*Journal of Species Research* 12(1):95-108, 2023

# New record of ten ciliate species (Protozoa, Ciliophora) from South Korea

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Ciliates are unicellular eukaryotes and one of the most abundant and speciose protistan groups. However, their diversity is underestimated, and many new species are waiting for our discovery. During several field surveys conducted from 2018 to 2021 to document indigenous Korean ciliates, 10 unrecorded ciliate species were collected and investigated from freshwater, marine, and semiterrestrial habitats. The morphology of these species was studied based on observation of living and protargol-stained specimens. These species belong to five classes as follows: 1) class Heterotrichea - *Peritromus faurei*; 2) class Spirotrichea - *Heterotachysoma dragescoi*, *Pseudokeronopsis parasongi*, and *Certesia quadrinucleata*; 3) class Nassophorea - *Chilodontopsis depressa*; 4) class Prostomatea - *Plagiocampa rouxi* and *Urotricha furcata*; and 5) class Oligohymenophorea - *Metanophrys similis*, *Uronema gallicum*, and *Protocyclidium citrullus*. Also, we provide a brief diagnosis, photomicrographs, and information of the locality for each species. Further, we compare each species with the most recent description and with similar congeners.

Keywords: biodiversity, eukaryote, freshwater, marine, redescription, semiterrestrial

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DOI:10.12651/JSR.2023.12.1.095

## Introduction

Ciliates are one of the most abundant protistan groups with about 8,000 species (free-living, commensal, and extinct tintinnid loricae) from various habitats with suggestions of higher numbers of undiscovered species (Finlay *et al*., 1996; Foissner *et al*., 2002, 2008; Lynn, 2008; Agatha, 2011; Foissner, 2016). Korean habitats show high ciliate diversity with over 500 species described in the last few decades (Jung *et al*., 2017; Kwon *et al*., 2019). From April 2018 to August 2021, we collected many unrecorded ciliate species from various freshwater, marine, and semiterrestrial habitats from Korea. In the present study, we provide brief descriptions, remarks, photomicrographs, and information of the locality for 10, newly recorded, ciliate species from South Korea. The 10 species belong to five classes, eight orders, and 10 families.

## Materials and Methods

The ciliate species were collected from various habitats in Korea. The information about the locality is described in the 'Material examined' section for each species. The samples were collected and transferred to our laboratory as soon as possible and cultures were set in Petri dishes and 2−3 rice grains were added to each culture to increase bacteria as food source at a temperature of about 20°C. The morphology was studied using a stereomicroscope (Olympus SZ11, Japan), an optical microscope (Olympus BX53) at low (×40−200) to high (×400−1000) magnifications, and photomicrographs were captured using a digital camera (Olympus DP74). The protargol powder was synthesized using the method of Pan *et al*. (2013b) 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 the software of Helicon Focus 8.1.0 (HeliconSoft Ltd, Ukraine). The basic terminology and taxonomic classification follow Lynn (2008). The specific terminology of each taxon follows previous studies.

## Results and Discussion

Phylum Ciliophora Doflein, 1901
Class Heterotrichea Stein, 1859

Order Heterotrichida Stein, 1859
Family Peritromidae Stein, 1867
Genus *Peritromus* Stein, 1863

**1. *Peritromus faurei* Kahl, 1932 (Fig. 1)**

**Material examined.** Marine water (salinity 26.8‰) collected from Anin Beach, Gangdong-myeon, Gangneung-si, Gangwon-do, Korea (37°44′4″N, 128°59′25″E) on June 14, 2021.
**Diagnosis.** Size 60−100 × 40−55 μm in vivo and 40−50 × 25−35 μm after protargol impregnation (n = 5); body reniform with anterior half more broadly rounded than posterior, dorsoventrally flattened with distinct hump on dorsal side without ornamentation, very flexible and highly contractile; 2 globular macronuclear nodules, micronuclei not observed; cortical granules ellipsoidal and colorless; 23−25 ventral kineties of which 3 or 4 preoral kineties; adoral zone of membranelles occupies about third of extended body length and consists of 40−48 adoral membranelles.
**Distribution.** Benin, China, Germany, Mexico, USA, South Korea.
**Remarks.** The Korean population of *Peritromus faurei* corresponds with the Chinese population studied by Song and Wilbert (1997) in most features. Up to date, there are only two species in the genus, *P. faurei* and *P. kahli* Villeneuve-Brachon, 1940. *Peritromus faurei* differs from *P. kahli* mainly by the body size (≤100 μm vs. >100 μm), the number of somatic ciliary rows (20−26 vs. 25−50), the number of adoral membranelles (<50 vs. >60), and the ornamentation on dorsal side (absent vs. present) (Borror, 1963; Dragesco and Dragesco-Kernéis, 1986; Carey, 1992; Song and Wilbert, 1997; Rosati *et al*., 2004; Jin *et al*., 2021).
**Voucher slides.** One slide with protargol-impregnated specimens was deposited at the National Institute of Biological Resources, Korea (NIBRPR0000111065).

Class Spirotrichea Bütschli, 1889
Subclass Stichotrichia Small and Lynn, 1985
Order Sporadotrichida Fauré-Fremiet, 1961
Family Oxytrichidae Ehrenberg, 1830
Genus *Heterotachysoma* Shao *et al*., 2012

**2. *Heterotachysoma dragescoi* (Song and Wilbert, 1997) Shao *et al*., 2013 (Fig. 2)**

**Material examined.** Marine water (salinity 34.5‰) collected from Biin Bay, Seo-myeon, Seocheon-gun, Chungcheongnam-do, Korea (36°9′5.30″N, 126°30′47.40″E) on August 16, 2021.
**Diagnosis.** Size in vivo 40−45 × 20−25 μm and 25−30 × 10−15 μm after protargol impregnation (n = 7); body oval to elliptical; body flexible and slightly contractile; cortical granules colorless or slightly yellowish, about 1 μm in diameter, arranged in short, irregular lines of about 2−4 granules along dorsal kineties; 2 globular macronuclear nodules, each about 5 μm in diameter; 2 inconspicuous micronuclei each attached to macronucleus nodule; adoral zone of membranelles about one third of body length and composed of about 13 membranelles; right marginal row commences near mid-body and consists of 7 or 8 cirri, left marginal row consists of 7 or 8 cirri, marginal rows separate posteriorly; 3 frontal cirri, one buccal cirrus right to anterior portion of paroral membrane, 4 ventral, 3 postoral, 2 pretransverse, and 4 enlarged transverse cirri; three dorsal kineties with relatively widely spaced dikinetids; caudal cirri lacking.
**Distribution.** China, South Korea.
**Remarks.** The Korean population of *Heterotachysoma dragescoi* is identical to the type population described by Song and Wilbert (1997). Shao *et al*. (2013) established the genus *Heterotachysoma* and included oxytrichid ciliates without caudal cirri, dorsomarginal kineties, nor kinety fragmentation. To date, the genus *Heterotachysoma* contains three species, *H. multinucleatum* (Gong and Choi, 2007) Shao *et al*., 2013, *H. dragescoi*, and *H. ovata* (Song and Wilbert, 1997) Shao *et al*., 2013 (type species). The three species differ mainly in the nuclear apparatus (2 macronuclear nodules and 2 micronuclei in *H. dragescoi*, 2 macronuclear nodules and one macronucleus in-between in *H. ovata*, and several macronuclear nodules in *H. multinucleatum*) (Song and Wilbert, 1997; Gong and Choi, 2007; Shao *et al*., 2013).
**Voucher slides.** One slide with protargol-impregnated specimens was deposited at the National Institute of Biological Resources, Korea (NIBRPR0000111067).

