

# Morphology of one *Frontonia* and two *Spathidium* ciliates (Ciliophora: Intramacronucleata) from Korea

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Three ciliate species, *Frontonia schaefferi* Bullington, 1939, *Spathidium curiosum* Foissner, 2016, and *S. muscicola* Kahl, 1930, were collected from freshwater and terrestrial habitats in Korea. Their morphology was investigated based on live observations and protargol impregnation. *Frontonia schaefferi* was characterized by a cell size of 89-112 × 45-53 μm (after protargol impregnation) and three vestibular kineties. *Spathidium curiosum* was characterized by a cell size of ca. 125 × 25 μm in vivo and the unusual shape of the extrusomes. *Spathidium muscicola* was characterized by a cell size of ca. 135 × 40 μm in vivo and four to six macronuclear nodules. These three species are new records for Korea.

Keywords: freshwater, new record, soil

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## INTRODUCTION

The genus *Frontonia* was first recorded in Korea by Kim and Jung (2016). The important morphological characters that distinguish *Frontonia* from its congeners are body size and shape, the number of contractile vacuoles, the ciliary pattern of the oral apparatus, and the number of somatic kineties (Dragesco, 1960; Corliss, 1979; Dragesco and Dragesco-Kernéis, 1986; Foissner, 1994; Chen *et al.*, 2014).

In Korea, five *Spathidium* species were recorded by Jang *et al.* (2017): *Spathidium ascendens* Wenzel, 1955, *S. papilliferum* Kahl, 1930, *S. polynucleatum* (Foissner *et al.*, 2002), *S. rectoratum* Kahl, 1930, and *S. securiforme* Kahl, 1930. Spathidiids are distinguished from each other by a combination of characteristics: body size and shape, shape of extrusomes, the oral ciliary pattern, and the number of dorsal brush kineties and dikinetids of each row (Pan *et al.*, 2013; Jang *et al.*, 2017).

Here, we report a new record in Korea of one *Frontonia* and two *Spathidium* species, i.e., *Frontonia schaefferi* Bullington, 1939, *Spathidium curiosum* Foissner and Xu, 2016, and *S. muscicola* Kahl, 1930, and provide brief diagnoses for identification.

