

# New records of one marine and two soil ciliates (Ciliophora: Intramacronucleata) from Korea

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In this study, we present new records to Korea for three ciliate species [*Apogonostomum pantanalense* Foissner, 2016; *Keronopsis polychaeta* (Borror, 1966) Jankowski, 1979; *Frontonia canadensis* Roque and Puytorac, 1972] collected from marine (*F. canadensis*) and moss-covered soil (*A. pantanalense* and *K. polychaeta*) habitats. We examined the morphology of these three ciliates based on live observations and protargol impregnation. The main characters of the three ciliates are as follows: *A. pantanalense*: cell size approximately 130 × 45 μm, tail-like posterior end, and 6 or 7 ventral cirral pairs elongated to transverse cirri; *K. polychaeta*: size approximately 140 × 90 μm and approximately 18 frontal coronal cirri and 5 transverse cirri; *F. canadensis*: cell size approximately 100 × 50 μm and approximately 88 somatic kineties, 3 or 4 vestibular kineties, and 5 postoral kineties.

Keywords: *Apogonostomum*, Ciliate, *Frontonia*, *Keronopsis*

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DOI:10.12651/JSR.2019.8.1.113

## INTRODUCTION

To date, more than 400 species of ciliate have been identified from diverse habitats in Korea (Jung *et al.*, 2017; Kim *et al.*, 2017; Park *et al.*, 2017b; Choi *et al.*, 2018; Jung *et al.*, 2018; Kim and Jung, 2018). Jung *et al.* (2017) listed the 331 ciliate species known in Korea as of 2016, and Park *et al.* (2017a) reported a further 38 unrecorded ciliates (8 classes, 16 orders, 23 families, and 34 genera) in the form of a checklist. Since then, additional new or previously unrecorded species have been discovered or identified.

In this study, we present new records for the ciliate species *Apogonostomum pantanalense* Foissner, 2016; *Keronopsis polychaeta* (Borror, 1966) Jankowski, 1979; *Frontonia canadensis* Roque and Puytorac, 1972, along with brief diagnoses. These species are classified into three genera, three families, three orders, and two classes.

## MATERIALS AND METHODS

We isolated two ciliates, *A. pantanalense* and *K. polychaeta* from moss-covered soil samples, whereas *F. canadensis* was collected from seawater. The moss-covered soil samples were initially transferred to a laboratory, where they were dried at room temperature for approxi-

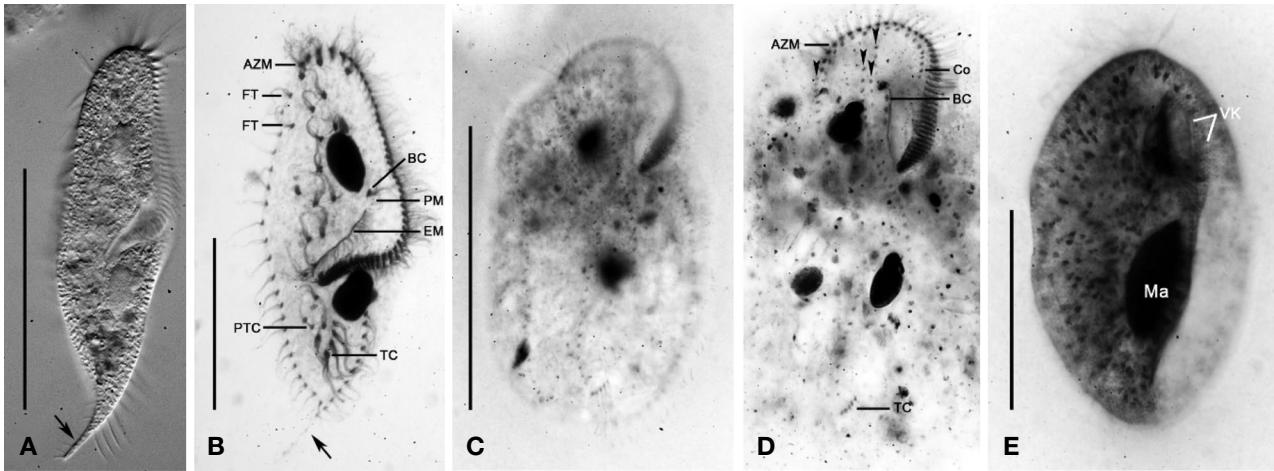
mately one week. In order to induce excystment, sterilized distilled water was poured onto the dried soil, which was thereafter maintained at room temperature. The marine sample was moved into petri dishes with rice grains as food sources, and maintained at room temperature. Using a bright-field microscope at ×50 to ×1,000 magnification (Leica DM2500; Wetzlar, Germany), the three ciliates were examined as living specimens and following protargol impregnation using the protocol reported by Foissner (2014). The taxonomic terminologies used for *A. pantanalense*, *K. polychaeta*, and *F. canadensis* follows those of Foissner (2016), Borror (1966), Pan *et al.* (2013), respectively.