Order Urostylida Jankowski, 1979
Family Pseudokeronopsidae Borror and Wicklow, 1983
Genus *Pseudokeronopsis* Borror and Wicklow, 1983

**3. *Pseudokeronopsis parasongi* Li and Xu, 2020 (Fig. 3)**

**Material examined.** Marine water (salinity 34.5−35‰) collected from Gangmun Bridge, Gangmun-dong, Gangneung-si, Gangwon-do, Korea (37°47′20″N, 128°54′34″E) on June 28, 2021.
**Diagnosis.** Size 127−151 × 29−35 μm after protargol impregnation (n = 5); body narrowly elliptical, flexible and slightly contractile, yellowish under low magnification, cytoplasm colorless, two types of cortical granules, type I yellow, 0.7 μm in diameter, type II colorless, blood-cell shaped, 1.8 μm in diameter; 65−78 macronuclear nodules; adoral zone of membranelles 34−49 μm long

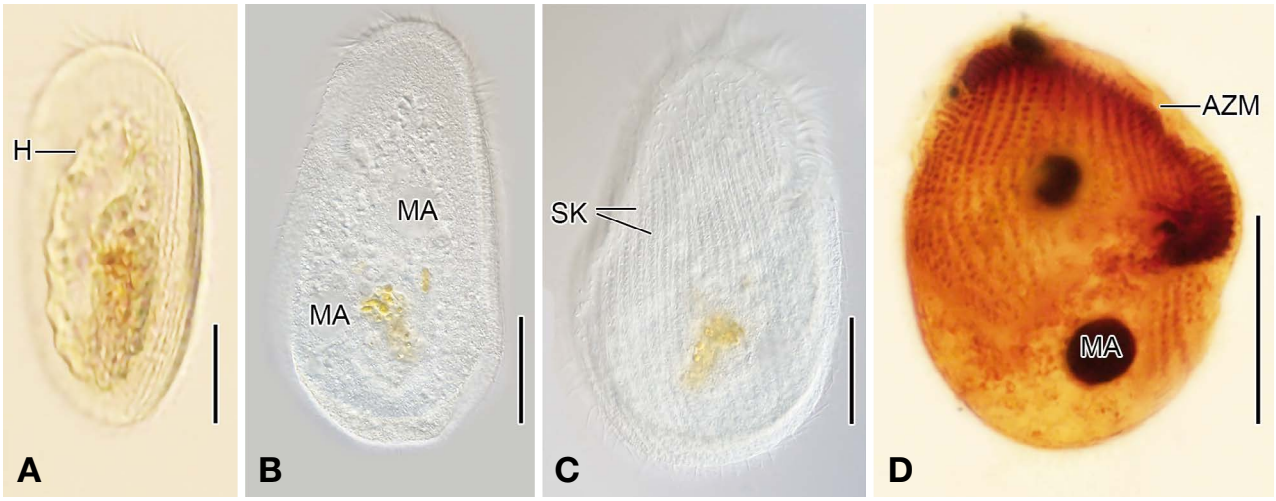


**Fig. 1.** *Peritromus faurei* in life (A–C) and after protargol impregnation (D). A–C, Dorsal (A, B) and ventral (C) view showing the body shape, the adoral zone of membranelles, the globular macronuclear nodules, the dorsal hump, and the somatic kineties. D, Ventral view showing the somatic and oral ciliature, and the nuclear apparatus. AZM, adoral zone of membranelles; H, dorsal hump; MA, macronucleus; SK, somatic kineties. Scale bars 20 μm.

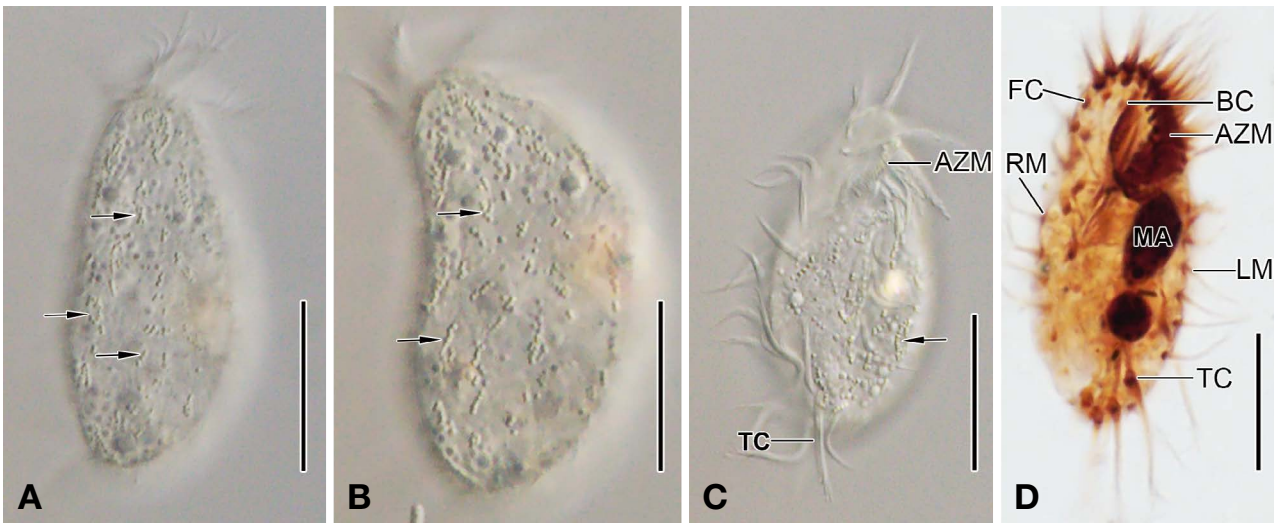


**Fig. 2.** *Heterotachysoma dragescoi* in life (A–C) and after protargol impregnation (D). A–C, Dorsal (A, B) and ventrolateral (C) view showing the shape and flexibility of body and the shape and arrangement of cortical granules (arrows). D, Ventral view showing the infraciliature and the nuclear apparatus. AZM, adoral zone of membranelles; BC, buccal cirrus; FC, frontal cirri; LM, left marginal row; MA, macronuclear nodule; RM, right marginal row; TC, transverse cirri. Scale bars 20 μm (A–C) and 10 μm (D).

and consists of 36–59 adoral membranelles; 1 buccal cirrus; 9–14 frontal cirri in bicorona, 5–8 cirri in anterior corona and 4–6 cirri in posterior corona; 2–3 frontoterminal cirri; 22–34 midventral pairs; 35–49 left and 33–49 right marginal cirri; 3–4 transverse cirri; 4 dorsal kineties; caudal cirri lacking.

