

⟨Original article⟩

Six Taxa of Newly Recorded Species of Charophytes (Charophyta) in Korea

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Abstract - Six taxa of unrecorded Korean species of charophytes are described. Freshwater and aerial charophytes were collected from the bark of trees, reservoirs, small ponds and swamps from April 2017 to September 2017. The newly recorded species of Korea were *Cosmarium quadrifarium* f. *octastichum*, *Euastrum turneri*, *Spondylosium nitens* var. *triangulare*, *Staurastrum kouwetsii*, *Stauroidesmus dickiei* var. *latus*, and *Klebsormidium subtile*. *K. subtile* was transferred from *Stichococcus subtilis*.

Keywords : charophytes, freshwater and aerial algae, Korean unrecorded species

INTRODUCTION

Charophyta can be classified into 6 classes including Conjugatophyceae and Klebsormidiophyceae and there are about 4,738 species reported worldwide. There are about 4,346 and 44 species reported in classes Conjugatophyceae and Klebsormidiophyceae, respectively (Guiry and Guiry 2018). Domestically, there are 874 and 4 taxa of Conjugatophyceae and Klebsormidiophyceae reported, respectively (Lee and Kim 2015).

Desmids have been studied extensively by early microscopic researchers for its beauty of symmetrical form and structural diversity (Ralfs 1848). For this reason, more than 6,000 species of Desmidiaceae have been reported from different habitats around the world. In addition, external morphology, internal cell structure, systematics, sexual and asexual reproduction, and genetic studies were performed (Brook 1981).

The desmids are mostly attached algae distributed in acidic waters. Most of them are distributed in clean waters,

but some occur in polluted waters. Also, there are aerial algae distributed in moist terrestrial ecosystems. Therefore, it plays an important role as a primary producer and in the secondary transition process (John *et al.* 2002). It has an important ecological position as an indicator of environmental change in aquatic ecosystem (Chung and Lee 1986).

And members of the filamentous green algae genus *Klebsormidium* are one of the essential components of soil crusts. These algae are widely distributed in terrestrial habitats worldwide (Hoffmann 1989).

For this study, we collected samples from fresh waters and aerial environments and added the unrecorded charophytes to the algal flora of Korea.

MATERIALS AND METHODS

From April 2017 to September 2017, freshwater and aerial charophytes were collected from Gangwon-do, Gyeong-sangnam-do, Jeollanam-do, Jeollabuk-do and Jeju-do (Table 1). The collection was performed separately the planktonic and the periphytic algae. The planktonic algae were collected using a 20 µm-mesh phytoplankton net with a 30 cm di-

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Table 1. The information about the location of five sites from where the phytoplankton samples were collected in 2017

Site	Location	Habitat	Latitude (N)	Longitude (E)
st.1	Seonheul-ri, Jocheon-eup, Jeju-si, Jeju-do	Small pond	33°30'51.5"	126°43'07.4"
st.2	Yonggok-ri, Jangdong-myeon, Jangheung-gun, Jeollanam-do	Reservoir	34°43'06.2"	126°57'17.5"
st.3	Sinpo-ri, Sabuk-myeon, Chuncheon-si, Gangwon-do	Reservoir	38°01'32.8"	127°38'32.6"
st.4	Bongsan-ri, Gyeseong-myeon, Changnyeong-gun, Gyeongsangnam-do	Swamp	35°26'34.7"	128°28'48.8"
st.5	Aerial Busong-dong, Iksan-si, Jeollabuk-do	Bark of tree	35°58'07.0"	126°59'42.6"

ameter and a van Dorn water sampler. The periphytic algae was collected by scrubbing off aquatic plants, submerged land plants and rocks (Sourmia 1978). Aerial algae attached to the bark of tree and the rocks were also collected. 1% Lugol solution was used for fixation.

The sample was identified with a light microscope (Axio Imager A2, Carl Zeiss, Germany / Olympus BX41, Olympus, Japan) at a magnification of 100 to 1,000. Photographs were taken using an AxioCam HRC camera (Carl Zeiss, Germany) and an Olympus UC-90 (Olympus, Japan). The unialgal samples were cultured in Bold's basal medium (Bold 1949). The specimens were cultured under the following conditions: a temperature of 25°C, light/dark cycle of 16 : 8 and 40 $\mu\text{mol m}^{-2} \text{s}^{-1}$ light (Stein 1973; Bold and Wynne 1978).