## RESULTS AND DISCUSSION

Class Spirotrichea Bütschli, 1889  
Order Sporadotrichida Fauré-Fremiet, 1961  
Family Gonostomatidae Small & Lynn, 1985  
Genus *Apogonostomum* Foissner, 2016  
박각구하모충속(신칭)

### 1. *Apogonostomum pantanalense* Foissner, 2016 다모박각구하모충(신칭) (Fig. 1A, B)

**Material examined.** Moss-covered soil collected from Songdang-ri, Gujwa-eup, Jeju-si, Jeju-do Island, Korea



**Fig. 1.** Photomicrographs of three ciliates based on live observations (A) and after protargol impregnation (B-E). A, B, *Apogonostomum pantanalense*, ventral view of live (A) and protargol impregnated (B) specimens, arrows indicate tail-like posterior end; C, D, *Keronopsis polychaeta*, ventral view of protargol impregnated specimen, arrowheads in (D) denote frontoventral rows; E, *Frontonia canadensis*, ventral view of protargol impregnated specimen. AZM, adoral zone of membranelles; BC, buccal cirri; Co, frontal corona; EM, endoral membrane; FT, frontoterminal cirri; Ma, macronucleus; PM, paroral membrane; PTC, pretransverse cirri; TC, transverse cirri; VK, vestibular kineties. Scale bars = 100  $\mu\text{m}$  (A, C), 50  $\mu\text{m}$  (B, E).

(33°26'N, 126°44'E), June 30, 2017.

**Diagnosis.** Size 115-165  $\times$  40-80  $\mu\text{m}$  after impregnation; body shape elongated ellipsoid having a tail-like posterior end and narrow anterior end; buccal field occupied approximately 55% of body length; adoral zone composed of approximately 43 membranelles; paroral membrane composed of approximately 14 kinetids; 3 frontal and 2 frontoterminal cirri; 1 buccal cirrus above anterior end of endoral and adjacent to paroral membrane; 6 or 7 ventral cirral pairs; 2 pretransverse and 4 or 5 transverse cirri; right and left marginal rows composed of approximately 22 and 13 cirri, respectively; 3 dorsal kineties; 2 macronuclear nodules with 2 micronuclei.

**Voucher slide.** A slide of protargol-impregnated specimens has been deposited at the Nakdonggang National Institute of Biological Resources, Korea (NNIBR2018 113IV1953).

**Remarks.** The Korean population of *Apogonostomum pantanalense* is similar to the original description of the Brazilian population (Foissner, 2016). The Korean population is, however, slightly different from the Brazilian population in terms of the numbers of paroral kinetids (12-15 vs. 14-26) and ventral cirral pairs (6 or 7 vs. 7-9).

Order Stichotrichida Fauré-Fremiet, 1961  
Family Keronopsidae Jankowski, 1979  
Genus *Keronopsis* Penard, 1922

**2. *Keronopsis polychaeta* (Borror, 1966) Jankowski, 1979** 다극모각모하모충 (신칭) (Fig. 1C, D)

**Material examined.** From moss-covered soil collected

from Toseong-myeon, Goseong-gun, Gangwon-do, Korea (38°12'N, 128°30'E), October 21, 2017.

**Diagnosis.** Cell size approximately 140-155  $\times$  80-100  $\mu\text{m}$  after protargol impregnation; ellipsoidal body outline, slightly cephalized, anterior and posterior ends slightly rounded; adoral zone occupied approximately 56% of body length, and composed of 42-50 adoral membranelles; 15-21 frontal coronal cirri; 4 frontoventral rows; 2 or 3 buccal cirri; left and right frontoventral rows with 22-29 and 30-35 cirri, respectively; left and right marginal rows composed of 29-32 and 29-38 cirri, respectively; 5-7 transverse cirri; 3 dorsal kineties; 2 ellipsoidal macronuclear nodules and 2 or 3 micronuclei.

**Voucher slide.** A slide of protargol-impregnated specimens has been deposited at the National Institute of Biological Resources, Korea (NIBRPR0000109475).

**Remarks.** *Keronopsis polychaeta* was originally described as *Paraholosticha polychaeta* by Borror (1966), but was subsequently transferred to the genus *Keronopsis* on the basis of the presence of transverse cirri by Jankowski (1979). Although the Korean population of *K. polychaeta* is morphologically identical to the American population, they differ in terms of the habitat from which they were collected (moss-covered soil vs. tidal marsh pool, 3‰) (Borror, 1966).

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 전구섬모충과 (신칭)  
Genus *Frontonia* Ehrenberg, 1838 전구섬모충속 (신칭)

### 3. *Frontonia canadensis* Roque and Puytorac, 1972 작은전구섬모충 (신칭) (Fig. 1E)

**Material examined.** Collected from seawater at Bongpo Port, Bongpo-ri, Toseong-myeon, Goseong-gun, Gangwon-do, Korea (38°15'N, 128°34'E), October 22, 2017.