**Distribution.** China, Korea.

**Remarks.** The Korean population of *Pseudokeronopsis parasongi* is similar to the Chinese population in all aspects except the number of macronuclear nodules (65–78 vs. 135–168) (Li and Xu, 2020). Li and Xu (2020) also reported a single contractile vacuole at 66% of body length and occasionally a second one at 25% in vivo; however, the anterior and posterior contractile vacuoles in the Korean population are slightly displaced posteriad (at 30% of body length) and anteriad (at 55% of body length), respectively. *Pseudokeronopsis parasongi* can be distinguished from *P. carnea*, *P. erythrina*, *P. multinucle-*

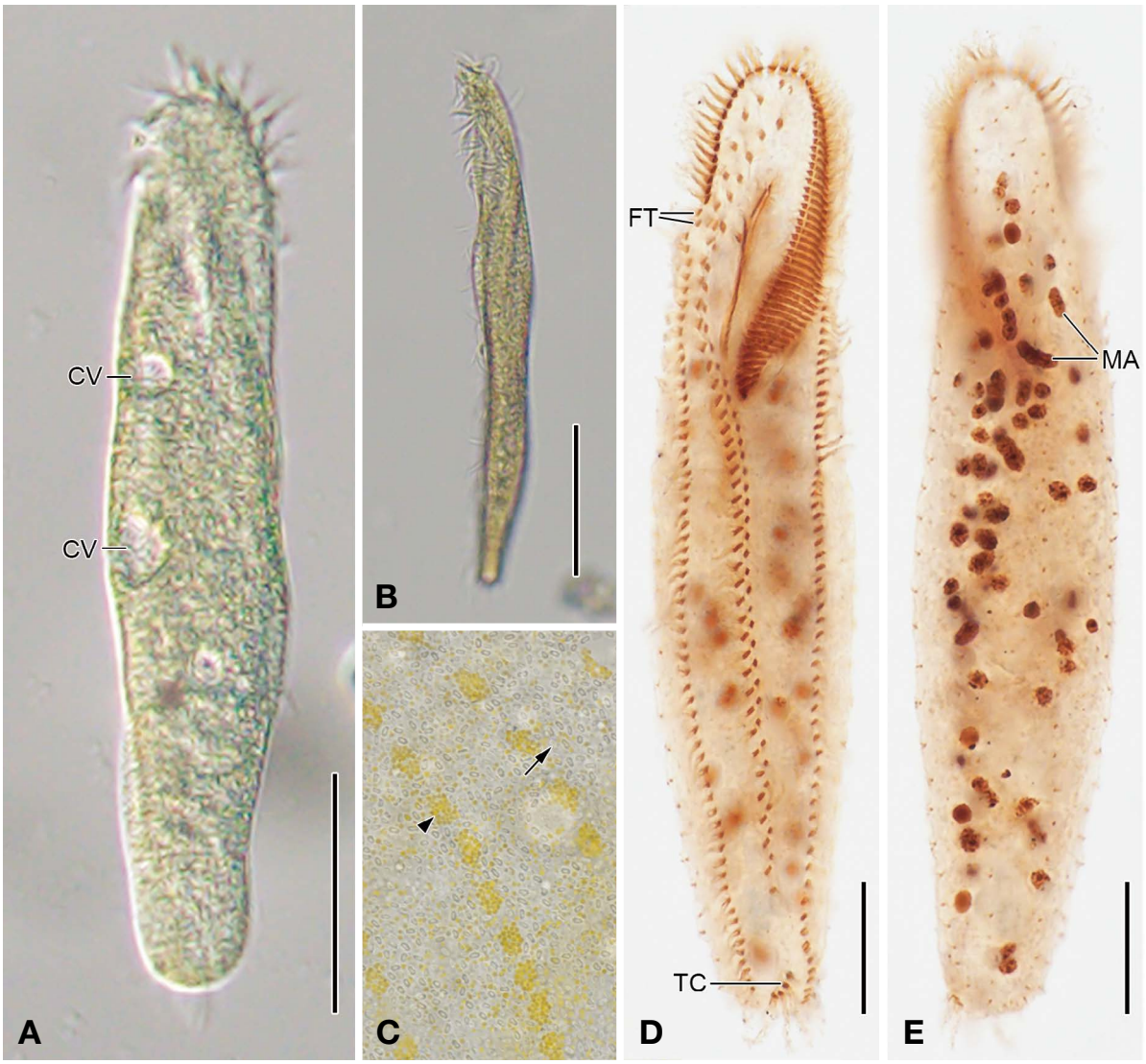


**Fig. 3.** *Pseudokeronopsis parasongi* in life (A–C) and after protargol impregnation (D, E). A, B, Dorsal (A) and lateral (B) view showing the body shape and the two contractile vacuoles. C, Dorsal view showing the arrangement of the cortical granules; the yellow type I (arrowhead) and the colorless, blood cell shaped type II (arrow). D, E. Ventral (D) and dorsal (E) view showing the midventral pairs, the nuclear pattern and the four dorsal kineties. CV, contractile vacuole; FT, frontoterminal cirri; MA, macronuclear nodules; TC, transverse cirri. Scale bras 50 μm (A, B) and 20 μm (D, E).

*ate*, *P. pararubra*, and *P. rubra* by the body color (yellow vs. red or orange) and from *P. elongata*, *P. similis*, and *P. decolor* by the number of transverse cirri (3–4 vs. up to 6) (Hu and Song, 2001; Song *et al*., 2002b; 2004; 2006; Hu *et al*., 2004; Shi *et al*., 2007; Baek *et al*., 2011; Chen *et al*., 2011; Li *et al*., 2017). On the other hand, *P. parasongi* resembles *P. flava*, *P. flavicans*, and *P. songi* in most features. However, *P. parasongi* occasionally possessing two contractile vacuoles, while in *P. flava*, *P. flavicans*, and *P. songi* has only one contractile vacuole. In addition, *P. parasongi* is similar to *P. flava* and *P. flavicans* in having yellow cortical granules, while in *P. songi* have dark-reddish cortical granules (Song *et al*., 2002b; 2006; Li *et al*., 2017; Li and Xu, 2020).

**Voucher slides.** One slide with protargol-impregnated specimens was deposited at the National Institute of Biological Resources, Korea (NIBRPR0000111071).

Subclass Hypotrichia Stein, 1859
Order Euplotida Small and Lynn, 1985
Suborder Euplotina Jankowski, 1979
Family Certesiidae Borror and Hill, 1995
Genus *Certesia* Fabre-Domergue, 1885

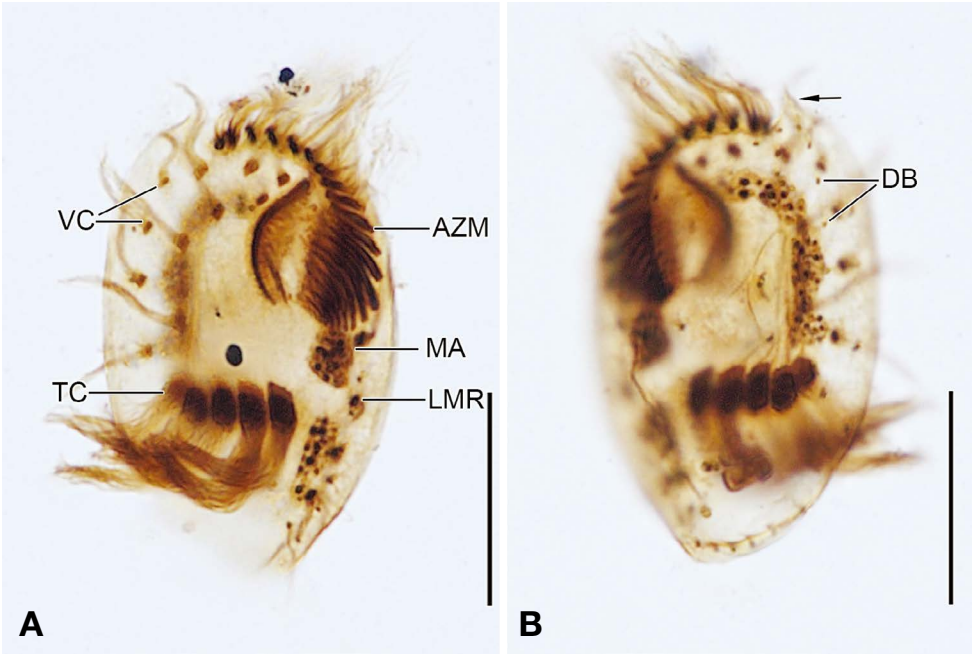


**Fig. 4.** *Certesia quadrinucleata* after protargol impregnation. A, B, Ventral and dorsal view showing the body shape, the spine-like projection on right side of anterior end (arrow), the ventral and dorsal ciliature, and the nuclear apparatus. AZM, adoral zone of membranelles; DB, dorsal bristles; LMR, left marginal row; MA, macronuclear nodule; TC, transverse cirri; VC, ventral cirri. Scale bars 20 μm.

