

〈Original article〉

## Four Newly Recorded Taxa of Charophytes and Chlorophytes (Charophyta and Chlorophyta, Viridiplantae) in Korea

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**Abstract** - The freshwater algae were collected at reservoirs and small ponds in Gyeonggi-do and Jeju-do on June 2016. Four species of Korean previously unrecorded algae were collected in domestic fresh waters: *Coelastrum rugosum*, *Cosmarium baccatum*, *Cosmarium norimbergense* and *Staurastrum connatum* var. *pseudoamericanum*. The morphological characteristics of the four taxa identified in this study were showed mostly similar to the characteristics of the previously reported characteristics. However, *Cosmarium baccatum* was larger than the previously recorded species and *Staurastrum connatum* var. *pseudoamericanum* was wider than the previously recorded species.

**Key words** : Chlorophyceae, Conjugatophyceae, newly recorded species, phytoplankton

### INTRODUCTION

Algae are responsible for photosynthesis and it generates a significant portion of the Earth's oxygen as well as produces many organic carbons that are used as food for other organisms. The quantitative changes of the algae community also uses as important data in the evaluation of water quality (Stoermer and Ladewski 1978). Moreover, several species are cultivated for the production of nutritional supplements or food additives such as  $\beta$ -carotene (Ben-Amotz *et al.* 1982; Alonso *et al.* 1996). The common freshwater colonial green algae *Chrorella saccharophila* is an example of another type of algae that produces large amounts of lipids. More than 300 lipid-producing algae strains have been identified as having economic potential for producing the biofuel (Roessler 1990; Graham *et al.* 2009; Chinnasamy *et al.* 2010).

In the case of Chlorophyceae of Chlorophyta, a total of 3,607 taxa have been reported worldwide (Guiry and

Guiry 2017). A total of 4,062 taxa of Conjugatophyceae of Charophyta have been reported worldwide. Domestically, a total of 484 taxa for the Chlorophyceae and 872 taxa for the Conjugatophyceae have been reported (Lee and Kim 2015). It shows the study of Korean flora must be further researched.

Among the existing research, the floristic studies by Chung (1968) and Chung (1993) stand out, regarding the chlorophytes of Korea. Furthermore, in the monographic studies conducted by The National Institute of Biological Resources and the Ministry of Environment, many species have been newly discovered and have been added to the flora of Korea (Kim 2012; Kim and Kim 2012). The unrecorded species of Korea have continuously been added to the Korean flora each year (Shin *et al.* 2013; Kim 2013a, 2014a, b; Kim 2013b, c, 2014c; Song and Lee 2014a, b). Six taxa of *Cosmarium* were added at lowland swamps, reservoirs, mountainous wetlands and the *Sphagnum* bogs (Lee 2015). Nine taxa of chlorophytes collected at artificial wetlands (Shin *et al.* 2015), as well as two genera and five species of filamentous blue-green algae were collected at aquatic plants, submerged land plants and rocks (Song and

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Lee 2015).

From this study, the newly recorded species of chlorophytes and charophytes in Korea were collected and identified from various freshwater lakes in order to expand the recorded species of the Korean flora.

## MATERIALS AND METHODS

These samples were collected at the Seo-ho and Buk-ri reservoir at Gyeonggi-do in 2016 (Table 1). We collected phytoplanktonic algae using a 25 µm-mesh phytoplankton net with a 30 cm diameter. The periphytic algae was collected by scrubbing off aquatic plants, submerged land plants and rocks (Sournia 1978).

The collected specimens were separated using a Pasteur pipette under a light microscope and they were cultured in solid media. Once a colony was formed by a single species, it was subsequently transferred to liquid media. The unialgal specimens were cultured in Bold's basal media under the following conditions: a temperature of 25°C, light/dark cycle of 16 : 8, and 40 µmol m<sup>-2</sup> s<sup>-1</sup> light (Stein 1973; Bold and Wynne 1978).

Each sample was examined using an ×400–1000 magnification under a Zeiss Microscope (Axio Imager A2; Carl Zeiss, Germany) and was photographed using an AxioCam HRC camera (Carl Zeiss, Germany).