**Diagnosis.** Size approximately 95-110 × 45-60 μm after protargol impregnation; ellipsoidal body outline, anterior and posterior ends slightly narrow, body length to width ratio of 1.6-2.5 : 1; spindle-shaped extrusomes densely arranged beneath pellicle; buccal field approximately 19% of body length; approximately 88 somatic kineties; 3 or 4 vestibular and 5 postoral kineties; peniculi 1-3 each with 4 kinety rows; 1 ellipsoidal macronucleus; one contractile vacuole.

**Voucher slide.** A slide of protargol-impregnated specimens has been deposited at the National Institute of Biological Resources, Korea (NIBRPR0000109476).

**Remarks.** *Frontonia canadensis* was originally described by Roque and Puytorac (1972) and re-described by Pan *et al.* (2013). The Korean population of *F. canadensis* closely resembles the description of the Chinese population in terms of the body shape, the number of somatic, postoral, and vestibular kineties, and the number of peniculi 1-3 kinety rows (Pan *et al.*, 2013).

### ACKNOWLEDGEMENTS

This study was supported by a grant from the National Institute of Biological Resources (NIBR, NIBR201801202) for *Keronopsis polychaeta* and *Frontonia canadensis* and the project on the Survey and discovery of Freshwater animal and plant of the Nakdonggang National Institute of Biological Resources (NNIBR 111-1301) for *Apogonostomum pantanalense*, funded by the Ministry of Environment (MOE) of the Republic of Korea.

### REFERENCES

- Borror, A.C. 1966. *Paraholosticha polychaeta* n. sp. (Ciliata, Hypotrichida) from a New Hampshire tidal marsh. *J Protozool* 13:418-421.
- Choi, J.M., J.-H. Jung and Y.-O. Kim. 2018. First record of *Amphisiella milnei* (Ciliophora, Stichotrichida) from Korea. *Anim Syst Evol Divers* 34:143-151.
- Foissner, W. 2014. An update of 'basic light and scanning electron microscopic methods for taxonomic studies of ciliated protozoa'. *Int J Syst Evol Microbiol* 64:271-292.
- Foissner, W. 2016. Terrestrial and semiterrestrial ciliates (Protozoa, Ciliophora) from Venezuela and Galápagos. *Denisia* 35.
- Jankowski, A. 1979. Revision of the order Hypotrichida Stein, 1859. Generic catalogue, phylogeny, taxonomy. *Proc Acad Sci USSR* 86:48-85.
- Jung, J.-H., J. Cho, Y.H. Jang and D.Y. Gil. 2018. Morphology and molecular phylogeny of *Holostichides terrae* nov. spec. (Ciliophora: Spirotrichea) with discussion on the possible non-monophyly of Holostichides. *Eur J Protistol* 62:69-78.
- Jung, J.-H., M.-H. Park, S.Y. Kim, J.M. Choi, G.-S. Min and Y.-O. Kim. 2017. Checklist of Korean ciliates (Protozoa: Ciliophora). *J Species Res* 6:241-257.
- Kim, J.H. and J.-H. Jung. 2018. New record of five ciliates (Protozoa, Ciliophora) collected in eastern Gangwon-do Province, South Korea. *J Species Res* 7:181-186.
- Kim, K.-S., J.-H. Jung and G.-S. Min. 2017. Morphology and molecular phylogeny of two new ciliates, *Holostichides heterotypicus* n. sp. and *Holosticha muuiensis* n. sp. (Ciliophora: Urostylida). *J Eukaryot Microbiol* 64(6):873-884.
- Pan, X., F. Gao, W. Liu, X. Fan, A. Warren and W. Song. 2013. Morphology and SSU rRNA gene sequences of three *Frontonia* species, including a description of *F. subtropica* spec. nov. (Ciliophora, Peniculida). *Eur J Protistol* 49:67-77.
- Park, M.-H., J.H. Moon, K.N. Kim and J.-H. Jung. 2017b. Morphology, morphogenesis, and molecular phylogeny of *Pleurotricha oligocirrata* nov. spec. (Ciliophora: Spirotrichea: Stylonychinae). *Eur J Protistol* 59:114-123.
- Park, M.-H., Y.-D. Han, C.B. Kwon, E.S. Lee, J.H. Kim, Y.S. Kang, S.-J. Kim, H.-M. Yang, T. Park, J.-S. Yoo, H.-J. Kil, E. Nam, M.K. Shin and G.-S. Min. 2017a. Unrecorded species of Korean ciliates (Protozoa, Ciliophora) discovered through the project of "Discovery of Korean Indigenous Species" (2006-2010). *J Species Res* 6(SE):172-176.
- Roque, M. and P. de Puytorac. 1972. *Frontonia canadensis* sp. nov. (Cilié Hyménostome Péniculien). *Natural Canad* 99:411-416.

Submitted: October 18, 2018

Revised: November 9, 2018

Accepted: January 10, 2019