### 4. *Certesia quadrinucleata* Fabre-Domergue, 1885 (Fig. 4)

**Material examined.** Marine water collected from Gyeongpo Lake, Gangmun-dong, Gangneung-si, Gangwon-do, Korea (37°47′55″N, 128°54′59″E) on February 11, 2020.
**Diagnosis.** Size 40−50 × 25−30 μm after protargol impregnation (n = 5); body ovoid with a spine like projection on right margin of anterior end; invariably 4 ellipsoidal macronuclear nodules connected by short funiculus; adoral zone of membranelles occupies about 40% of body length and composed of 19−20 membranelles; 10 or 11 frontoventral cirri, invariably 5 transverse cirri; left marginal row with 4−5 cirri; 5−6 dorsal kineties; caudal cirri lacking.
**World distribution.** China, France, Germany, Japan, USA, South Korea.
**Remarks.** The Korean population of *Certesia quadrinucleata* is most similar to the Japanese population described by Hu (2013). Also, these two populations agree with other previously described populations but they are significantly smaller (40−50 × 25−30 μm in the Korean population and 40−75 × 20−40 μm in the Japanese population vs. 66−92 × 44−68 μm in Chinese population, 75−80 μm in French population, 70−100 μm in German population, and 54−78 × 34−53 μm in USA population) (Fabre-Domergue, 1885; Kahl, 1932; Wicklow, 1983). *Certesia quadrinucleata* is unique among the euplotid ciliates in having a left marginal row and the lack of caudal cirri, thus in their revision of the order Euplotida, Borror and Hill (1995) established the new family Certesiidae for the monotypic genus *Certesia*.
**Voucher slides.** One slide with protargol-impregnated specimens was deposited at the National Institute of Biological Resources, Korea (NIBRPR0000110840).

Class Nassophorea Small and Lynn, 1981
Order Synhymeniida de Puytorac *et al*. in Deroux, 1978
Family Scaphidiodontidae Deroux in Corliss, 1979
Genus *Chilodontopsis* Blochmann, 1895

### 5. *Chilodontopsis depressa* (Perty, 1852) Blochmann, 1895 (Fig. 5)

**Material examined.** Water sample from a temporary puddle from Baugil, Gangneung-Wonju National University, Jibyeon-dong, Gangneung-si, Gangwon-do, Korea (37°46′30.30″N, 128°51′46″E) on May 18, 2021.
**Diagnosis.** Size about 100 × 45 μm in vivo and 65−80 × 25−30 μm after protargol impregnation (n = 7); body ellipsoidal, length:width ratio about 3 : 1, dorsoventrally flattened; cortex studded with cortical granules between ciliary rows both in vivo and after protargol impregnation; macronucleus in mid-body and sometimes in posterior third of body, globular about 15 μm in diameter;

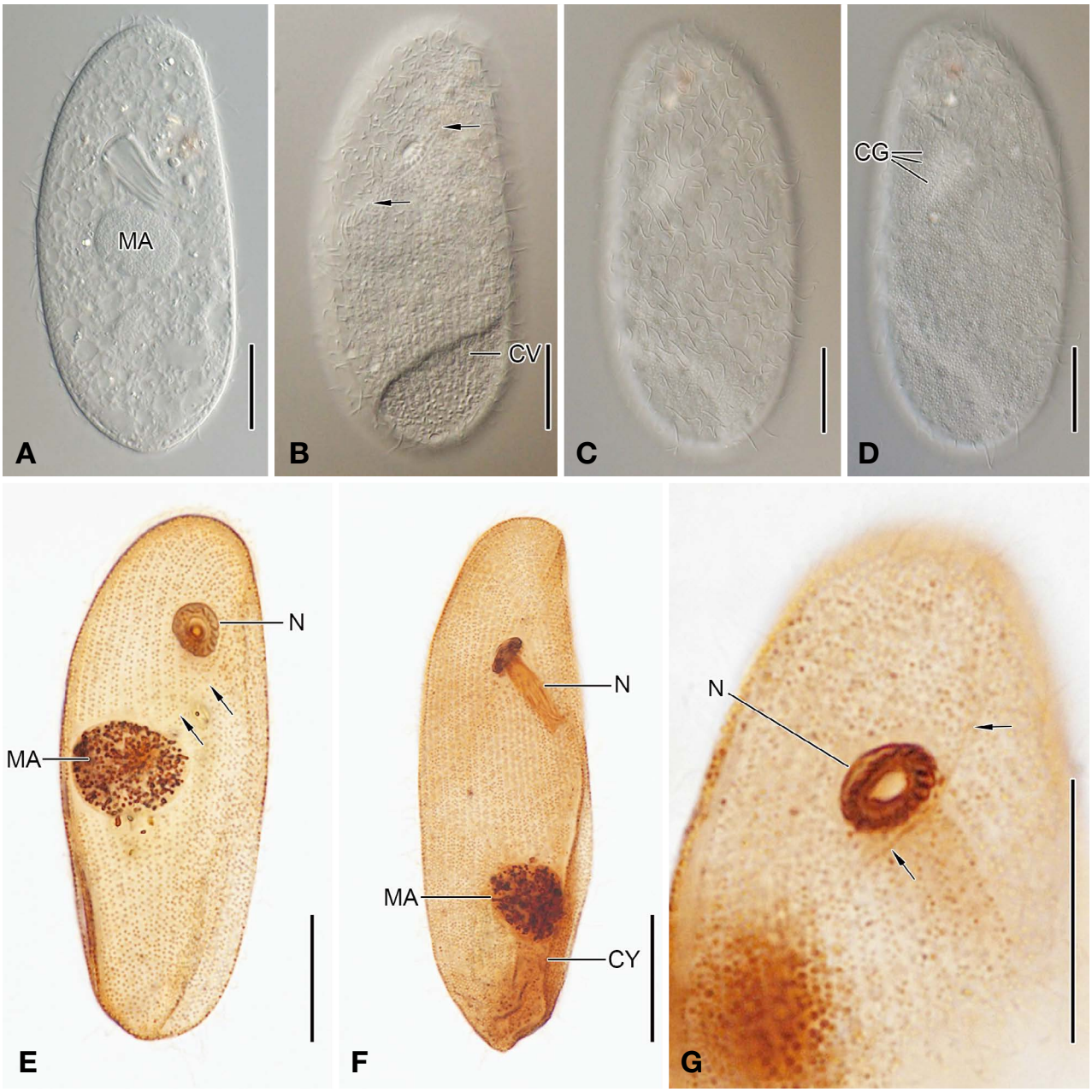


**Fig. 5.** *Chilodontopsis depressa* in life (A–D) and after protargol impregnation (E–G). A–D, Ventral (A, B) and dorsal (C, D) views, showing the body shape, the cyrtos in anterior body half, the macronucleus in mid-body, the cortical granules, and the oblique synhymenium (arrows). E, F, Ventral views showing the body shape, the nuclear apparatus either in mid-body or in posterior third of body. Arrows denote the synhymenium. Note the cortex is covered with impregnated cortical granules between somatic kineties. G, Ventral view showing the cyrtos, which consists of about 14 nematodesmal rods. Arrows indicate the synhymenium. CG, cortical granules; CV, contractile vacuole; CY, cytopyge; MA, macronucleus; N, nematodesmal rods. Scale bars 20 μm.

contractile vacuole very large in posterior ventral portion of body; cyrtos in anterior third of body and consists of about 14 nematodesmal rods; synhymenium running obliquely on ventral side, composed of about 30 dikinetids; 30–40 somatic ciliary rows.