## MATERIALS AND METHODS

The three species were collected from freshwater and

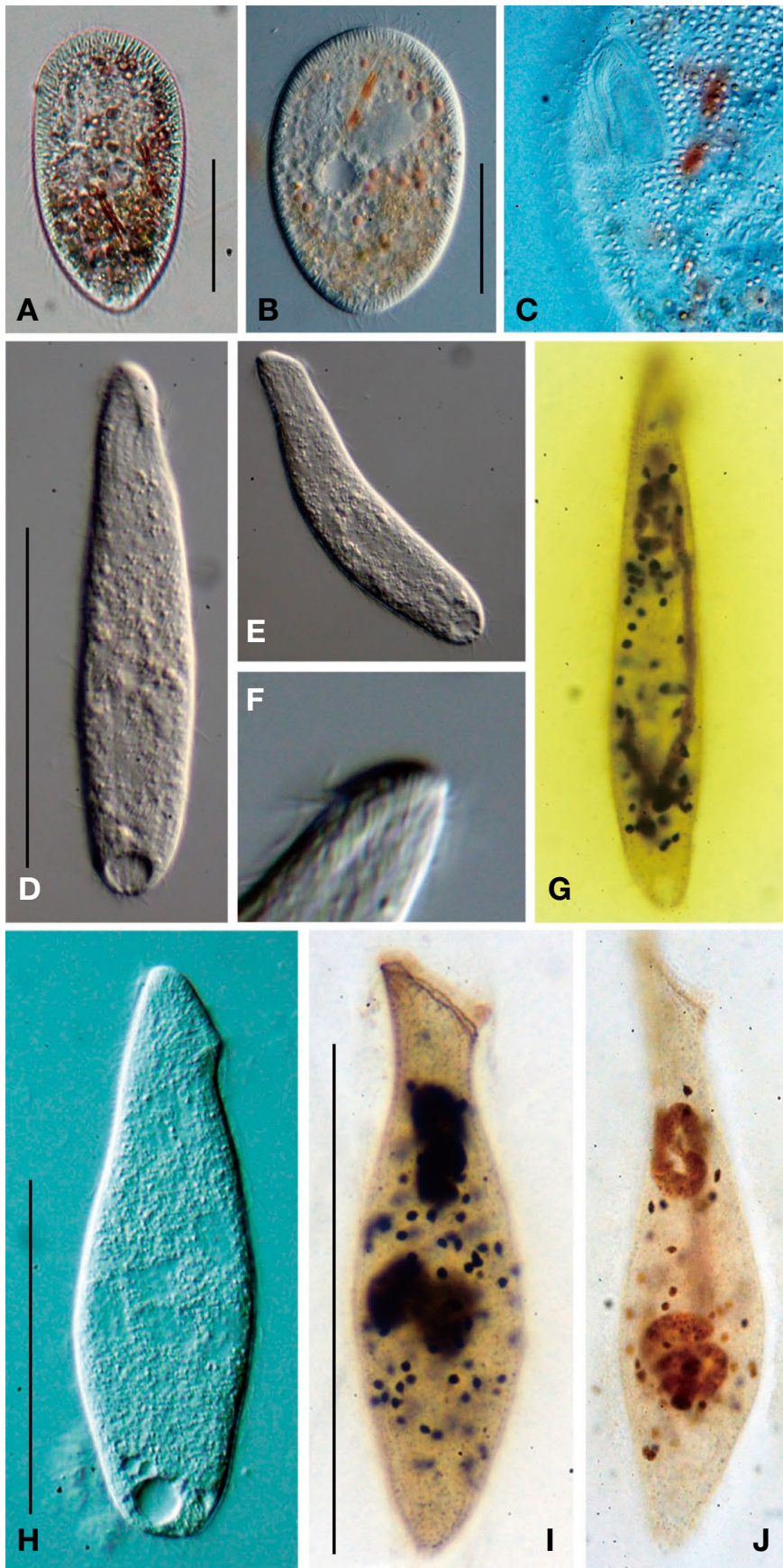
terrestrial habitats in Korea. *Frontonia schaefferi* was transferred to petri dishes and cultured with rice grains at room temperature. The moss-covered soil sample was washed with distilled water and maintained at room temperature. From the soil culture, we sampled two spathidiids, *Spathidium curiosum* and *S. muscicola*. These three ciliates were investigated based on living specimens by using a bright-field at magnifications of 50-1,000 × (Leica DM2500; Wetzlar, Germany) and protargol impregnations using the protocol reported by Foissner (1991). Terminology used followed that of Pan *et al.* (2013) for *F. schaefferi*, and that of Foissner (2016) for *S. curiosum* and *S. muscicola*.

## RESULTS AND DISCUSSION

Class Oligohymenophorea de Puytorac *et al.*, 1974  
Subclass Peniculia Faure-Fremiet in Corliss, 1956  
Order Peniculida Faure-Fremiet in Corliss, 1956  
Family Frontoniidae Kahl, 1926  
Genus *Frontonia* Ehrenberg, 1838

### 1. *Frontonia schaefferi* Bullington, 1939 (Figs. 1A-C)

**Material examined.** Dutasan Recreational Forest, Jinbu-myeon, Pyeongchang-gun, Gangwon-do, Korea (37° 35' N, 127° 34' E), May 28, 2017.



**Fig. 1.** Photomicrographs of three ciliates based on live observations (A-F, H) and after protargol impregnation (G, I, J). A-C, *Frontonia schaefferi*, left side view of body (A, B) and oral apparatus (C); D-G, *Spathidium curiosum*, right side view of body (D, E, G) and frontal views (F) showing curious shape of extrusomes; H-J, *Spathidium muscicola*, right side view of body (H-J), macronucleus in dividing cell in (J). Scale bars = 50  $\mu$ m (A, B), 80  $\mu$ m (D, H, I).