The taxonomic classification system was based on Algae-Base (Guiry and Guiry 2017) and Komárek and Fott (1983). The taxa were identified based on information taken from West and West (1908), Hirose *et al.* (1977), Prescott *et al.* (1981, 1982) and Komárek and Fott (1983).

## RESULTS AND DISCUSSION

The four newly added Korean species were *Coelastrum rugosum*, *Cosmarium baccatum*, *Cosmarium norimber-*

*gense* and *Staurastrum connatum* var. *pseudoamericanum*.

We described the morphological characteristics of the newly recorded species and provided microscopic photographs of them (Figs. 1–4). The cultured and fixed specimens were deposited at the Nakdonggang National Institute of Biological Resources (NNIBR), at the Ministry of Environment (MOE) of the Republic of Korea.

Phylum Chlorophyta  
Class Chlorophyceae  
Order Sphaeropleales  
Family Scenedesmaceae  
Genus *Coelastrum* Nägeli 1849

### *Coelastrum rugosum* (Rich) Tsarenko 2011 (Fig. 1)

The cells are oval to triangular shaped, with distinct wrinkles on the surface of the cells. The spherically shaped colony consists of 8 or 16 cells, and the cells are directly adjacent to one another without connecting strands. The diameter of the cell is 6–11 µm and the length is 7–12 µm.

**Ecology:** We collected this species in planktonic samples from eutrophic reservoirs.

**Distribution:** Europe: Germany, Hungary (Hegewald *et al.* 2010); Romania (Caraus 2002); Asia: Taiwan (Shao 2003–2014)

**Site of collection:** Seo-ho, Gyeonggi-do (June 15, 2016)

**Specimen Locality:** KTSN 120000207733

Phylum Charophyta  
Class Conjugatophyceae (Zygnematophyceae)  
Order Desmidiiales  
Family Desmidiaceae  
Genus *Cosmarium* Corda ex Ralfs 1848

### *Cosmarium baccatum* Scott & Grönblad 1957 (Fig. 2)

The cells are large, and a little longer than they are broad. The median constriction is deep and narrowly linear. Semi-cells are subpyramidate shaped, and the lower angles are

**Table 1.** The locational information of three sites which collected the phytoplankton in 2016

Sites	Location				Latitude	Longitude	pH
1	Hwaseodong	Paldal-gu	Suwon-si	Gyeonggi-do	37°16'48.3"	126°59'12.3"	7.2
2	Buk-ri	Cheoin-gu	Yongin-si	Gyeonggi-do	37°09'11.3"	127°09'22.3"	7.2

