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New records of freshwater algae from Korea II

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This study summarizes the distribution and taxonomic description about 26 taxa of the freshwater algae recorded for the first time in Korea collected from several swamps, reservoir and mountainous wetlands in the South Korea from 2014 to 2024. These algae classified into 3 taxa of Cyanophyceae, 1 taxon of Chlorophyceae, 13 taxa of Conjugatophyceae, 4 taxa of Euglenophyceae, 1 taxa of Raphidophyceae, 1 taxon of Dinophyceae, 2 taxon of Chrysophyceae and 1 taxon of Xanthophyceae. Among these, 3 genera of *Merotricha* of Raphidophyceae, *Ammatoidea* of Cyanophyceae and *Mischococcus* of Xanthophyceae were newly recorded in the Korean freshwater algal flora.

Keywords: algal flora, *Ammatoidea*, freshwater algae, *Merotricha*, *Mischococcus*, new record in Korea

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Introduction

Since Kawamura (1918) reported a species of *Centritractus* (Xanthophyceae) at lake Seoho, Suwon, total 6,653 taxa of algae have been described from various water bodies all over Korea (Kim, 2015; 2018; Lee and Joh, 2015; Lee and Kim, 2015a; Lee and Kim, 2015b; Kim and Kim, 2017; Kim and Lee, 2022; National Institute of Biological Resources, 2023). Of these, about 4,100 taxa have been reported as freshwater algae, which are composed of diatoms (33.1%), charophytes (24.2%), chlorophytes (17.2%), euglenophytes (9.2%), cyanobacteria (8.7%), heterokontophytes (5.3%), dinophytes (1.7%) and other taxa (0.6%) (Nakdonggang National Institute of Biological Resources, 2024). The recorded algal species from Korea is only less than 10 % of estimated 72,500 algal species worldwide (Guiry and Guiry, 2024). Also, 60–70% of some algal groups are cosmopolitan or world-widely distributed, whereas 30–40% are distributed in endemic or restricted to particular regions (Coesel, 1996; Kristiansen and Lind, 2005), although it may be hard to generalize to all of the algal species. In this light, it is presumed that there are more freshwater algae growing in Korea that have not been reported yet.

Recently, the importance of biological diversity has been increasing emphasized, with the discovery of indigenous species as biological resources recognized as an urgent national task to secure biological sovereignty.

Therefore, this make it all the more important to carry out continuous and detailed investigations of freshwater algae on diverse wetlands environments across the country including unique environments such as highland wetlands, mountain sphagnum bogs, lagoons and craters (orum) as well as lowland reservoirs, swamp and pond.

Various samples from various water bodies throughout the country were collected and thoroughly investigated. In

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the present study, 3 genera and 26 taxa of freshwater algae are reported for the first time in Korea.

Materials and Methods

Samples were collected from 18 different regions including mountainous wetlands, volcanic lakes (orum), lowland swamps, old reservoirs and pond from 2014 to 2024 (Table 1). The materials were obtained by means of plankton net (mesh size 20 μm), spuit or by squeezing submerged macrophytes, and living materials were immediately examined. After first examination living materials, they were preserved in 5% formalin solution for permanent preservation and detail identification. Microscopic examinations were made at magnification ×400−×630 using a Zeiss Microscope (Axio Imager. A2) and photographs were taken with a AxioCam HRC camera (Zeiss). pH and conductivity were measured in the field by means of a HI8314 membrane pH meter and a HI9835 EC meter (HANNA instruments, USA). All the taxa reported in the present study are illustrated with photomicrographs. The materials are deposited in the Department of Biology, Kyungpook National University.

Results and Discussion

Cyanobacteria
Cyanophyceae
Oscillatoriales
Microcoleaceae (Phormidiaceae, Microcoleoideae)

***Ammatoidea sinensis* Ley 1944 (Fig. 1A, B)**

Reference. Chu 2007, p. 66, pl. 15, fig. 4; Komárek & Anagnostidis 2008, p. 552, fig. 830.
Occurrence. Imdang weir (April 23, 2016).

Filaments isopolar, curved like arch-shaped, 13−14 μm wide in the middle part, gradually attenuated towards ends, with terminate in hair-like; trichomes not constricted at cross-walls, 8−10 μm wide in central parts, 2−4 μm long, gradually tapering towards ends, cells at terminal part longer than wide; sheath thin, colourless; hormogonia arise from central parts of trichomes.

Nostocales
Nodulariaceae

***Nodularia moravica* Hindák, Smarda & Komárek 2003 (Fig. 1C, D)**

Reference. Komárek 2013, p. 914, fig. 1187.
Occurrence. Taein reservoir (April 17, 2024).

Filaments solitary or in mucilaginous, microscopic to macroscopic mats on the substrate; individual filament 8−15 μm wide, parallel arranged or entangled. Trichomes cylindrical, constricted at the cross-walls, not attenuated towards ends. Sheath cylindrical, thin, colourless, open at both ends. Cells short barrel-shaped, always shorter than wide, with homogeneous content, without gas vesicles, blue-green, sometimes slightly granulated. Trichomes with intercalary regular distances heterocysts, occasionally

Table 1. Informations of sampling sites.