**Diagnosis.** Size about  $89\text{--}112 \times 45\text{--}53 \mu\text{m}$  after impregnation; body shape elliptical, anterior end broad, posterior end slightly narrowed, 2 : 1 ratio of body length and width; extrusomes spindle-shaped and densely arranged beneath pellicle; buccal field about 21% of body length; about 67 somatic kineties; three vestibular and five postoral kineties; one ellipsoidal macronucleus; one contractile vacuole.

**Voucher slides.** A slide of protargol-impregnated specimens was deposited at the Nakdonggang National Institute of Biological Resources, Korea (NNIBRIV4).

**Remarks.** The Korean population of *Frontonia schaefferi* closely resembles the Chinese population described by Pan *et al.* (2013), except for the ratio of length : width of the body (2 : 1 vs. 3 : 1).

Class Litostomatea Small and Lynn, 1981  
Subclass Haptoria Corliss, 1974  
Order Haptorida Corliss, 1974  
Family Spathidiidae Kahl in Doflein and Reichenow, 1929  
Genus *Spathidium* Dujardin, 1841

## 2. *Spathidium curiosum* Foissner and Xu, 2016 (Figs. 1D-G)

**Material examined.** Mt. Goesan, Goesan-gun, Chungcheongbuk-do, Korea ( $36^{\circ}48' \text{N}$ ,  $127^{\circ}57' \text{E}$ ), September 5, 2015.

**Diagnosis.** Size about  $125 \times 25 \mu\text{m}$  in vivo,  $70\text{--}120 \times 12\text{--}19 \mu\text{m}$  after impregnation; oral bulge oblong, obliquely narrowly spatulated, about 2/3 of body width; cortical granules arranged between somatic kinety rows; macronuclear nodule, long and highly tortuous; micronuclei, 4-8; one contractile vacuole; extrusomes, fusiform developmental stage impregnates with protargol; mature oral bulge extrusomes in vivo rod-shaped to acicular; 20-24 somatic kineties, three anteriorly differentiated to form a dorsal brush.

**Voucher slides.** A slide of protargol-impregnated specimens was deposited at the Nakdonggang National Institute of Biological Resources, Korea (NNIBRIV5).

**Remarks.** *Spathidium curiosum* can be distinguished from congeners by the curious shape of the extrusomes (toxicysts) (Foissner, 2016).

## 3. *Spathidium muscicola* Kahl, 1930 (Figs. 1H-J)

**Material examined.** The ridge of a leaf road, Damyang-gun, Jeollanam-do, Korea ( $35^{\circ}24' \text{N}$ ,  $126^{\circ}59' \text{E}$ ), June 4, 2016.

**Diagnosis.** Size about  $135 \times 40 \mu\text{m}$  in vivo,  $89\text{--}125 \times 19\text{--}40 \mu\text{m}$  after impregnation; oral bulge oblong, obliquely narrowly spatulated, about 2/3 of body width; cortical

granules arranged between somatic kinety rows; four to six macronuclear nodules; micronucleus not observed; one contractile vacuole positioned rear of body end; extrusomes, fusiform developmental stage impregnates with protargol; mature oral bulge extrusomes in vivo rod-shaped; 20-23 somatic kineties, three anteriorly differentiated to form a dorsal brush.

**Voucher slides.** A slide of protargol-impregnated specimens was deposited at the Nakdonggang National Institute of Biological Resources, Korea (NNIBRIV6).

**Remarks.** The Korean population of *Spathidium muscicola* is consistent with the description provided by Dragesco and Dragesco-Kernéis (1986) and differs from *S. curiosum* species in the number of macronuclear nodules (four to six vs. one) (Foissner, 2016).

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