**Distribution.** Austria, Brazil, Chile, Germany, South Korea.

**Remarks.** The Korean population of *Chilodontopsis depressa* agrees with the description of Foissner *et al.* (1994) in almost all features. Up to date, 11 species are assigned to the genus *Chilodontopsis*, only five of them with known morphology (Wang *et al.*, 2012), i.e., *C.*

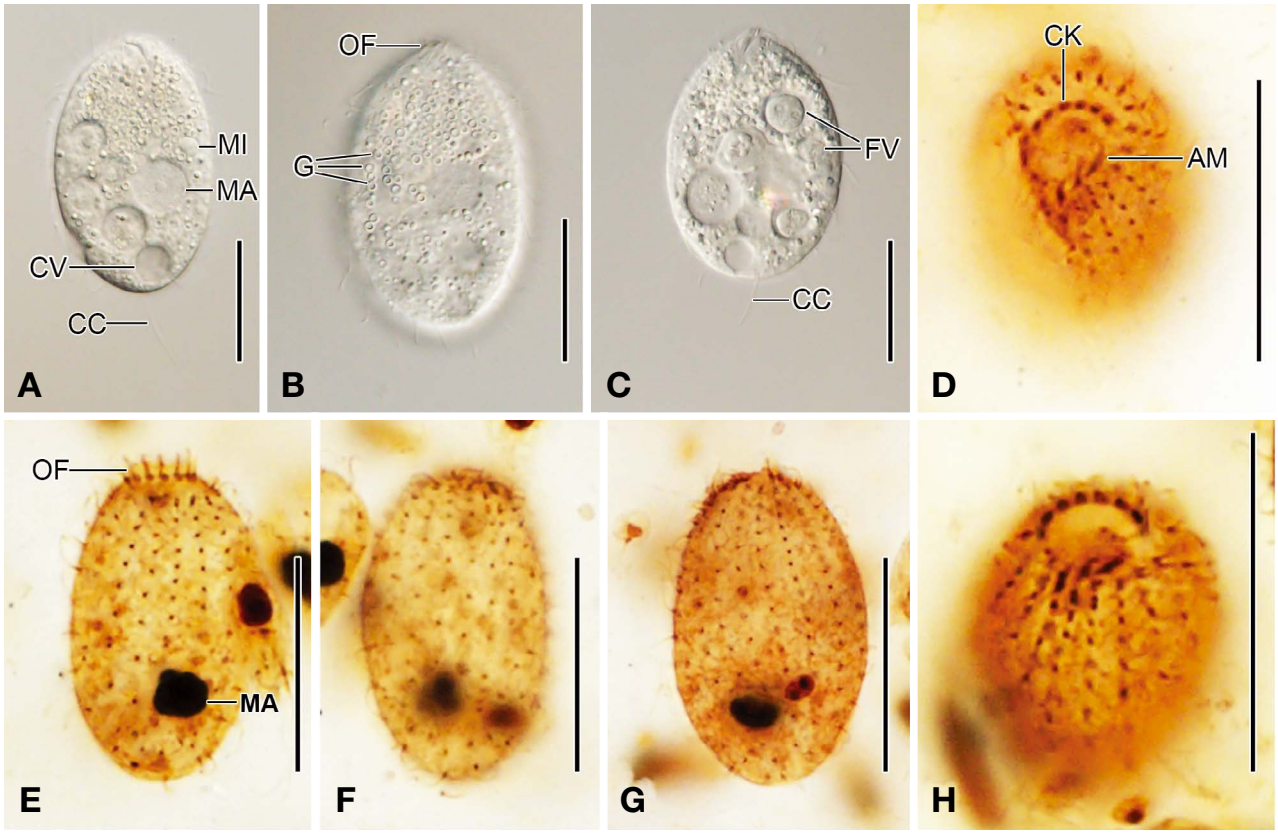


**Fig. 6.** *Plagiocampa rouxi* in life (A–C) and after protargol impregnation (D–H). A–C, Lateral views showing the ellipsoidal and obovate body shape, the cytoplasm studded with ring-shaped granules especially in anterior half, the nuclear apparatus, the oral flaps surrounding the oral opening, the single caudal cilium, and the posteriorly located contractile vacuole. D, H, Apical views showing the circumoral kinety consisting of dikinetids and the brosse consisting of three adoral membranelles. E–G, Dorsal (E) and lateral (F, G) views showing the somatic ciliature and the nuclear apparatus. AM, adoral membranelles (brosse); CC, caudal cilium; CK, circumoral kinety; CV, contractile vacuole; FV, food vacuoles; G. cytoplasmic granules; MA, macronucleus; MI, micronucleus; OF, oral flaps. Scale bars 20 μm.

*Depressa*; *C. kurensis* Alekperov, 1985; *C. muscorum* Kahl, 1931; *C. simplex* Ozaki and Yagiu, 1941; and *C. vermiformis* Deroux, 1978 (Kahl, 1931; Ozaki and Yagiu, 1941; Deroux, 1978; Alekperov, 1985). *Chilodontopsis depressa* is most similar to *C. muscorum* but they differ mainly in the body shape (ellipsoidal vs. oval), the size of macronucleus (~15 μm vs. 10 × 5 μm), and the number of somatic kineties (30–40 vs. ~21) (Foissner, 1984). Also, *C. depressa* differs from *C. simplex*, which was described in details by Wang *et al*. (2012), in the smaller body size (65–80 × 25–30 μm vs. 90–160 × 45–95 μm), the body shape (ellipdoidal vs. oval), the smaller macronucleus (15 × 15 μm vs. 25–55 × 20–40 μm), the lower number of somatic kineties (30–40 vs. 59–78), and the dikinetids in the synhymenium (~30 vs. 45–90) (Wang *et al*., 2012).

**Voucher slides.** One slide with protargol-impregnated specimens was deposited at National Institute of Biological Resources, Korea (NIBRPR0000111063).

Class Prostomatea Schewiakoff, 1896
Order Prorodontida Corliss, 1974
Family Plagiocampidae Kahl, 1926
Genus *Plagiocampa* Schewiakoff, 1893

### 6. *Plagiocampa rouxi* Kahl, 1926 (Fig. 6)

**Material examined.** Water sample collected from a temporary puddle from Baugil, Gangneung-Wonju National University, Jibyeon-dong, Gangneung-si, Gangwon-do, Korea (37°46′28″N, 128°51′54.20″E) on June 4, 2021.