Sampling sites	Longitude/Latitude	Characteristic of sampling site	pH	EC (μS/cm)	Alt. (m)	Sampling date
Mulyoungari-orum	126°41′36″E, 33°22′09″N	Oligotrophic caldera lake	5.6	36.1	479	2015.7.17
Muljangal-orum	126°36′25″E, 33°24′28″N	Oligotrophic caldera lake	6.7	22.0	886	2015.7.17
1100m wetland	126°21′27″E, 33°21′27″N	Oligotrophic *Sphagnum* bog	6.5	24.6	1097	2015.6.17
Sumeonmulbangdi	126°26′54″E, 33°21′50″N	Oligotrophic *Sphagnum* bog	5.4	47.0	981	2016.10.16
Dongbaekdongsan	126°42′55″E, 33°31′06″N	Oligotrophic shallow rock pond	6.1	54.7	99	2016.4.22
Udo Unnamed pond	126°57′12″E, 33°30′04″N	Mesotrophic shallow agricultural pond	7.1	55.1	29	2024.2.17
Taein reservoir	127°45′13″E, 34°57′08″N	Mesotrophic agricultural reservoir	7.6	110.4	5	2024.4.17
Hwaeomneup	129°05′56″E, 35°24′22″N	Oligotrophic *Sphagnum* bog	5.6	23.5	772	2016.7.17
Mujechineup	129°08′34″E, 35°27′37″N	Oligotrophic *Sphagnum* bog	5.8	25.3	545	2016.3.24
Sajapyeong wetland	128°59′23″E, 35°32′11″N	Oligotrophic *Sphagnum* bog	6.1	17.5	774	2018.11.19
Palgongsan wetland	128°34′46″E, 36°02′12″N	Old mountainous small reservoir	6.7	43.3	844	2014.7.22
Guryong reservoir	128°57′56″E, 35°50′07″N	Mesotrophic highland small reservoir	6.8	90.6	561	2016.3.13
Mochje	128°13′43″E, 35°36′38″N	Oligotrophic mountainous shallow pond	6.6	75.0	150	2016.4.22
Sangho	128°39′38″E, 38°05′06″N	Oligotrophic shallow lagoon	6.9	65.3	4	2016.4.22
Imdang weir	128°54′58″E, 35°42′20″N	Oligotrophic stream	7.1	75.0	100	2016.4.23
Jangcheok reservoir	128°29′05″E, 35°26′10″N	Old mesotrophic reservoir	7.5	125.0	30	2016.4.23
Geomdan-ecological wetland	128°37′33″E, 35°54′03″N	River side wetland	7.2	85.2	24	2014.7.22
Namsan reservoir	128°50′16″E, 35°46′44″N	Mesotrophic reservoir	7.5	91.4	84	2016.10.16

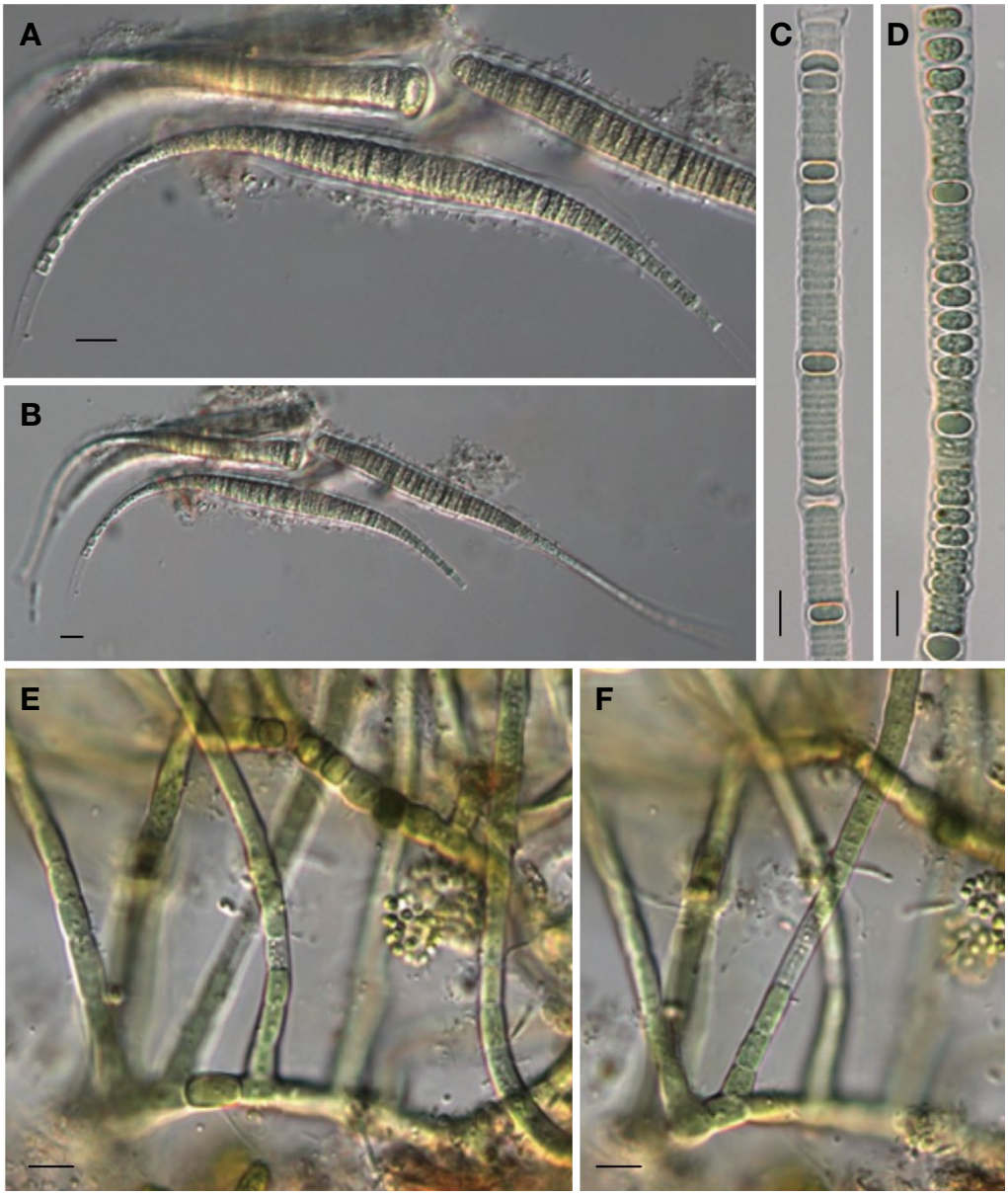

Fig. 1. A, B. *Ammatoidea sinensis*, C, D. *Nodularia moravica*, E, F. *Hapalosiphon hibernicus*. Scale bars = 10 μm.

in terminal position, solitary, shortly barrel-shaped, with greenish-yellowish, homogeneous content. Akinetes subspherical, in series, shorter than wide, with brownish granular content. Cells 8−11 μm in wide, 2−4(6) μm long, Heterocysts 8.5−11 μm in wide, 4−7 μm long, Akinetes 10−12 μm in wide, 6−8 μm long.