The taxonomic classification system was based on AlgaeBase (Guiry and Guiry 2018). The taxa were identified based on information taken from Prescott *et al.* (1977, 1981, 1982), Croasdale *et al.* (1983), Coesel and Meesters (2013) and Mikhailiuk *et al.* (2015).

RESULTS AND DISCUSSION

We identified six unrecorded taxa in Korea. The six taxa were *Cosmarium quadrifarum* f. *octastichum*, *Euastrum turneri*, *Spondylosium nitens* var. *triangulare*, *Staurastrum kouwetsii*, *Staurodesmus dickiei* var. *latus* and *Klebsormidium subtile*.

Class Conjugatophyceae Engler 1892
 Order Desmidiaceae C.E. Bessey 1907
 Family Desmidiaceae Ralfs 1848
 Genus *Cosmarium* Corda ex Ralfs 1848

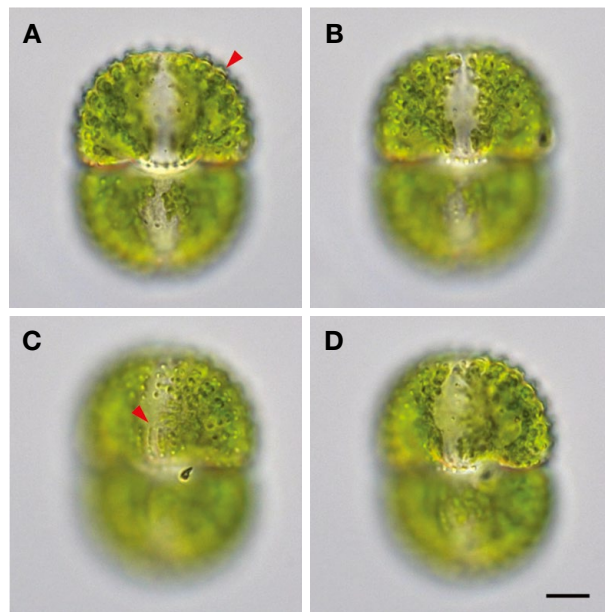


Fig. 1. Microscopic photographs of *Cosmarium quadrifarum* f. *octastichum* Nordstedt 1888. A–D; facial view. A and B provide focus on 8 parallel series of emarginate warts (arrowhead) in the marginal region. C, D shows facial protrusion with 7 vertical rows of granules (arrowhead). Scale bar represents 10 μm .

Cosmarium quadrifarum f. *octastichum* Nordstedt 1888 (Fig. 1)

Synonym: *Cosmarium hexastichum* var. *octastichum* Nordstedt 1873

Cells are above medium size, about 1.25 times longer than broad. The median constriction is deep. And sinus is narrowly linear. The semicells are semicircular, lower angles are subrectangular and a little rounded, lateral margin broadly convex over the apex. This form is distinguished from the typical by its semicells having 8 parallel series of emarginate warts in the marginal region, inner series often somewhat reduced and the facial protrusion with 7 or 8 ver-

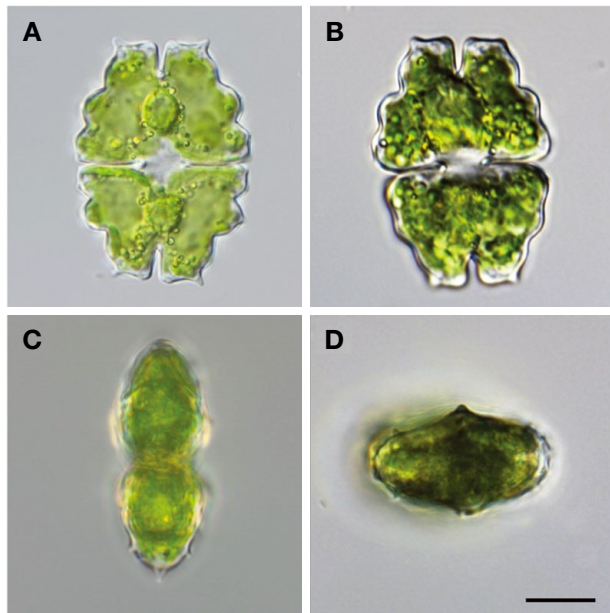


Fig. 2. Microscopic photographs of *Euastrum turneri* West 1892. A and B; facial view, C; lateral view, D; vertical view. Scale bar represents 10 μm .

tical rows of granules. The length of cell is 47–48 μm , the width is 35–36 μm and the isthmus is 12 μm .