**Diagnosis.** Size 35–45 × 20–25 μm in vivo and 25–32 × 18–22 μm after protargol impregnation (n = 11); body obovate to ellipsoid with posterior end more broadly rounded than anterior end; single globular macronucleus about 8 μm in diameter, with a single or several nucleoli, in or posterior to mid-body, micronucleus spherical, about 2 μm in diameter and near or attached to macronucleus; cytoplasm studded with ring-shaped, colorless granules especially in anterior half of body; contractile vacuole in posterior body end; 18 or 19 so-

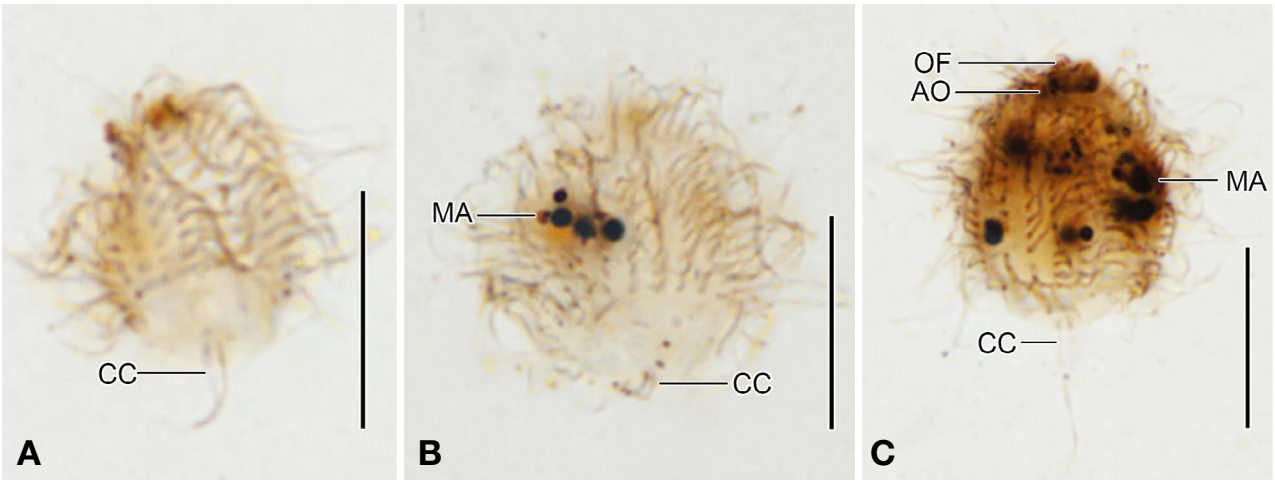


**Fig. 7.** *Urotricha furcata* after protargol impregnation. A–C, Ventral (A), posterolateral (B), and dorsal (C) view, showing the body shape, the posteriorly shortened ciliary rows, the non-ciliated posterior area with two caudal cilia, the nuclear apparatus, and the oral flaps surrounding the oral opening. AO, adoral organelles; CC, caudal cilia; MA, macronucleus; OF, oral flaps. Scale bars 10 μm.

matic ciliary rows; 15–18 kinetids in each somatic kinety; a single caudal cilium up to 18 μm long in vivo; oral opening in center of anterior pole surrounded by 7–10 dikinetids (circumoral kinety), each dikinetid associated with an oral flap about 2 μm long in vivo; 3 adoral membranelles (brosse).

**Distribution.** Cosmopolitan.

**Remarks.** The Korean population of *Plagiocampa rouxi* is very similar to the three populations described by Foissner (1978; 1984; 2016). *Plagiocampa rouxi* was described several times and show some variations especially in the number of somatic kineties, i.e., 17–18 (Foissner, 1978), 13–16 (Foissner, 1984), and 13–15 (Foissner, 2016). The most similar species to *P. rouxi* is *P. difficilis* Foissner, 1981. However, *P. difficilis* is smaller than *P. rouxi* and has fewer circumoral dikinetids. Foissner (2016) suggests that *P. difficilis* could be a junior synonym of *P. rouxi* (Foissner, 1981).

**Voucher slides.** One slide with protargol-impregnated specimens was deposited at the National Institute of Biological Resources, Korea (NIBRPR0000111069).

Family Urotrichidae Small and Lynn, 1985
Genus *Urotricha* Claparède and Lachmann, 1859

### 7. *Urotricha furcata* Schewiakoff, 1892 (Fig. 7)

**Material examined.** Slightly saline fresh water (salinity 0.4‰) collected from Gyeongpo Stream, Unjeong-dong, Gangneung-si, Gangwon-do, Korea (37°47′20.02″N, 128°54′34.47″E) on April 12, 2018.

**Diagnosis.** Size 11–16 × 8–12 μm after protargol impregnation (n = 5); body broadly ellipsoidal to ovate, length:width ratio 1.3–1.5 : 1; macronucleus globular, about 5 μm in diameter, located in body center, micronucleus globular, about 2 μm in diameter, attached to macronucleus; 22–23 somatic ciliary rows, each kinety consists of about 12 dikinetids, kineties distinctly shortened posteriorly leaving a barren area with only 2 elongated caudal cilia in center of posterior end, each about half to two thirds of body length; adoral organelles inconspicuous in preparations because very small; oral opening surrounded by oral flaps 1–3 μm long each.

**Distribution.** Austria, Chile, Czech Republic, Ethiopia, France, Germany, Hungary, Iceland, Italy, Norway, Poland, Romania, Slovakia, Spain, Sweden, Switzerland, South Korea.

**Remarks.** The Korean population of *Urotricha furcata* agrees with the populations described by Foissner *et al*. (1994) and Frantal *et al*. (2022) in most features. The size of *U. furcata* distinctly shrinks after protargol impregnation and makes the observation of adoral organelles difficult (Frantal *et al*., 2022; present study). Members of the genus *Urotricha* can be distinguished by the number of the caudal cilia. *Urotricha furcata* belongs to the group with 2 caudal cilia, which contains *U. macrostoma* and *U. pseudofurcata*. However, *U. furcata* can be distinguished from both species in the absence (vs. presence) of extrusomes. Also, *U. pseudofurcata* is cylindrical while *U. furcata* is broadly ellipsoidal. *Urotricha macrostoma* can also be distinguished from *U. furcata* in the larger body size (30–40 vs. 20–30 μm in vivo) (Foissner *et al*., 1994; 1999; Krainer, 1995; Frantal *et al*., 2022).

**Voucher slides.** One slide with protargol-impregnated specimens was deposited at the National Institute of Biological Resources, Korea (NIBRPR0000110844).