Hapalosiphonaceae

***Hapalosiphon hibernicus* West & G.S.West 1896 (Fig. 1E, F)**

Reference. Komárek 2013, p. 514, fig. 626.
Occurrence. 1,100 m wetland (July 17, 2015).

Filaments solitary among other algae or forming small clusters. Main axis with slightly bends and numerous narrower branches perpendicular to it. Main filament 7−10 μm in wide, branches 4.5−5.5 μm in wide; cells of the branches usually much longer than wide, typically 3−4 times, occasionally up to 8 times and sometimes almost resembling a multicellular hair. Akinete develops from several cells which from a common wall, which is thick and dark yellow-brown. Cells pale blue-green, cylindrical or very slightly barrel-shaped widened, 3−7.5 μm in wide, isometric, rarely shorter than wide; apical cells rounded, rarely slightly widened. Heterocysts intercalary, cylindrical, up to 5 times longer than wide, 3.8−6.6 μm.

Chlorophyta
Chlorophyceae
Chlamydomonadales
Chlamydomonadaceae

***Sphaerellopsis sphaerelloides* Pascher 1927 (Fig. 2A, B)**

Reference. Ettl 1983, p. 540, f. 782.
Occurrence. Mulyoungari-orum (March 25, 2015), Mochje (April 22, 2016).

Cells solitary, biflagellated, flat, broad ellipsoid, both ends rounded, covered with a broad hyaline envelop; protoplast narrow ellipsoid to spindle-shaped; cell wall smooth, flagella as long as cell length; chloroplast cup-shaped, with basal pyrenoid and without stigma; cells 17−19 μm in diameter, 28−30 μm long.

Charophyta
Conjugatophyceae
Desmidiales
Closteriaceae

***Closterium acutum* var. *variabile* (Lemmermann) W. Krieger 1935 (Fig. 2C, D)**

Reference. Coesel & Meesters 2007, p. 39, pl. 8, figs. 18, 19; Růžička 1977, p. 97, pl. 6, figs. 32−37; Prescott *et al*., 1975, p. 31, pl. 16, figs. 8−10.
Occurrence. Gasan-sanseung (July 22, 2014).

Cells slender, 10 to 36 times longer than wide, irregularly curved and mostly strongly curved (nearly semicircular), sometimes one semicell curved and the other nearly straight, sigmoid forms common; gradually tapering from the middle to ends; cells 2.5−6 μm in wide, 40−150 μm long.

Desmidiales
Desmidiaceae

***Cosmarium amoenum* var. *mediolaeve* Nordstedt 1887 (Fig. 2E−H)**

Reference. Coesel & Meesters 2007, p. 105, pl. 71, figs. 11-12; Prescott *et al*. 1981, p. 65, pl. 287, figs. 3, 11.
Occurrence. Sajapyeong wetland (November 19, 2018).

Cells medium sized, about 1.3 to 1.6 times longer than broad, moderately constricted in the middle, sinus narrowly open to almost closed; cell wall granulated, granules disposed in vertical and lateral series, just above the isthmus arranged in two transverse rows and the median part of the semicell face without granules; semicells subquadrate, lateral margins slightly convex and subparallel each other, apex straight to slightly convex, apical angles broadly rounded; side view of semicells ovate-oblong; vertical view of semicells broadly elliptic; cells 33−38 μm in broad, 50−55 μm long, isthmus 14−15 μm.

***Cosmarium quadratum* var. *willei* (Schmidle) W.Krieger & Gerloff 1969 (Fig. 2I, J)**
(Syn. *Cosmarium quadratum* f. *wellei* (Schmidle) West & G.S.West 1908)

Reference. Prescott *et al*. 1981, p. 261, pl. 293, figs. 6, 7.
Occurrence. Sajapyeong wetland (April 22, 2018).

Cells medium sized, about twice as long as broad, moderately constricted in the middle, sinus narrowly linear, almost closed; semicells subquadrate, lateral margins straight and parallel each other, apex straight to slightly convex, apical angles broadly rounded, basal angles rectangularly rounded; side view of semicells ovate; vertical view of semicells elliptic; cells 32−35 μm in broad, 55−60 μm long, isthmus 17−20 μm.

***Cosmarium quadratum* var. *minus* Förster 1965 (Fig. 2K, L)**

Reference. Yamagishi & Akiyama 1987, v. 11, p. 13.
Occurrence. Mujechi-neup (March 24, 2016), Hwaeomneup (July 17, 2019).

Cells medium sized, about 1.7−1.8 times longer than broad, moderately constricted in the middle, sinus narrowly linear and closed; semicells slightly pyramidal, lateral margins tapered to apex, apex retuse at the middle, basal angles mostly protruding and rounded; side view of semicells narrowly pyramidal; vertical view of semicells broadly elliptic; cell wall punctate; cells 23−29 μm in broad, 37−50 μm long, isthmus 10−12 μm.

***Cosmarium speciosum* f. *minus* Wille 1879 (Fig. 2M−P)**

Reference. West & West 1908, p. 251, pl. 89, figs. 8−10; Prescott *et al*. 1981, p. 289, pl. 272, fig. 6, pl. 273, fig. 4.
Occurrence. Sajapyeong wetland (April 22, 2018).

Cells medium sized, about 1.4−1.5 times longer than broad, moderately constricted in the middle, sinus narrowly linear and closed; semicells slightly pyramidal, lateral margins slightly tapered to apex and crenate, crenations 6, apex evidently truncate and 4 crenate, apical crenations 4, granulate within the margin, 3−4 granules in regular concentric and radial series, with 6−9 vertical series of granules just above the isthmus; vertical view of semicells elliptic; cells 22−23 μm in broad, 31−33 μm long, isthmus 11−13 μm. This variety differ from the typical in that the semicells rather more pyramidate, with the apex more evidently truncate and smaller size.

