

⟨Original article⟩

## Five Taxa of Newly Recorded Species of Scenedesmaceae (Sphaeropleales, Chlorophyceae, Chlorophyta) in Korea

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**Abstract** - Phytoplanktons were collected from various environments including small marshes, small ponds, reservoirs and brackish water from March 2017 to November 2017. In this study, five species of family Scenedesmaceae were newly recorded in Korea. The genus *Desmodesmus* was newly reported in Korea. The newly recorded species are *Scenedesmus nanus*, *S. praetervisus*, *Desmodesmus costato-granulatus*, *D. lunatus* and *D. spinulatus*. *S. nanus* and *S. praetervisus* are known to occur in freshwater, but they were found in the brackish water in this study.

**Keywords** : *Desmodesmus*, newly recorded species in Korea, phytoplankton, *Scenedesmus*

### INTRODUCTION

In order to solve the seasonal shortage of water resources, Korea has artificially created reservoirs to secure water resources (Song *et al.* 2011). For most reservoirs in Korea, rapid eutrophication is underway due to the influx of pollutants from the summer rains (NIER 1999). Eutrophication of reservoirs causes phytoplankton blooming, which results in the hindrance to water purification process causing filtration problems, toxins, and unpleasant odors (Seo *et al.* 2003). Recently, various studies have been carried out to suppress phytoplankton blooming in Korea (Shin *et al.* 2014; Park and Jun 2016; Chung *et al.* 2017).

Among the Scenedesmaceae belonging to Chlorophyceae, the most taxa belong to genus *Scenedesmus*, which is floating, and it usually appears in the eutrophic ponds and lakes (Guiry and Guiry 2018). *Scenedesmus* was first named in Meyen (1829). Subsequently, Chodat (1926) divided genus *Scenedesmus* into several subgenus according to

morphological features. The genus *Scenedesmus* has been described based on morphological features, as about 1,300 taxa (Hegewald and Silva 1988). The cell walls structure of subgenus *Desmodesmus*, which may be visible in light microscope as spines, short teeth, ribs or granulates (Hegewald *et al.* 1990). However, several studies have shown that genus *Scenedesmus* and subgenus *Desmodesmus* cannot be distinguished from one another only from their morphological characteristics (Trainor and Egan 1990; Trainor 1998). Thereafter, *Scenedesmus* and *Desmodesmus* separated as inferred from ITS-2 rDNA sequence comparisons (An *et al.* 1999). In recent years, many species of genus *Scenedesmus* have been transferred to genus *Desmodesmus* (Hegewald 2000; Guiry and Guiry 2018).

A total of 3,541 species of Chlorophyceae have been reported worldwide in AlgaeBase (Guiry and Guiry 2018), and 484 taxa have been reported in Korea (Lee and Kim 2015). A total of 562 taxa of Scenedesmaceae have been reported worldwide, of which 278 and 99 taxa were reported to be genera *Scenedesmus* and *Desmodesmus*, respectively (Guiry and Guiry 2018). A total of 149 taxa of Scenedesmaceae have been reported in Korea, of which 121 taxa were

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

Site	Location	Habitat	Latitude (N)	Longitude (E)
St.1	Gwanggyosan-ro, Yeongtong-gu, Swon-si, Gyeonggi-do	Small-pond	37°18'18.1	127°02'03.3
St.2	Bugu-ri, Buk-myeon, Uljun-gun, Gyeongsangbuk-do	Brackish water (estuary)	37°06'11.2	129°22'32.0
St.3	Haechang-ri, Anyang-myeon, Jangheung-gun, Jeollanam-do	Brackish water (small stream)	34°37'32.9	127°00'14.8
St.4	Yonggok-ri, Jangdong-myeon, Jangheung-gun, Jeollanam-do	Small reservoir	34°43'06.9	126°57'24.0
St.5	Seonheul-ri, Jocheon-eup, Jeju-si, Jeju-do	Small marsh	33°30'48.9	126°42'59.1

genus *Scenedesmus* (Lee and Kim 2015). Chlorophytes have been continuously added to Korean flora (Kim 2015, 2017; Jung *et al.* 2017; Kim and Kim 2017). Genus *Scenedesmus* was reported to 134 taxa since 2017, and the taxa of genus *Desmodesmus* have not yet been reported in Korea.