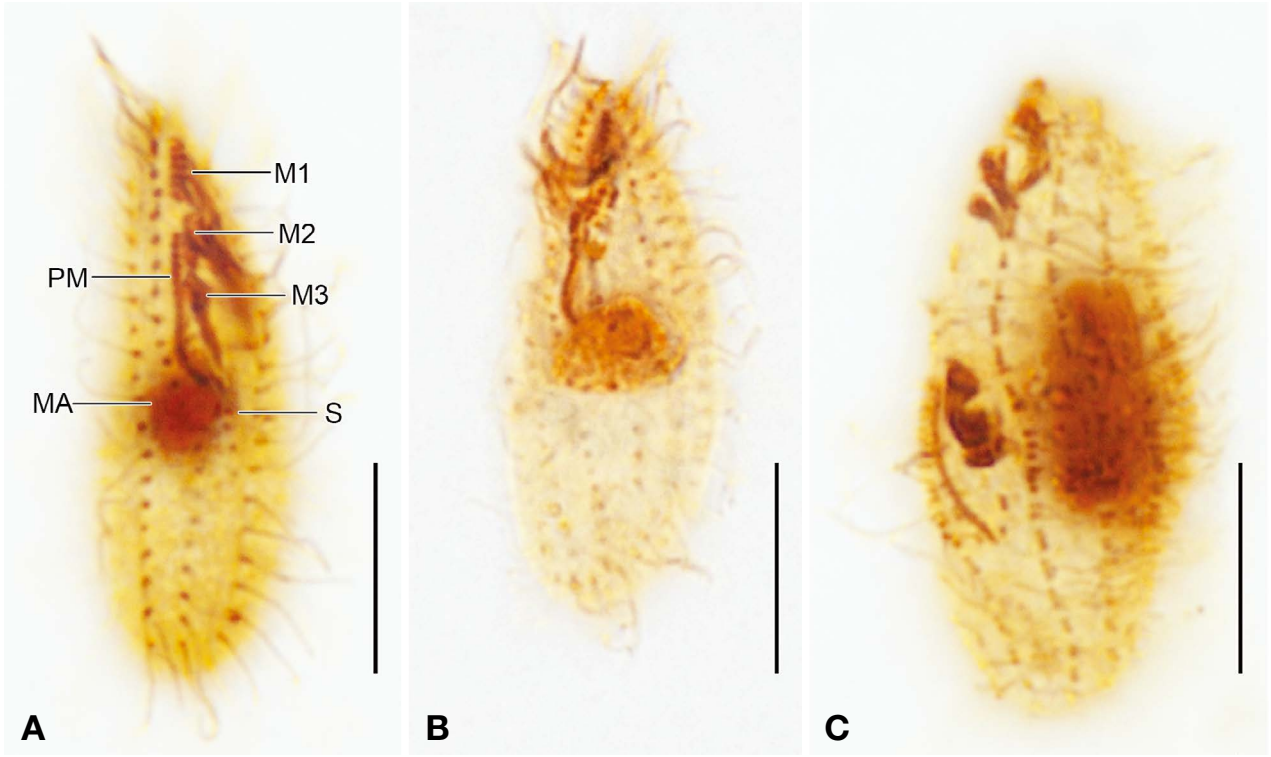


**Fig. 8.** *Metanophrys similis* after protargol impregnation. A, B, Ventral views showing the arrangement and structure of oral membranelles, membranelle 1 with three rows of basal bodies, paroral commences at level of half of membranelle 2, and the scutica. C, A dividing cell showing the three membranelles in both daughter cells. M1−3, oral membranelles; MA, macronucleus; PM, paroral membrane; S, scutica. Scale bars 10 μm.

Class Oligohymenophorea de Puytorac *et al*., 1974
Subclass Scuticociliatia Small, 1967
Order Philasterida Small, 1967
Family Orchitophryidae Cépède, 1910
Genus *Metanophrys* de Puytorac *et al*., 1974

**8. *Metanophrys similis* Song *et al*., 2002a (Fig. 8)**

**Material examined.** Marine water (salinity 33‰) collected from Uihang Beach, Sowon-myeon, Taean-gun, Chungcheongnam-do, Korea (36°50′26.3″N, 126°10′16.9″E) on August 11, 2021.
**Diagnosis.** Size 25−35 × 10−15 μm after protargol impregnation (n = 8); body elongated ovate with rounded ends, anterior end distinctly narrower than posterior; macronucleus globular, in mid-body, about 5 μm in diameter; 12−13 ciliary rows; scutica consists of few basal bodies arranged in a short row; membranelle 1 consists of 3 longitudinal rows and as long as membranelle 2, paroral membrane extends anteriorly to mid-level of membranelle 2; length of buccal field about 40% of body length.
**Distribution.** China, South Korea.
**Remarks.** The Korean population of *Metanophrys similis* is similar to the type population described by Song *et al*. (2002a) and to another Chinese population described by Pan *et al*. (2016) in most features. However, the somatic kineties number of the Korean population slightly differs from the Chinese populations (12−13 vs. invariably 12 or 11−12). *Metanophrys similis* differs from other congeners in the number of rows in M1 (3 vs. 2). Also, it differs from *M. sinensis* in the number of somatic kineties (11−13 vs. 10 or 11) and also differs from *M. carcini* in the length of the buccal field (40% vs. 25−33%) (Song and Wilbert, 2000; Song *et al*., 2002a; Pan *et al*., 2016). Further, it can be distinguished from *M. orientalis* in the number of rows in M1 (3 vs. 2) (Pan *et al*., 2013a). The genera *Metanophrys*, *Mesanophrys*, and *Paramesanophrys* look very similar to each other, however they can be distinguished only by the structure of membranelle 2 (two-rowed in *Metanophrys* vs. more than two rows in *Mesanophrys* vs. granulated in *Parametanophrys*) (Pan *et al*., 2016).
**Voucher slides.** One slide with protargol-impregnated specimens was deposited at the National Institute of Biological Resources, Korea (NIBRPR0000111068).

Family Uronematidae Thompson, 1964
Genus *Uronema* Dujardin, 1841

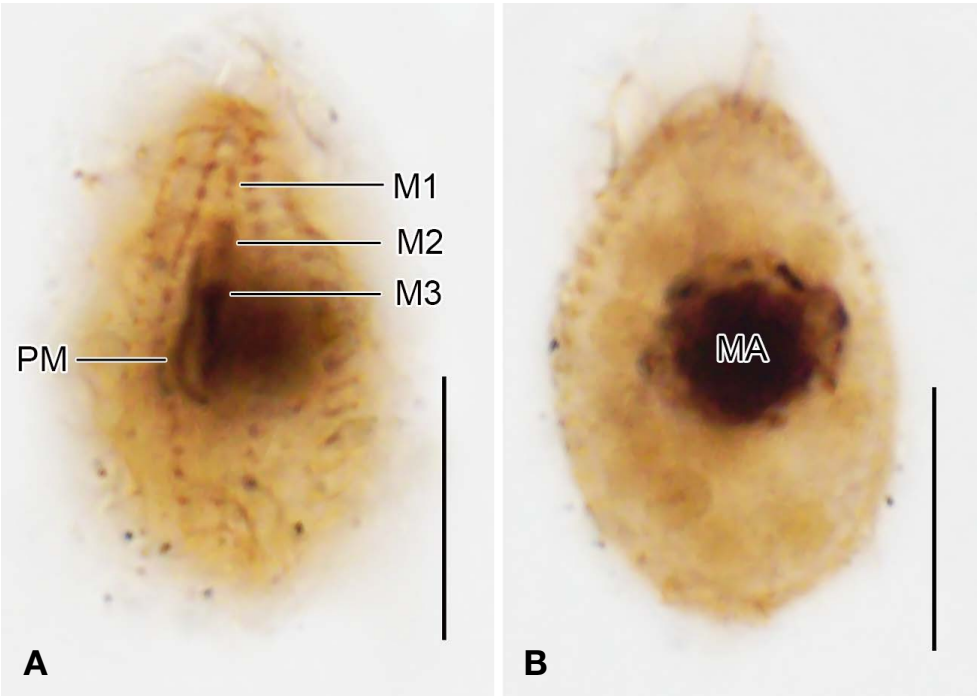


**Fig. 9.** *Uronema gallicum* after protargol impregnation. Ventral (A) and dorsal (B) view showing the body shape, membranelle 1 consists of a single row of basal bodies, oral apparatus extends to about 2/3 of body length. M1–3, oral membranelles; MA, macronucleus; PM, paroral membrane. Scale bars 10 μm.