***Cosmarium turpinii* Brebisson 1856 (Fig. 3A−C)**

Reference. West & West 1908, p. 189, pl. 82, figs. 16−17, pl. 83, fig. 1; Prescott *et al*. 1981, p. 338, pl. 275, figs. 5, 7; Coesel & Meesters 2007, p. 148, pl. 78, fig. 1.
Occurrence. Imdang weir (May 01, 2017).

Cells medium sized, slightly longer than broad, very deep

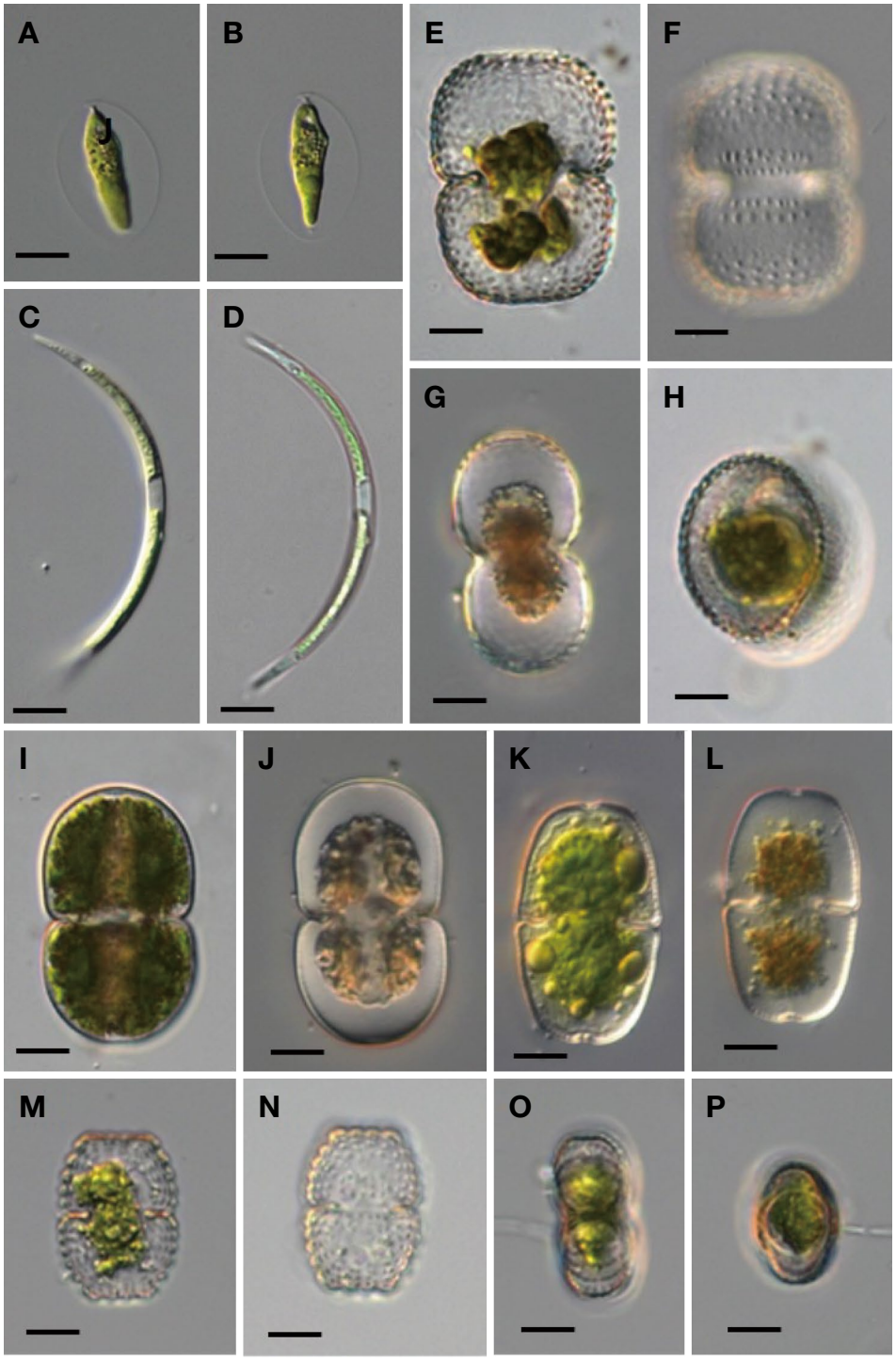

Fig. 2. A, B. *Sphaerellopsis sphaerelloides*, C, D. *Closterium acutum* var. *variabile*, E−H. *Cosmarium amoenum* var. *mediolaeve*, I, J. *Cosmarium quadratum* var. *willei*, K, L. *Cosmarium quadratum* var. *minus*, M−P. *Cosmarium speciosum* f. *minus*. Scale bars = 10 μm.

constricted in the middle, sinus narrowly linear, somewhat open outwards; semicells pyramidate to trapeziform, basal angles rounded, lateral margins slightly concave in the upper part, apical angles obtuse, apex straight to slightly retuse; cell wall with densely and regularly disposed granules, in the center of the semicells with a pair of closely adjacent tumours, each furnished with a group of verrucae; Just above the isthmus some transversal series of granules;