In this study, we collected phytoplanktons from various environments, such as small marshes, small ponds, reservoirs and brackish water. We aimed to add newly recorded species in Korean flora of phytoplankton.

## MATERIALS AND METHODS

The collection of phytoplankton was conducted in various environments such as small marshes, small ponds, reservoir and brackish water in Gyeonggi-do, Jeollanam-do, Gyeongsangbuk-do and Jeju-do from March to November 2017 (Table 1). Planktonic algae were collected by vertical and horizontal sampling using a plankton net with a diameter of 30 cm and a mesh size of 25  $\mu\text{m}$  (Sournia 1978).

The samples were observed at 400-1000 magnification using light microscopes (Axio Imager A2, Carl Zeiss, Germany / Olympus BX41, Olympus, Japan). Photographs were taken using an AxioCam HRC camera (Carl Zeiss, Germany) and an Olympus UC-90 (Olympus, Japan).

The samples were separated into solid medium using a Pasteur pipette for the unialgal culture. When the colonies were grown in the solid medium, they were subsequently transferred to a liquid medium. Collected samples and unialgal-cultured samples were adapted to Bold's basal media (Bold 1949) and incubated at 25°C in a light/dark cycle of 16:8 with 40  $\mu\text{mol m}^{-2} \text{s}^{-1}$  light (Stein 1973; Bold and Wynne 1978).

The taxonomic classification system was based on Algae-Base (Guiry and Guiry 2018), and morphological identifi-

cation of the taxa was done by using Hirose *et al.* (1977), Komárek and Fott (1983), Hegewald *et al.* (1990) and John *et al.* (2011).

## RESULTS AND DISCUSSION

Five species of the Scenedesmaceae were newly recorded in Korea. The newly recorded species found in this study were *Scenedesmus nanus*, *S. praetervisus*, *Desmodesmus costato-granulatus*, *D. lunatus* and *D. spinulatus*. We have provided morphological features and photomicrographs of the species (Figs. 1–5).

### Family Scenedesmaceae

#### Genus *Scenedesmus* Meyen 1829

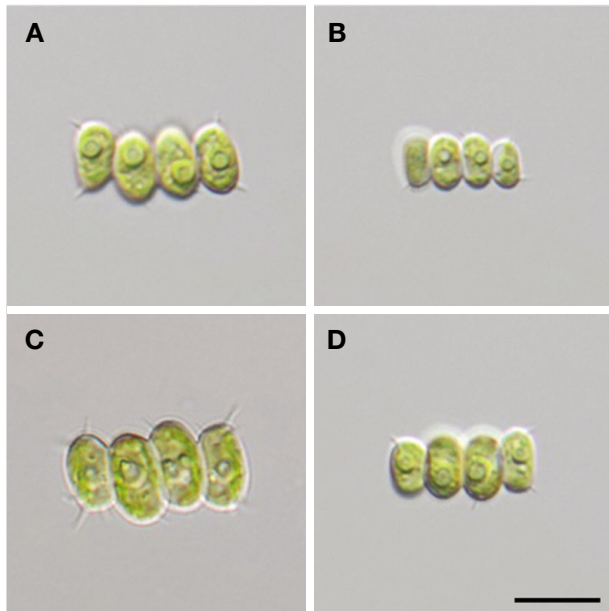
Coenobia are composed of 2 to 8 cells in 1 or 2 rows, with flat, straight and slightly curved. Cells are elongate, cylindrical, ovoid, ellipsoid to ovoid, with apices usually rounded. Cell walls are smooth, granular or warty. Chloroplast is parietal, with a single pyrenoid.

