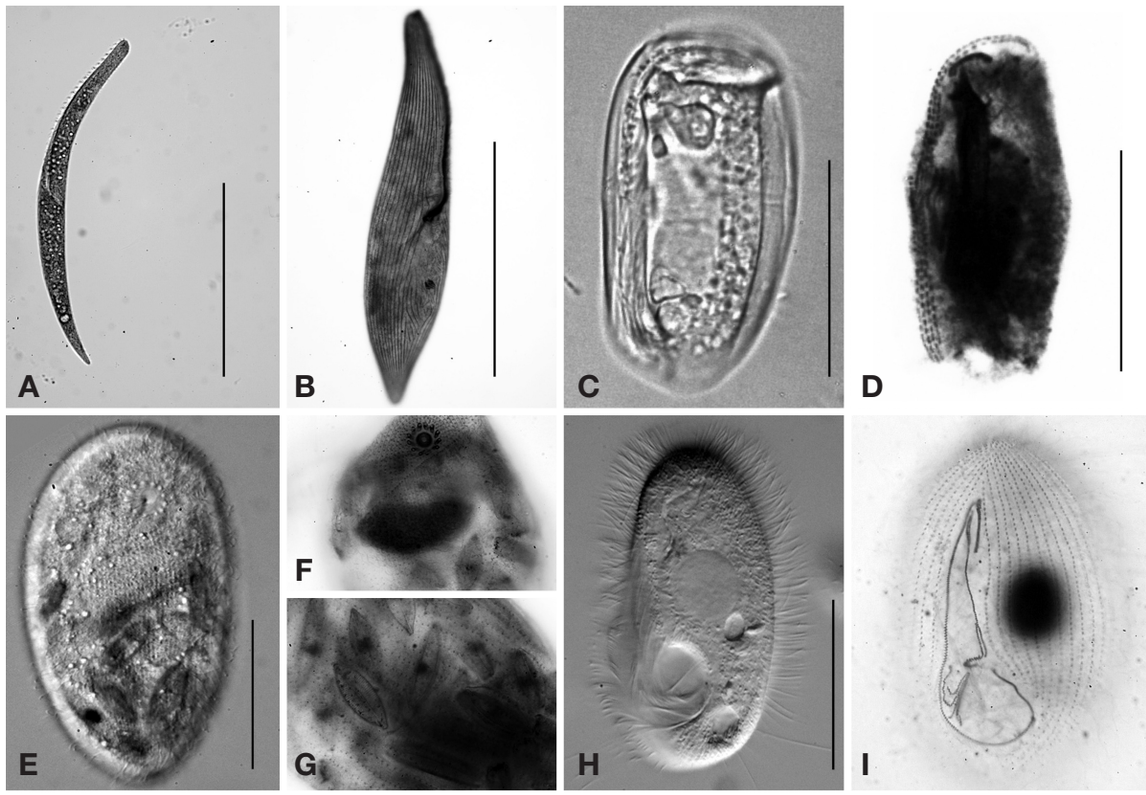


Fig. 1. Photomicrographs of four ciliates on the basis of live observation (A, C, E, H) and after protargol impregnation (B, D, F, G, I). A, B, *Gruberia calkinsi*, left side view of a living specimen (A) and right side view of a protargol-impregnated specimen (B); C, D, *Dysteria crassipes*, left side views of living (C) and protargol-impregnated (D) specimens; E-G, *Zosterodasys agamaliev*, ventral view of a living specimen (E), and ventral (F) and dorsal (G) views of potargol-impregnated specimens; H, I, *Pleuronema salmastra*, ventral views of living (H) and protargol-impregnated (I) specimens. Scale bars: A = 500 μm, B = 300 μm, C, D = 30 μm, E, H = 50 μm.

respect to cell size and form of macronucleus (Al-Rasheid, 2001). However, *G. calkinsi* can be distinguished from the *G. beninensis* population redescribed by Al-Rasheid (2001) in the number of adoral membranelles (273-441 vs. 130-170).

Class Phyllopharyngea de Puytorac *et al*., 1974
Order Dysterida Deroux, 1976
Family Dysteriidae Claparède and Lachmann, 1858
Genus *Dysteria* Huxley, 1857

2. *Dysteria crassipes* Claparède and Lachmann, 1859 (Fig. 1C, D)

Diagnosis. Cell size ca. 55 × 25 μm in impregnated specimens; nearly rectangular to pentagonal in shape; four right kineties, two outermost kineties extending to dorso-apical region; one macronucleus, 18-25 μm in length; two ventral contractile vacuoles.
Material examined. On July 31, 2008, at Incheon Harbor, the Yellow Sea, Korea (37°26′N, 126°35′E).
Voucher slides. A slide of protargol-impregnated specimens was deposited at the National Institute of Biological Resources, Korea (NIBRPR0000107180).
Remarks. *Dysteria crassipes* can be clearly distinguished from its congeners by the difference of the number of right kineties (Gong *et al*., 2007). The morphology and infraciliature of this population correspond well with those of the Chinese isolate reported by Gong *et al*. (2007).

Order Synhymeniida de Puytorac *et al*. in Deroux, 1978
Family Orthodonellidae Jankowski, 1968
Genus *Zosterodasys* Deroux, 1978

3. *Zosterodasys agamaliev* Deroux, 1978 (Fig. 1E-G)

Diagnosis. Size about 112-165 × 87-118 μm after protargol impregnation; obovoidal to ellipsoidal in shape; about 58-68 ciliary rows, 39-46 ventral and 19-22 dorsal rows; on average, 12 nematodesmal rods.
Material examined. On December 16, 2014, at Aam-

do Waterfront Park, the Yellow Sea, Korea (37°26′N, 126°37′E).
Voucher slides. A slide of protargol-impregnated specimens was deposited at the National Institute of Biological Resources, Korea (NIBRPR0000106618).
Remarks. *Zosterodasys agamaliev* was originally described by Deroux (1978) as the type species of the genus *Zosterodasys*. Although *Z. agamaliev* and *Z. transversus* (Kahl, 1928) are very similar, they can be distinguished in habitats (marine vs. freshwater) (Vd'ačný and Tirjaková, 2012).

Class Oligohymenophorea de Puytorac *et al*., 1974
Order Scuticociliatida Small, 1967
Family Pleuronematidae Kent, 1881
Genus *Pleuronema* Dujardin, 1841

4. *Pleuronema salmastra* Dragesco, 1986 (Fig. 1H, I)

Diagnosis. Cell size about 83-100 × 34-68 μm in impregnated specimens; four to six preoral kineties and 47-56 somatic kineties; membranelle 1 about 25% of membranelle 2 in length; posterior part of membranelle 2 hook-like; membranelle 3 three rows.
Material examined. On November 11, 2014, at Seonnyeobawi Beach, the Yellow Sea, Korea (37°26′N, 126° 22′E).
Voucher slides. A slide of protargol-impregnated specimens was deposited at the National Institute of Biological Resources, Korea (NIBRPR0000106617).
Remarks. Among species of the *coronatum*-type group, *Pleuronema salmastra* is similar to *P. coronatum* Kent, 1881 in most respects except the number of somatic kineties (47-56 vs. 27-43) (Wang *et al*., 2008).

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