Ecology: This is a freshwater species (Guiry and Guiry 2018). We collected this species from the submerged plants in a large reservoir.

Distribution: North America: Tennessee (Johansen *et al.* 2007); South America: Argentina (Tell 1985); Australia and New Zealand: New South Wales (Day *et al.* 1995).

Site of collection: Sinpo-ri, Gangwon-do (September 14, 2017).

Specimen Locality: ACKU2017NR11

Genus *Euastrum* Ehrenberg ex Ralfs 1848

***Euastrum turneri* West 1892 (Fig. 2)**

Cell is small and 1.5 times longer than broad. The semi-cell is truncate-pyramidal in outline. The basal angles are biundulate at the margins. The margins of semi-cells are retuse and converging to upper lateral lobules, a U-shaped sinus between the upper, lateral lobules and the polar lobe, which has a small protrusion below the apical angles where there is a short, stout spine. The apical margin is flat but un-

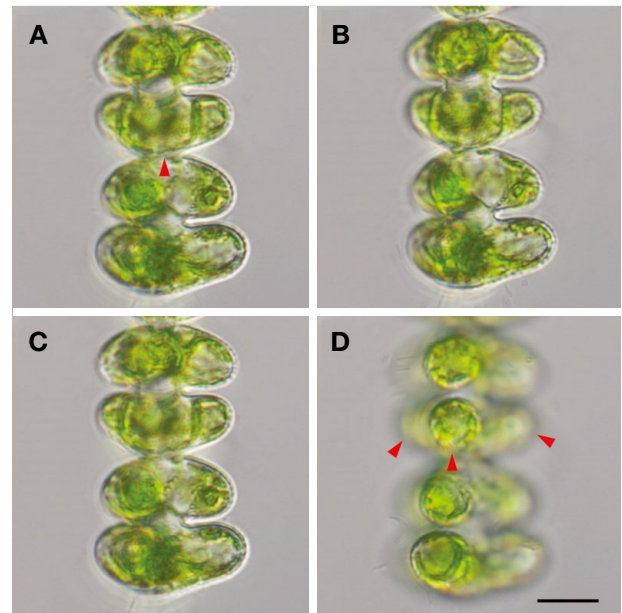


Fig. 3. Microscopic photographs of *Spondylosium nitens* var. *triangulare* W.B. Turner 1893. A–D; facial view. A–C shows that the apices are evenly convex (arrowhead) and the sinus is open with the interior surface as broad and rounded structure. D provides focus on 3-lobed semi-cells (arrowheads). Scale bar represents 10 μm .

dulate, with an open median incision. The face of semi-cell has a median protrusion bearing a circle large granule, and cell wall with a scattering of granules in the apical lobules and over the face of the basal lobes. The lateral view is elliptic, the poles pointed with a micro. The length of cell is 43 μm , the width is 30 μm and the isthmus is 7 μm .

Ecology: This is an epiphytic species and was collected from a swamp.

Distribution: Europe: Britain (John *et al.* 2011); North America: Northwest Territories (Sheath and Steinman 1982).

Site of collection: Bongsan-ri, Gyeongsangnam-do (June 8, 2017).