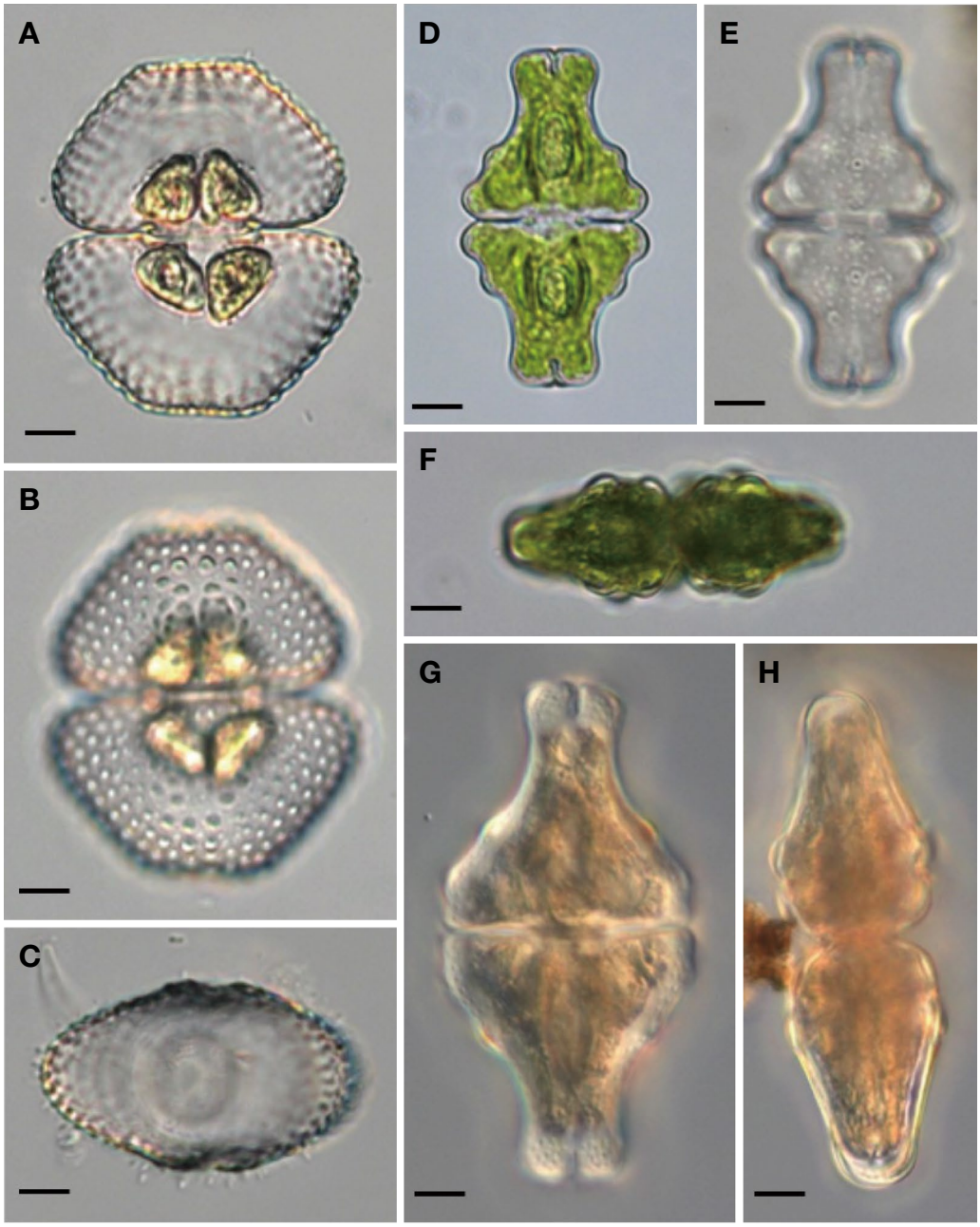

Fig. 3. A–C. *Cosmarium turpinii*, D–F, *Euastrum dedelta* var. *capitatum*, G, H. *Euastrum didelta* var. *japonicum*. Scale bars = 10 μm.

vertical view of semicells ellipsoid with a pair of adjacent granular tumours at the middle on either side; cells 50–66 μm in broad, 60–77 μm long, isthmus 12–14 μm.

***Euastrum didelta* var. *capitatum* (A.M.Scott & Prescott) Anissimova & Guiry 2021 (Fig. 3D–F)**
(Syn. *Euastrum sinuosum* var. *capitatum* A.M.Scott & Prescott 1961)

Reference. Yamagishi & Akiyama 1988, v. 8, p. 44.
Occurrence. Mulyoungari-orum (May 21, 2015), Muljangal-orum (May 21, 2015).

Cells medium sized, 1.7–1.9 times longer than broad, median constriction deep, sinus narrowly linear, somewhat delated extremity; semicells subtriangular, five lobed, polar lobe elongated, apex flat to slightly domed, with a deep and closed median incision; apical angles rounded, upper lateral lobes mamilate, lateral margins of lower lateral lobes divergent; sell wall with five protuberance, three transversely disposed at the base of semicells and two at the central part; between the central protuberances and isth-

mial protuberance a distinct mucilage pore; cells 35−40 μm in diameter, 56−70 μm long, isthmus 7−10 μm.

***Euastrum didelta* var. *japonicum* M.Hirano 1951 (Fig. 3G, H)**

Reference. Yamagishi & Akiyama 1986, v. 5, p. 33.
Occurrence. Sajapyeong wetland (September 17, 2018).

Cells large, about two times longer than broad, median constriction deep, sinus narrowly linear, somewhat delated extremity; semicells subpyramidate, polar lobe relatively short with parallel margins, apex truncately rounded to slightly domed, with a deep and closed median incision; lateral lobes trapeziform, lower lateral margins parallel and retuse at the middle; lateral view of semicells narrow pyramidate, lower lateral margins with two protrusions and broad rounded apex; semicells with a prominent protuberance just above and four more protuberances (two at the base and two near the centre); between the central protuberances usually a distinct mucilage pore; cells 55−60 μm in diameter, 110−115 μm long, isthmus 13−15 μm.

***Staurastrum botrophilum* Wolle 1881 (Fig. 4A−C)**

Reference. West & West 1912, p. 166, pl. 126, fig. 4; Prescott *et al*. 1982, p. 145, pl. 342, fig. 7; Coesel & Meesters 2013, p. 75, pl. 52, figs. 6−9.
Occurrence. Hwaeom-neup (Jun 16, 2016).

Cells medium sized, about as long as broad or slightly longer than broader, median constriction deep, sinus narrowly linear and slightly dilated extremity; semicell pyramidate-truncate, basal angles broadly rounded, lateral margins granular, subconvex, apex truncate and straight; cell wall with about 6 series of granules arranged in concentric around the angles; semicells in vertical view triangular, lateral margins slightly concave in the middle, angles broadly rounded; granules forming annular series around the lobes; cells 35−40 μm wide, 38−42 μm long, isthmus 10−11 μm.