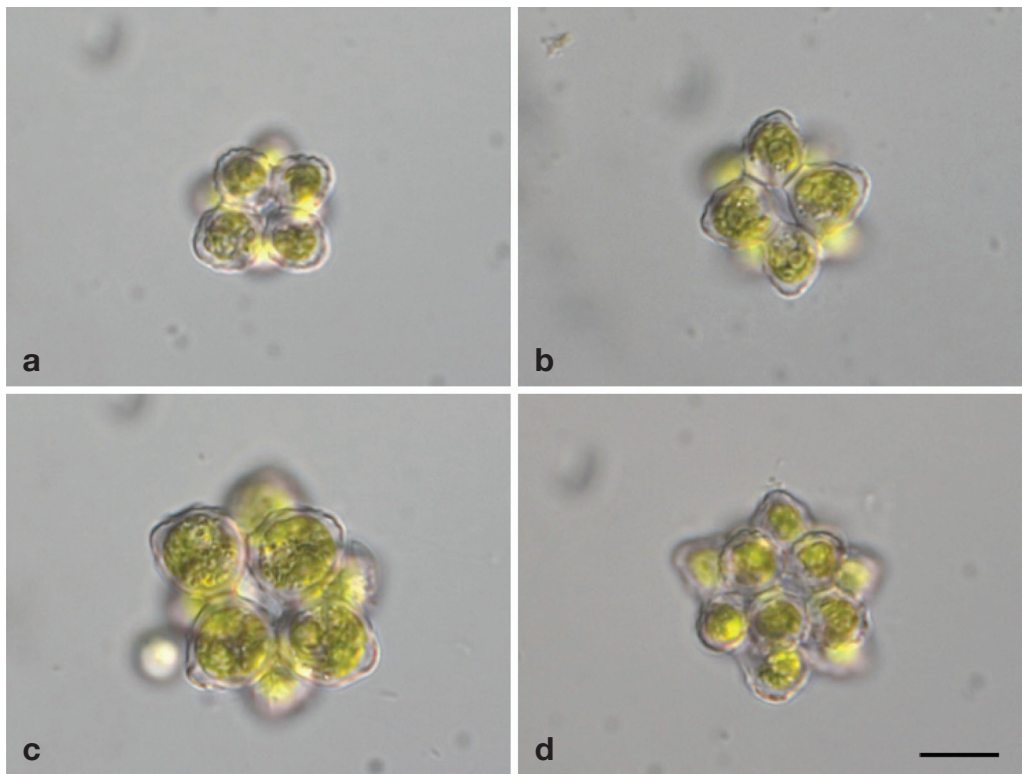


Fig. 1. Microscopic photographs of *Coelastrum rugosum* (Rich) Tsarenko. Scale bar represents 10  $\mu\text{m}$ .

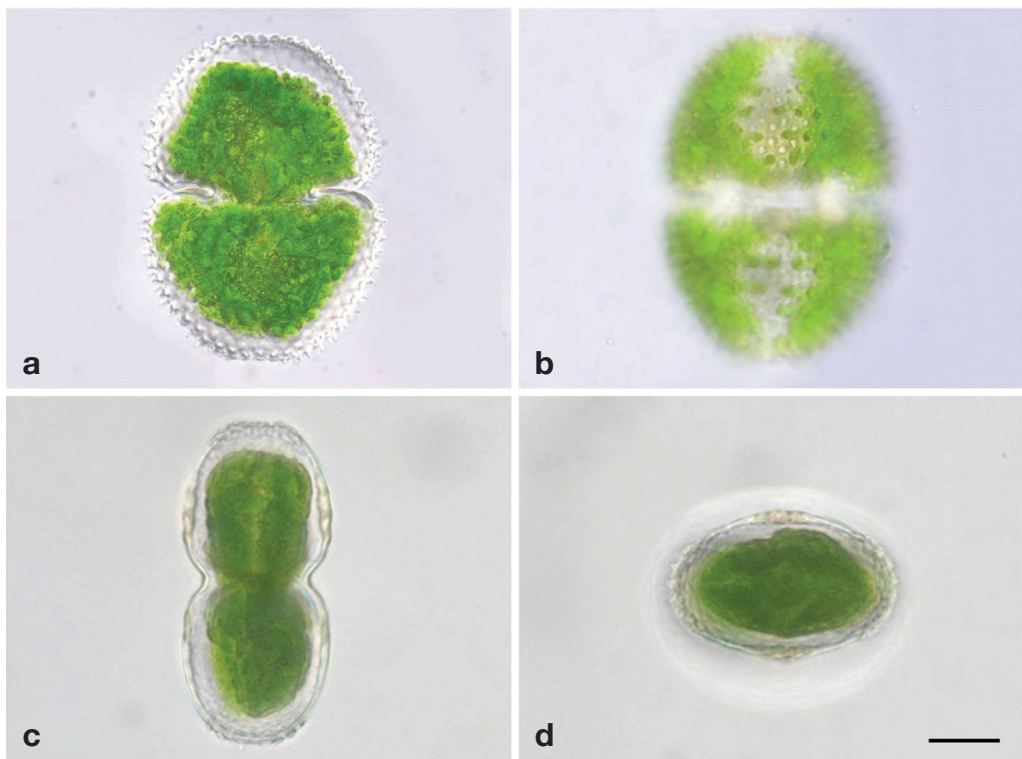


Fig. 2. Microscopic photographs of *Cosmarium baccatum* Scott & Grönblad. Scale bar represents 20  $\mu\text{m}$ .