**9. *Uronema gallicum* Pérez-Uz and Song, 1995 (Fig. 9)**

**Material examined.** Marine water (salinity 30.0‰) collected from Goha island, Dal-dong, Mokpo-si, Jeollanam-do, Korea (34°46′15″N, 126°21′32″E) on December 2, 2019.
**Diagnosis.** Size 24–26 × 8–10 μm after protargol impregnation (n = 7); body ovate with broadly rounded posterior end, anterior end narrower than posterior; macronucleus ellipsoidal to globular, in mid-body, about 5 μm in diameter; 14–15 somatic ciliary rows, each consists of dikinetids anteriorly and monokinetids posteriorly, somatic kinety 1 as long as other kineties, almost reaches posterior body end; caudal cilium about 10 μm long after protargol impregnation; buccal apparatus extend to about 2/3 of cell length, consists of three membranelles, membranelle 1 single-rowed, membranelle 2 with two rows.
**Distribution.** France, South Korea.
**Remarks.** The Korean population of *Uronema gallicum* agrees with the type population described from France in most features (Pérez-Uz and Song, 1995). *Uronema gallicum* can be easily distinguished from other congeners by the position of the oral apparatus, i.e., in the middle third of body vs. anterior to mid-body. Somatic kinety 1 of *U. gallicum* is similar to that of *U. marinum* in that it extends to posterior body end and both differ from *U. nigricans*, which has kinety 1 shortened posteriorly (Pérez-Uz and Song, 1995; Song *et al*., 2009; Liu *et al*., 2017).
**Voucher slides.** One slide with protargol-impregnated specimens was deposited at the National Institute of Biological Resources, Korea (NIBRPR0000110843).

Order Pleuronematida Faure-Fremiet in Corliss, 1956
Family Cyclidiidae Ehrenberg, 1838
Genus *Protocyclidium* Alekperov, 1993

**10. *Protocyclidium citrullus* (Cohn, 1866) Foissner *et al*., 2002 (Fig. 10)**

**Material examined.** Slightly saline fresh water (salinity 0.4‰) collected from Gyeongpo Stream, Unjeong-dong, Gangneung-si, Gangwon-do, Korea (37°47′20.02″N, 128°54′34.47″E) on April 12, 2018.
**Diagnosis.** Size 18–21 × 9–11 μm after protargol impregnation (n = 6); body ellipsoidal, length : width ratio 2 : 1; macronucleus in anterior portion of cell, globular with small nucleoli, about 5 μm in diameter, micronucleus inconspicuous; 13–15 somatic ciliary rows, each consists of dikinetids in anterior half of body, monokinetids in third quarter, and shortened posteriorly, kinety n-1 with a condensation of 6 or 7 monokinetids posteriorly at level of end of oral apparatus, cilia about 7 μm long, a single caudal cilium about 15 μm long after protargol impregnation; oral apparatus extends to about 2/3

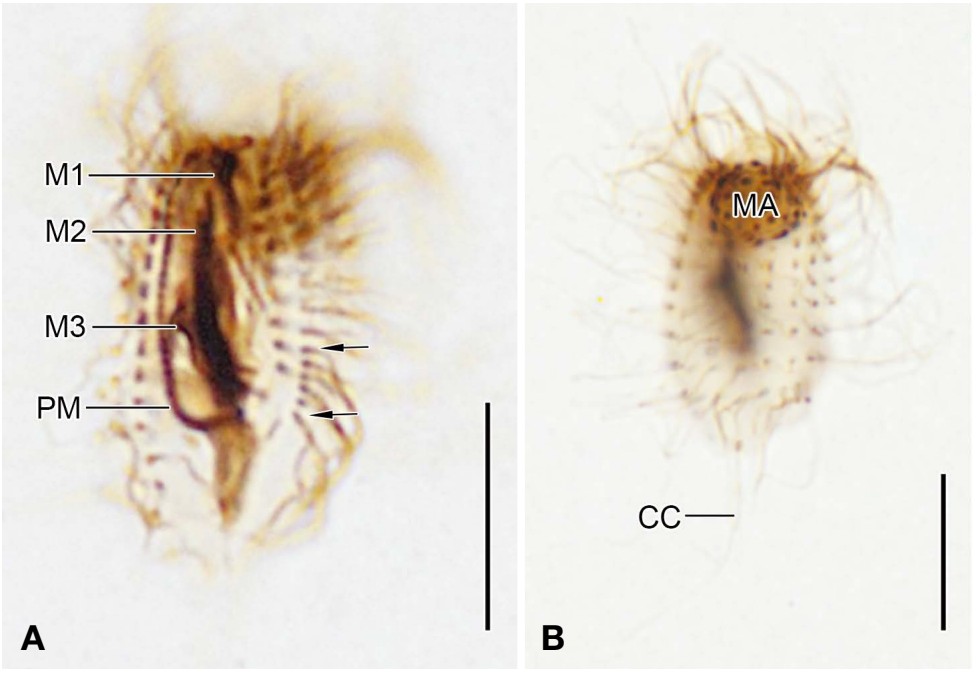


**Fig. 10.** *Protocyclidium citrullus* after protargol impregnation. A, Ventral view showing the oral apparatus and the ventral infraciliature. Arrows denote the condensation of about 6 ciliated kinetids at the end of the shortened kinety n-1. B, Dorsal view showing the dorsal infraciliature. CC, caudal cilium; M1−3, oral membranelles; MA, macronucleus; PM, paroral membrane. Scale bars 10 μm.

of body length; paroral hook-like, extends anteriorly to beginning of adoral membranelle 1; membranelle 1 consists of few basal bodies, membranelles 2 and 3 hardly distinguishable.

**Distribution.** Cosmopolitan.

**Remarks.** The Korean population of *Protocyclidium citrullus* agrees with the descriptions of Czapik (1963), Wilbert (1995), and Esteban *et al*. (2000) in most features. The four populations share the body size, the number of somatic kineties. On the other hand, the condensation of basal bodies in the end of kinety n-1 was described in all populations except that of Czapik (1963). However, *P. citrullus* is unique among congeners in having a condensation of kinetids in posterior end of the significantly shortened kinety n-1 (i.e., terminates posteriorly at the cytostome level). The overall morphology of *P. citrullus* is also similar to *Cyclidium glaucoma* but they can be distinguished by the arrangement of membranelles 2 and 3 (indistinguishable vs. separated), the number of somatic ciliary rows (14−16 vs. about 10), the length of the somatic kinety n-1 (shortened posteriorly vs. extends to caudal area), and the presence (vs. absence) of the ciliary condensation in somatic kinety n-1 (Foissner, 1996; Foissner *et al*., 2002; Song and Wilbert, 2002; Kim *et al*., 2020).

**Voucher slides.** One slide with protargol-impregnated specimens was deposited at the National Institute of Biological Resources, Korea (NIBRPR0000110841).

## Acknowledgements

This study was supported by grants from the National Institute of Biological Resources (NIBR) funded by the Ministry of Environment (MOE) of the Republic of Korea (NIBR202002204, NIBR202102203, NIBR202333201).

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*Submitted: August 8, 2022*
*Accepted: November 23, 2022*