#### *Scenedesmus nanus* Chodat 1913 (Fig. 1)

**Synonym:** *Scenedesmus carabus* Chodat 1926

Coenobia are composed of 2 to 4 cells, connected to the 1/2–2/3 of the cell length, and arranged to alternate slightly. The cells are oval in shape, and cell walls are smooth. A short spine appears on both ends of the outer cell, and a rare spine appears on the inner cell. The length of cell is 5.5–10.5  $\mu\text{m}$ , and the width of cell is 2.5–4.5  $\mu\text{m}$ .

**Ecology:** This species is rarely found in many ponds and reservoirs (Komárek and Fott 1983). We collected it from



**Fig. 1.** Microscopic photographs of *Scenedesmus nanus* Chodat. Scale bar: 10  $\mu\text{m}$ . A, B and D shows slightly and alternately arranged coenobia, C focuses on short spines appearing at both the ends of the outer cells and rare spines appearing on the inner cells.

brackish water on the southern coast of Korea.

**Distribution:** Iraq (Maulood *et al.* 2013), China (Liu and Hu 2012).

**Site of collection:** 784-1, Haechang-ri, Anyang-myeon, Jangheung-gun, Jeollanam-do.

**Date of collection:** August 7, 2017.

**Specimen Locality:** ACKU2017IR09

***Scenedesmus praetervisus* Chodat 1926 (Fig. 2)**

**Synonym:** *Scenedesmus armatus* var. *ecornis* f. *elegans* Hortobágyi 1943

*Scenedesmus armatus* var. *spinuliferum* West and West 1901

*Scenedesmus brasiliensis* var. *quadrangularis* (Corda) Borge 1936

*Scenedesmus brasiliensis* var. *spinuliferum* Fott and Komárek 1960

*Scenedesmus cieszynicus* Sosnowska 1956

Coenobia are composed of 2 to 4 cells, linear or slightly alternating, and sometimes gently curved. The cells are oval to almost cylindrical, sometimes slightly asymmetrical



**Fig. 2.** Microscopic photographs of *Scenedesmus praetervisus* Chodat. Scale bar: 10  $\mu\text{m}$ . A and B shows short spines on the long cell axis, C focuses on the ribs toothed slightly, and D is a lateral view of coenobia.

or ovate and poles are rounded, obtusely conical to rounded-polygon. One short spine is straight or slightly oblique to the long cell axis, and the other two spines appear parallel to the outer long axis. Ribs show entire or interrupted on the cell sides, sometimes slightly toothed. The length of cell is 12.8–13.1  $\mu\text{m}$ , and the width of cell is 5  $\mu\text{m}$ . The length of spines is 4–7  $\mu\text{m}$ .

**Ecology:** This species is planktonic and generally found in ponds and lakes. Most occur in the temperate regions and rarely in the tropical regions (Komárek and Fott 1983). We collected it from brackish water on the East coast.

**Distribution:** Netherlands (Veen *et al.* 2015), China (Liu and Hu 2012).

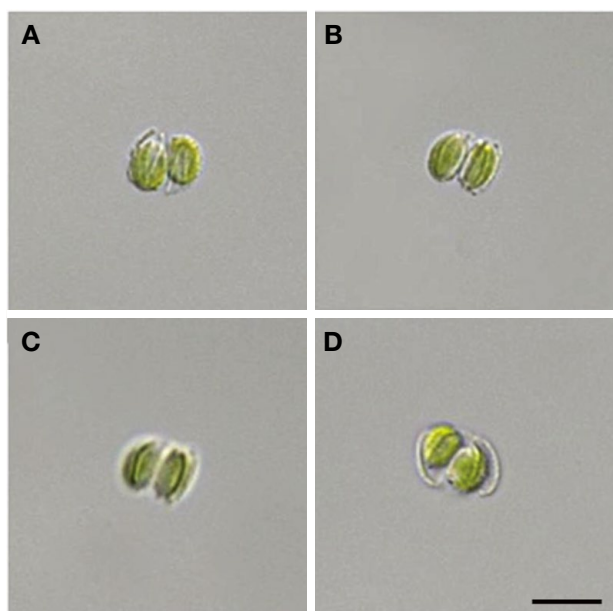
**Site of collection:** 163-49, Bugu-ri, Buk-myeon, Uljin-gun, Gyeongsangbuk-do.