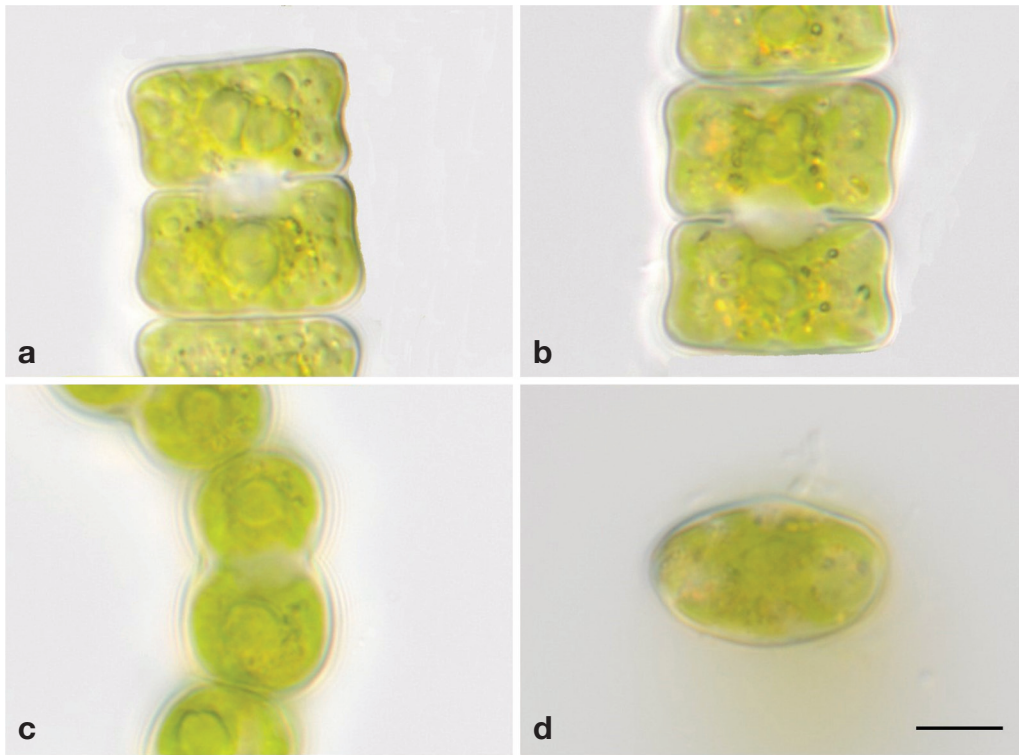


Fig. 3. Microscopic photographs of *Cosmarium norimbergense* Reinsch. Scale bar represents 10  $\mu$ m.