***Staurastrum octodontum* var. *tetrodontum* Scott et Grönblad 1957 (Fig. 4D)**

Reference. Prescott *et al*. 1982, p. 263, pl. 403, fig. 9.
Occurrence. Udo unnamed pond (Feb. 17, 2024).

Cells small, about as long as broad or slightly longer than broader with processes, median constriction shallow, sinus open U-shaped in face view; semicells bowl-shaped, the extreme base of the semicells convex and with a single short spine, apical margin broadly concave, apical angles projected upward into a long nodulated process, tipped with three sharp spined, lateral margin with teeth along the midline; semicells in vertical view fusiform, angles extending into processes with spine margins; cells 28−34 μm wide, 33−36 μm long with processes, 10−13 μm long without processes, isthmus 4−5 μm.

***Staurodesmus brevispina* (Brebisson) Croasdale 1957 (Fig. 4E−G)**

(Syn. *Staurastrum brevispinum* Ralfs)

Reference. West & West 1912, p. 145, pl. 123, figs. 1−3; Coesel & Meesters 2007, p. 158, pl. 90, figs. 15−18; Prescott *et al*. 1982, p. 150, pl. 332, figs. 11, 16.
Occurrence. Imdang weir (May 01, 2017).

Cells medium sized, about as long as broad, median constriction deep, sinus open and acute-angled at the apex; semicells oblong-elliptic, ventral margin usually more convex than the dorsal margin, apex convex or subtruncate, lateral angles broadly rounded and furnished with a mucro or papilla; cell wall smooth; semicells in vertical view triangular, the sides concave, angles broadly rounded and furnished with a small mucro; cells 25−30 μm wide, 28−35 μm long, isthmus 8−10 μm.

***Xanthidium concinnum* W.Archer 1883 (Fig. 4H−K)**

Reference. West & West 1912, p. 86, pl. 112, fig. 10; Prescott *et al*. 1982, p. 61, pl. 310, fig. 24, pl. 312, fig. 7.
Occurrence. Mulyoungari-orum (May 21, 2015).

Cells small sized, about as broad as long, median constriction deep, sinus narrow and linear, acutely open outward; semicells transversely subhexagonal, apex truncate, lateral angles furnished with a single minute spine, apical angles furnished with a pair of minute spines; lateral view of semicell subcircular, with a small papilla at the middle on either side and a pair of minute spines at the apical margin; in the vertical view of semicells elliptic, with a prominent papilla on the middle on either side and with one minute spine at both poles; cell wall smooth; cells 10−12 μm in diameter without spines, 10−11 μm long, isthmus 3.5−4.5 μm.

***Xanthidium planum* (Roll) Coesel & Meesters 2023 (Fig. 4L, M)**

(Syn. *Xanthidium antilopaeum* var. *planum* Roll 1936)

Reference. Coesel & Meesters 2007, p. 153, pl. 83, figs. 4, 5; Prescott *et al*. 1982, p. 54, pl. 316, fig. 5.
Occurrence. 1,100 m wetland (May 21, 2015).

Cells medium sized, about as broad as long, median constriction deep, sinus shortly linear with a slightly dilated extremity, acutely open outward; semicells subelliptic-hexagonal, all the angles very slightly rounded, each of the four exposed angles furnished with a pair of simple, straight or slightly curved, fairly stout long spines, upper lateral margins and apex straight to slightly concave, central part of semicell thickened, round or elliptic, variously scrobiculated; lateral view of semicell circular or subcircular, with a slightly thickened at both side, and a pair of diverging spines on the apical margin; in vertical view of semicells elliptic, with a slight thickening at the middle on each side, and with a pair of slightly divergent spines on each