**Date of collection:** May 31, 2017.

**Specimen Locality:** ACKU2017NR08

Family Scenedesmaceae

Genus *Desmodesmus* (Chodat) An, Friedl and Hegewald 1999



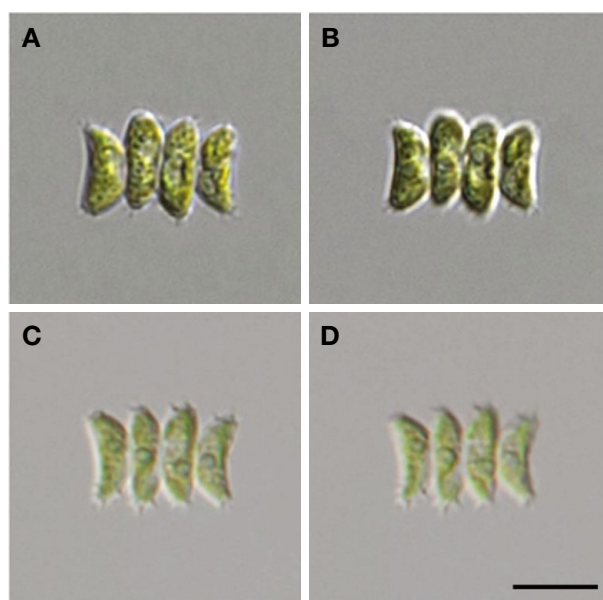
**Fig. 3.** Microscopic photographs of *Desmodesmus costato-granulatus* (Skuja) Hegewald. Scale bar: 10  $\mu\text{m}$ . A–D shows 2 cells of coenobia, especially C focuses on the ribs, and D represents the mother cell wall with granules.

Coenobia are composed of 2 to 8 cells in one row, with flat, straight and slightly curved. Cells are elongate, cylindrical, ovoid, ellipsoid to ovoid, with apices rounded, truncate capitate, or narrowing to an obtuse point and always bearing long spines or teeth. Cell walls are smooth granular, spiny or toothed, with nipple-like projections or ribs often present in various combinations. Chloroplast is parietal, with a single pyrenoid.

***Desmodesmus costato-granulatus* (Skuja) Hegewald 2000 (Fig. 3)**

**Synonym:** *Scenedesmus costato-granulatus* Skuja 1948

Coenobia are composed of 2 to 4 cells, with linear cells connected to three quarters of the cell length, completely disintegrating in the cultures. Cells are oblong ellipsoidal-oval, and conical-rounded at the poles, convex on the outside. Along the sides of the cell are some irregular rows of differently sized, colorless to dark, often merging into an incomplete. Between these ribs, granules of rib-like structure are scattered individuals. The length of cell is 4–4.7  $\mu\text{m}$ , and the width of cell is 2.3–3  $\mu\text{m}$ .



**Fig. 4.** Microscopic photographs of *Desmodesmus lunatus* (West and West) Hegewald. Scale bar: 10  $\mu\text{m}$ . A and B show the outer cells as semilunate-shaped with the poles bent outwards. C and D show the appearance of 1–3 short spines at the end of the cell.

**Ecology:** This species is found in slowly flowing reaches of rivers, ponds and lakes (John *et al.* 2011). We collected this species from a small pond in hill.