Specimen Locality: ACKU2017NR13

Genus *Spondylosium* Brébisson ex Kützing 1849

***Spondylosium nitens* var. *triangulare* W.B. Turner 1893 (Fig. 3)**

Synonym: *Leuronema nitens* Wallich 1860

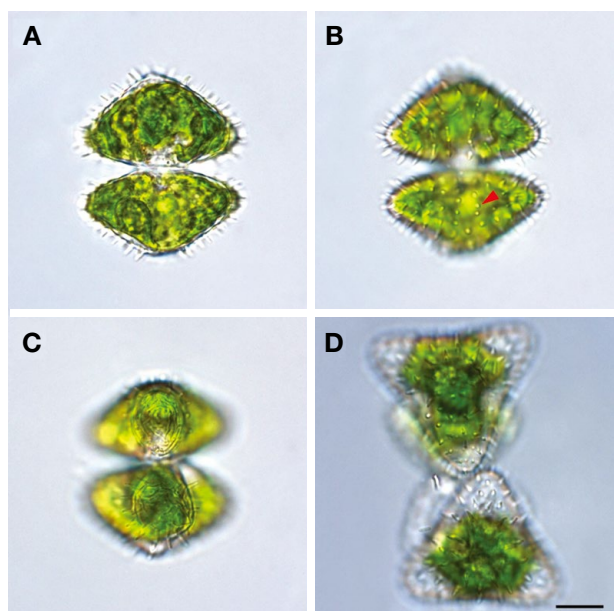


Fig. 4. Microscopic photographs of *Staurastrum kouwetsii* Coesel 1996. A–C; facial view, D; vertical view. A–C provides focus on subelliptic-rhomboid semicells and stout spines (arrowhead) arranged in concentric series around the angles. D represents the vertical view with slightly concave sides in the 3-angles. Scale bar represents 10 μm .

Cell is about as long as broad, sinus open and broadly rounded within. A variety has with the semicells 3-lobed, in vertical view triangular. The apices are evenly convex or truncately produced in the middle. The length of cell is 20–25 μm , the width is 20–30 μm and the isthmus is 8–10 μm .

Ecology: This is an epiphytic species and was collected from a large reservoir.

Distribution: South-west Asia: India (Das and Keshri 2016); South-east Asia: Thailand (Hirano 1992); Australia and New Zealand: Northern Territory (Day *et al.* 1995).

Site of collection: Sinpo-ri, Gangwon-do (September 14, 2017).

Specimen Locality: ACKU2017NR14

Genus *Staurastrum* Meyen ex Ralfs 1848

***Staurastrum kouwetsii* Coesel 1996 (Fig. 4)**

Cell is about as long as broad and deeply constricted. Sinus open from acute angled apex. Semicells are sub elliptic-rhomboid or sub pyramidal with broadly rounded

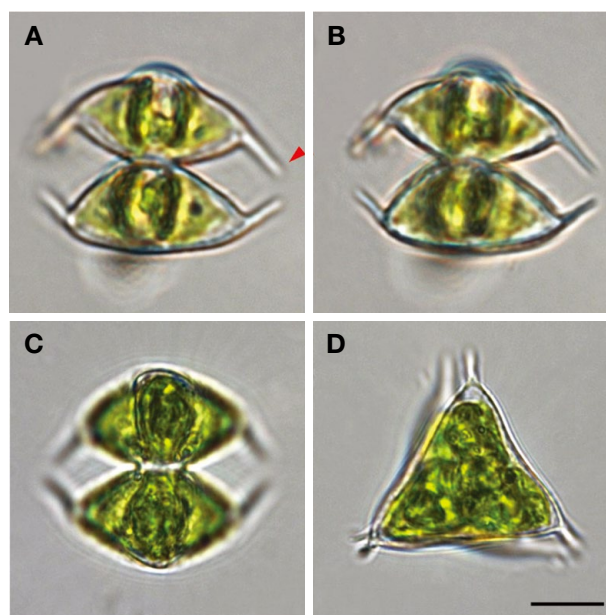


Fig. 5. Microscopic photographs of *Staurodesmus dickiei* var. *latus* (Hirano) Lacoste de Díaz 1963. A–C; facial view, D; vertical view. A and B provides focus on lateral spines which are relatively long and downwardly directed (arrowhead), C shows semicells with the narrow and fusiform shape. Scale bar represents 10 μm .

angles, equally covered with rather stout spine arranged in concentric series around angles. Semicells in apical view are 3-angular with slightly concave sides and broadly rounded angles. The length of cell is 45–48 μm , the width is 37–41 μm and the isthmus is 12.5 μm .