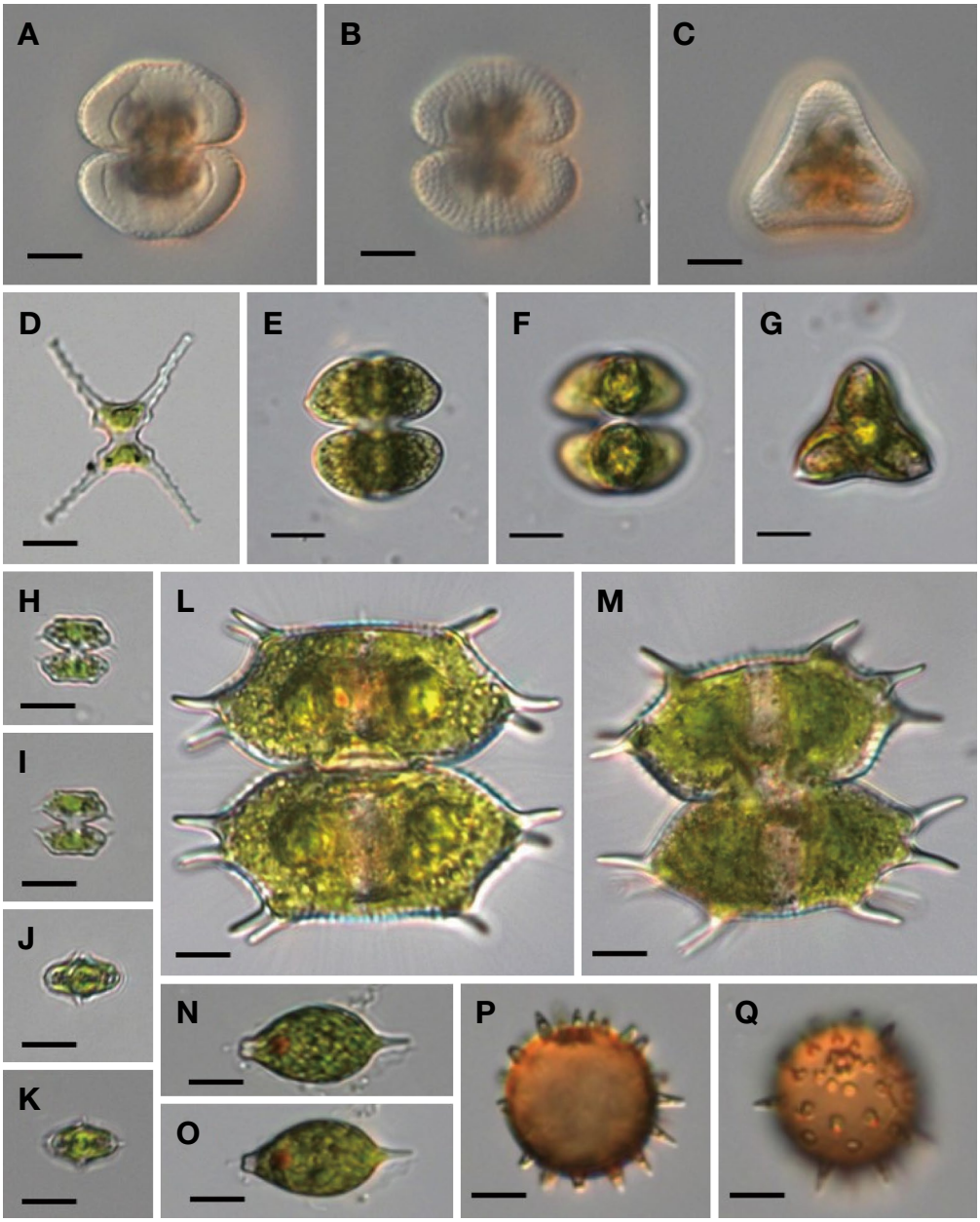

Fig. 4. A–C. *Staurastrum botrophilum*, D. *Staurastrum octodontum* var. *tetrodontum*, E–G. *Staurodesmus brevispina*, H–K. *Xanthidium concinnum*, L, M. *Xanthidium planum*, N, O. *Lepocinclis caudata* var. *wuhienweni*, P, Q. *Trachelomonas afra*. Scale bars = 10 μm.

polar margin; cell wall finely punctate; cells 48–55 μm in diameter without spines, 48–55 μm long, isthmus 15–17 μm, spines 8–10 μm long. This variety differs from the typical species in that the apical spines are widely more divergent as to form an angle of 100–135° with the apical margin of the semicell.

Euglenophyta
Euglenophyceae
Euglenales
Phacaceae

***Lepocinclis caudata* var. *wuhienweni* Chu 1935 (Fig. 4N, O)**

Reference. Yamagishi & Akiyama 1989, v. 10, p. 41.
Occurrence. Hwaeom-neup (March 25, 2016).

Cells spindle-shaped, anterior end narrowly produced, truncate and slightly bipapillated; posterior end projected into a long, straight, sometimes slightly curved cauda; periplasts spirally striated; paramylon bodies two, ring-like plate; cells 14–18 μm in diameter, 32–39 μm long with a cauda.

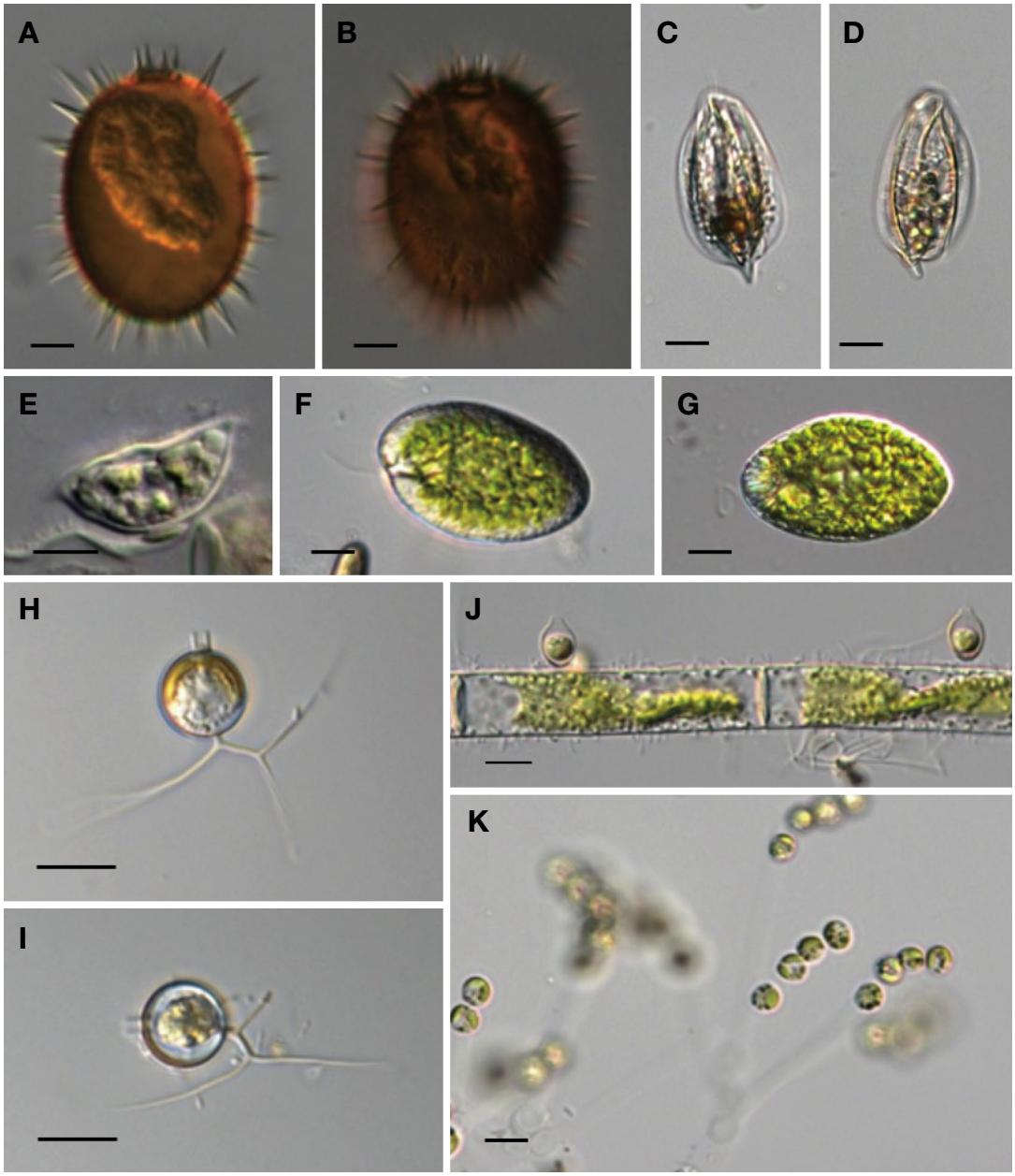

Fig. 5. A, B. *Trachelomonas megalacantha*, C, D. *Petalomonas platyrhyncha*, E. *Dinococcus oedogonii*, F, G. *Merotricha capitata*, H, I. *Chrysococcus furcatus*, J. *Chrysopyxis inaequalis*, K. *Mischococcus confervicola*. Scale bars = 10 μm.