**Distribution:** Netherlands (Veen *et al.* 2015).

**Site of collection:** Dongbaekdongsan, Seonheul-ri, Jocheon-eup, Jeju-si, Jeju-do, Republic of Korea.

**Date of collection:** May 20, 2017.

**Specimen Locality:** ACKU2017NR06

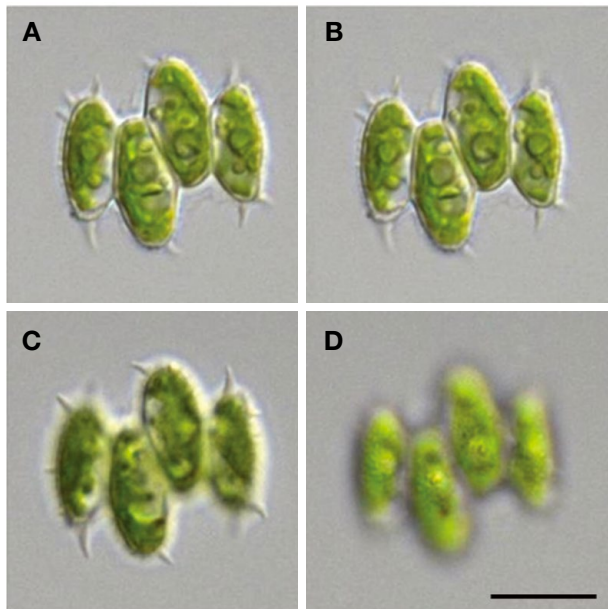
***Desmodesmus lunatus* (West and West) Hegewald 2000 (Fig. 4)**

**Synonym:** *Scenedesmus denticulatus* var. *lunatus* West and West 1895

*Scenedesmus lunatus* (West and West) Chodat 1926

Coenobia are composed of 2 to 8 cells, approximately 1/3 of the cells are linear or slightly alternating. The outer cells are semilunate-shaped with the poles bent outwards, and the inner cells are almost straight. At the end of the cell, 1–3 short teeth appear like spines. The length of cell is 9–9.6  $\mu\text{m}$ , and the width of cell is 3–3.5  $\mu\text{m}$ .

**Ecology:** This species is found mainly in the tropic areas



**Fig. 5.** Microscopic photographs of *Desmodesmus spinulatus* (Biswas) Hegewald. Scale bar: 10  $\mu\text{m}$ . A and B show an alternate arrangement of coenobia, C focuses on the rounded poles with 2–3 mighty and divergence spines, and D represents the presence of granules on the cell wall.

and lives in small ponds with many aquatic plants (Komárek and Fott 1983). We collected this species from a small pond.

**Distribution:** China (Liu and Hu 2012), Netherlands (Veen *et al.* 2015).

**Site of collection:** Kyonggi Univ., 154-42, Gwanggyo-san-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, Republic of Korea.

**Date of collection:** November 7, 2017.

**Specimen Locality:** ACKU2017NR07

***Desmodesmus spinulatus* (Biswas) Hegewald 2000 (Fig. 5)**

**Synonym:** *Scenedesmus spinulatus* Biswas 1934

*Scenedesmus polydenticulatus* Hortobágyi 1969

Coenobia are composed of 4 cells and slightly alternate (Komárek and Fott 1983, p. 869, fig. 10) or linear (Biswas 1934). Cells are oblong, oval-cylindrical with rounded poles on which 2–3 mighty, striking, different sized and divergence spines show. Some of these teeth on the outer cells are often oriented perpendicular to the long axis of the cell. The outer sides of the marginal cells covered with rows

of very dense, fine, short, hair-like spines. The length of the spine is 2–5  $\mu\text{m}$ , the cell is 10.9–11.3  $\mu\text{m}$ , and the width of the cell is 4.2–5.4  $\mu\text{m}$ .

**Ecology:** This species is rarely found in ponds (Komárek and Fott 1983). We collected this species from the static reservoir.

**Distribution:** India (Gupta 2012), China (Liu and Hu 2012), Russia (Medvedeva and Nikulina 2014).

**Site of collection:** Yonggok reservoir, Yonggok-ri, Jangdong-myeon, Jangheung-gun, Jeollanam-do.

**Date of collection:** August 7, 2017.

**Specimen Locality:** ACKU2017NR09

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