Ecology: This species occurs in benthos and tycho plankton of oligo-mesotrophic, acidic water bodies (Coesel and Meesters 2013). We collected it from a stagnant small pond.

Distribution: Europe: Britain (Lang *et al.* 2014), Netherlands (Coesel 1997); North America: Virginia (Wołowski *et al.* 2011).

Site of collection: Seonheul-ri, Jeju-do (May 20, 2017).

Specimen Locality: ACKU2017NR15

Genus *Staurodesmus* Teiling 1948

***Staurodesmus dickiei* var. *latus* (Hirano) Lacoste de Díaz 1963 (Fig. 5)**

Synonym: *Staurastrum dickiei* var. *latum* Hirano 1959

Cell is medium sized, about as broad as long and con-

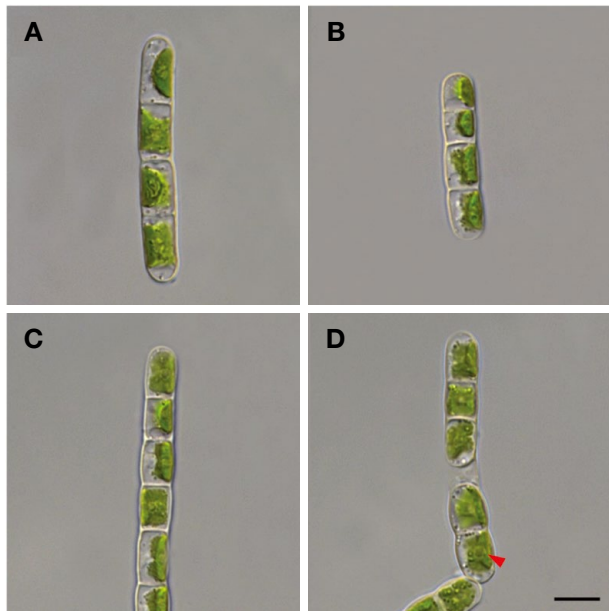


Fig. 6. Microscopic photographs of *Klebsormidium subtile* (Kützing) Mikhailiyuk, Glaser, Holzinger & Karsten 2015. A–C represent long and wide cylindrical cells. D shows one pyrenoid (arrowhead). Scale bar represents 10 μm .

striction is deep. Sinus is acute angled. This variety is different with relatively broader cells than the typical. Semi-cells are narrowly fusiform, the lateral spines are relatively long and downwardly directed. The length of cell is 27–30 μm , the width is 34.7–35.4 μm with spines and the isthmus is 6.5–8 μm .

Ecology: This type species occurs in benthos and plankton of acidic water bodies (Coesel and Meesters 2013). We collected it from a stagnant reservoir.

Distribution: Asia: Japan (Hirose *et al.* 1977); South America: Argentina (Tell 1985).

Site of collection: Yonggok-ri, Jeollanam-do (August 7, 2017).

Specimen Locality: ACKU2017NR16

Class Klebsormidiophyceae C. Hoek, D.G. Mann & H.M. Jahns 1995

Order Klebsormidiales K.D. Stewart & K.R. Mattox 1975
Family Klebsormidiaceae K.D. Stewart & K.R. Mattox 1975

Genus *Klebsormidium* P.C. Silva, Mattox & W.H. Blackwell 1972

Klebsormidium subtile (Kützing) Mikhailiyuk, Glaser, Holzinger & Karsten 2015 (Fig. 6)

Synonym: *Hormidium subtile* (Kützing) Heering, *Stichococcus subtilis* (Kützing) Klercker 1896, *Klebsormidium subtilissimum* (Rabenhorst) P.C. Silva, K.R. Mattox & W.H. Blackwell 1972

Filaments are long and are composed of wide cylindrical cells. There is no depression between the cells. Chloroplast has 1 pyrenoid, which is located on the side of cell. The length of cell is 7–21 μm , the width is 6–8 μm .

Ecology: We collected this species from the bark of tree and rock. It lives at moist aerial environments.

Distribution: South-west Asia: India (Gupta 2012)

Site of collection: Busong-dong, Jeollabuk-do (April 8, 2017)

Specimen Locality: ACKU2017IA02

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