Trachelomonas afra Rino 1981 (Fig. 4P, Q)

Reference. Yamagishi & Akiyama 1996, v. 16, p. 84.
Occurrence. Jangcheok reservoir (August 05, 2018).

Lorica spherical, brown in color; flagella apertures with a short cylindric collar having few short, blunt spines around the mouth; wall sparsely covered with short, stout, blunt spines having a clear dark-brown, transverse septa in the middle; lorica 24−28 μm in diameter, spines 4−6 μm long. This species is very similar to *Trachelomonas lismorensis* var. *mirabilis* Playfair in the shape of the lorica and stout spines covering the wall, but differs it in having the short cylindrical collar with short spines around the mouth.

Trachelomonas megalacantha A.M.Cunha 1914 (Fig. 5A, B)

Reference. Yamagishi & Akiyama 1988, v. 8, p. 90; Huber-Pestalozzi 1955, p. 307, fig. 579.
Occurrence. Guryong reservoir (May 01, 2017).

Lorica large ellipsoid, both ends narrowed and rounded; flagella apertures without a clear collar, but often surround-

ed by a circle of small spines; wall covered by many stout, long spines having a pointed apex; lorica 30−36 μm in diameter, length 55−60 μm, spines 10−12 μm long, 2−3 μm broad at the base.

Stavomonadea
Petalomonadida
Scytomonadidae

***Petalomonas platyrhyncha* Skuja 1948 (Fig. 5C, D)**

Reference. Huber-Pestalozzi 1955, p. 502, fig. 1026.
Occurrence. Dongbaekdongsan (July 17, 2016), Geomdan-ecological wetland (September 18, 2017).

Cells flat, rigid, ellipsoid; anterior end slightly narrowed and broadly rounded or truncate rounded, with a small furrow; posterior end gradually tapered and projected into a short, stout cauda; pellicle with strong longitudinal rib, with several keels with grooves on both dorsal and ventral side flat-convex; dorsal side convex and ventral side flat cells 18−25 μm in diameter, length 38−42 μm.

Dinophyta
Dinophyceae
Phytodiniales
Phytodiniaceae

***Dinococcus oedogonii* (P.G.Richter) Fott 1960 (Fig. 5E)**
(Syn. *Raciborskia bicornis* Wolozyńska 1919)

Reference. Dillard 2007, p. 84, pl. 17, fig. 10; John *et al*. 2011, p. 271, pl. 70, fig. G.
Occurrence. Mulyoungari-orum (October 12, 2014).

Cells epiphytic with broad disc-shape stock on the filamentous algae, ellipsoid in face view, both ends with a single short spine, upper margin straight, laternal margins roundly convex; cells 9−12 μm in diameter, length 25−35 μm.

Heterokontophyta
Raphidophyceae
Chattonellales
Vacuolariaceae

***Merotricha capitata* Skuja 1934 (Fig. 5F, G)**

Reference. Dillard 2007, p. 78, pl. 16, fig. 5.
Occurrence. Guryong reservoir (November 06, 2021), Namsan reservoir (October 16, 2016).

Cells solitary, free-swimming, ovoid to ellipsoid, posterior broadly round or slightly narrowed, anterior with a group of radially arranged trichocysts; flagella subapicular or lateral; cells diameter 25−28 μm, length 39−45 μm.

Chrysophyceae
Chromulinales
Chrysococcaeae

***Chrysococcus furcatus* Nicholls 1981 (Fig. 5H, I)**
(Syn. *Trachelomonas furcata* Dolgoff 1922)

Reference. Huber-Pestalozzi 1955, p. 350, fig. 752.
Occurrence. Namsan reservoir (January 31, 2021).

Lorica spherical, light brown in color; flagella apertures with a long cylindric collar; wall with a long, 1st or secondary branched spine; lorica 11−12.5 μm in diameter, spines 4−6 μm long; collar 2−2.5 μm in diameter, 2.5−3.0 μm long; spines 20−25 μm long.

Chrysosaccales
Stylococcaceae

***Chrysopyxis inaequalis* Fott 1952 (Fig. 5J)**

Reference. Yamagishi & Akiyama 1995, v. 14, p. 7.
Occurrence. Sajapyeong wetland (April 22, 2016).

Cells solitary, epiphytic on the filamentous algae, surrounded by a lorica; loricae circular to broad-ellipsoid in side view, anterior end with a short and narrow neck; attached to the host alga by two thread-like outgrowth from the rounded base; protoplasts ovoid to globose with a single laminate, golden-brown chromatophore; lorica 6−9 μm in diameter, length 9−11 μm.

Xanthophyceae
Mischococcales
Mischococcaceae

***Mischococcus confervicola* Nägeli 1849 (Fig. 5K)**

Reference. Dillard 2007, p. 60, pl. 11, fig. 2; Yamagishi & Akiyama 1985, v. 3, p. 56.
Occurrence. Sangho (February 08, 2021).

Thalli epiphytic, dendroid colony consisting of dichotomously or trichotomously branched, with cells in two or four at the apices of gelatinous tube. Cells globose, single or in pairs in the distal ends of the branching tubes; Chloroplasts single or few discoid, parietal, yellowish-green color. Cells diameter 3.5−5.5(5−8) μm.

Conflicts of Interest

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

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