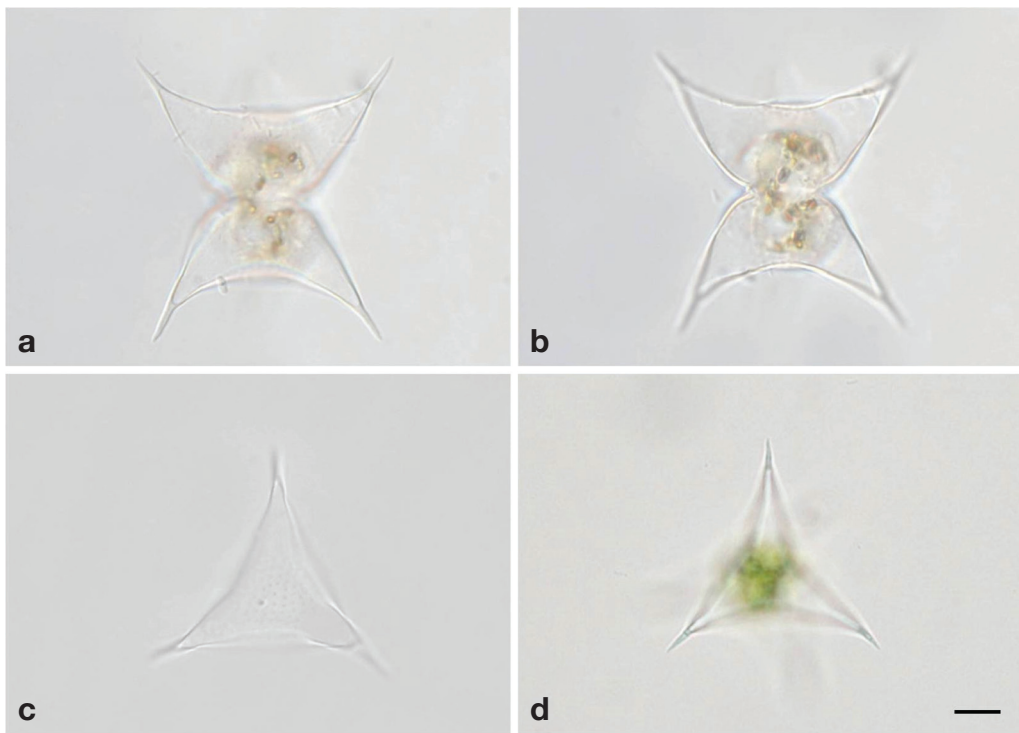


Fig. 4. Microscopic photographs of *Staurastrum connatum* var. *pseudoamericanum* Grönblad. Scale bar represents 10  $\mu$ m.

rotund. The lateral margins are convex and decidedly convergent toward the apex. The apex margin is truncated, and the margins are granular-undulate. In the face of the semi-cells, large granules are regularly arranged in longitudinal, oblique or concentric series. On each side of the isthmus are 3 or 4 large warts, a low swelling in the midregion bearing different pattern granules. The vertical view is broad-ovate shaped with a slight and conspicuous inflation at the mid-region on either side. From the lateral view, the semi-cell is circular, and the margins are granular-undulate, with 20–22 undulations along the margin. The length is 91–92  $\mu\text{m}$ , the width is 66–69  $\mu\text{m}$ , and the isthmus is 25–27  $\mu\text{m}$ .

These specimens are larger than the previously recorded species.

**Ecology:** We collected this species from the mesotrophic reservoirs at the Buk-ri reservoir, Gyeonggi-do.

**Distribution:** Florida, Virginia (Prescott *et al.* 1981); South-eastern United States: Homestead, Masaryk, Punta Gorda, Chiefland (Scott and Grönblad 1957).

**Site of collection:** Buk-ri reservoir, Gyeonggi-do (August 5, 2016)

**Specimen Locality:** KTSN 120000207785

#### *Cosmarium norimbergense* Reinsch 1867 (Fig. 3)

The cells are small, about as broad as they are long. The median constriction is deep and the sinus is closed. The semicell is transversely rectangular, and the lateral margin is retuse but subparallel to a truncate apex, which is as wide as the base of the semicell, and the basal angle is broadly rounded. From the lateral view, the semicell is circular and from the vertical view, the cell is elliptic. The length is 39–45  $\mu\text{m}$ , the width is 25–36.4  $\mu\text{m}$ , and the isthmus is 5.6–11  $\mu\text{m}$ .

**Ecology:** We collected this species from eutrophic reservoirs.

**Distribution:** Worldwide distribution (Croasdale and Flint 1988; Broady *et al.* 2012).

**Site of collection:** Seo-ho, Gyeonggi-do (June 15, 2016).

**Specimen Locality:** KTSN 120000207786

Phylum Charophyta

Class Conjugatophyceae (Zygnematophyceae)

Order Desmidiiales

Family Desmidiaceae

Genus *Staurastrum* Meyen ex Ralfs 1848

#### *Staurastrum connatum* var. *pseudoamericanum* Grönblad (Fig. 4)

The cells are larger than *S. connatum*. The ventral margins are convex, and the apical margins are straight towards the outside. The cell becomes thin and pointed towards the end. The median constriction is narrow and open, and the apex is either flat or slightly concaved. From the vertical view, the cell is triangular with each margin being slightly concaved. The length of the cell is 38–43  $\mu\text{m}$ , the width is 33.5–43.5  $\mu\text{m}$  without the spines, and the isthmus is 11–12  $\mu\text{m}$ .

**Ecology:** We collected this species from mesotrophic reservoirs.

**Distribution:** Germany, Finland (Hirano 1959).

**Site of collection:** Buk-ri Reservoir, Gyeonggi-do (August 6, 2016)

**Specimen Locality:** KTSN 120000207787

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