



Additions to the six taxa of the genus *Cosmarium* (Desmidiaceae, Charophyta) in Korea

Ok-Min Lee*

Department of Life Science, College of Natural Science, Kyonggi University, Suwon 16227, Korea

Abstract

The samples were collected at lowland swamps, reservoirs, mountainous wetlands, and sphagnum bogs from 2012 to 2014. The followings were newly recorded in Korea: two species, three varieties, and one form, including six taxa of the genus *Cosmarium*. The newly recorded Korean species were *Cosmarium bioculatum* var. *hians*, *C. bireme*, *C. pseudobiremum*, *C. nitidulum* var. *pseudorectangulare*, *C. trilobulatum* f. *retusum*, and *C. trilobulatum* var. *depressum*. The flora of the genus *Cosmarium* contains 303 taxa in total in Korea. The specimens were cultured and deposited on the algal culture collection of Kyonggi University (ACKU) and National Institute of Botanical Resources (NIBR).

Key words: flora, freshwater algae, genus *Cosmarium*, newly recorded species of Korea

INTRODUCTION

Desmids, which are exclusively freshwater algae, attracted the attention of early microscopists due to their forms. In particular, they exhibit great diversity in their external morphology and show a remarkably complex cell symmetry. As consequence of their diversity, more than 6,000 species have been described from fresh water in all parts of the world (Brook 1981). *Cosmarium* is the genus that typifies desmids. The cells are usually solitary, having a well-marked median constriction and semicells that are entire in outline, without lobes of any sort. As the great variability in size and form among *Cosmarium* species became apparent, the concept of polyphyletic evolution emerged among taxonomists. Recent assessments of the genus concept with molecular tools confirmed the polyphyletic nature of almost all traditional genera in the Desmidiaceae (Nam and Lee 2001a, 2001b, Moon and Lee 2003, 2004a, Gontcharov and Melkonian 2005, Hall et al. 2008a, 2008b). The most complex pattern of phyloge-

netic relationships was revealed in the traditional genus *Cosmarium* with its species being distributed among 11 mostly well-supported clades (Gontcharov and Melkonian 2008). In analyses of 291 *rbcL* sequences of the family Desmidiaceae, molecular phylogenetic data have shown that these morphological characteristics are highly homoplastic or plesiomorphic and thus cannot be used to delineate genera (Gontcharov and Melkonian 2011).

This genus is one of the earliest described genera of the Placoderm desmids and one of the largest, including as many as 1,275 species and hundreds of subspecific taxa. A conservative estimate is that 5% of these species occur in synonym (Prescott et al. 1981).

In Korea, a total of 267 species of the genus *Cosmarium* were reported before 1996. These can be divided into 122 species, 110 varieties, and 35 forms (Lee 1996). Since then, more newly found species in Korea have been recorded, bringing the total to 297 species (Moon and Lee 2004b,

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*Corresponding Author

E-mail: omlee@kyonggi.ac.kr

Tel: +82-31-249-9643

www.kci.go.kr

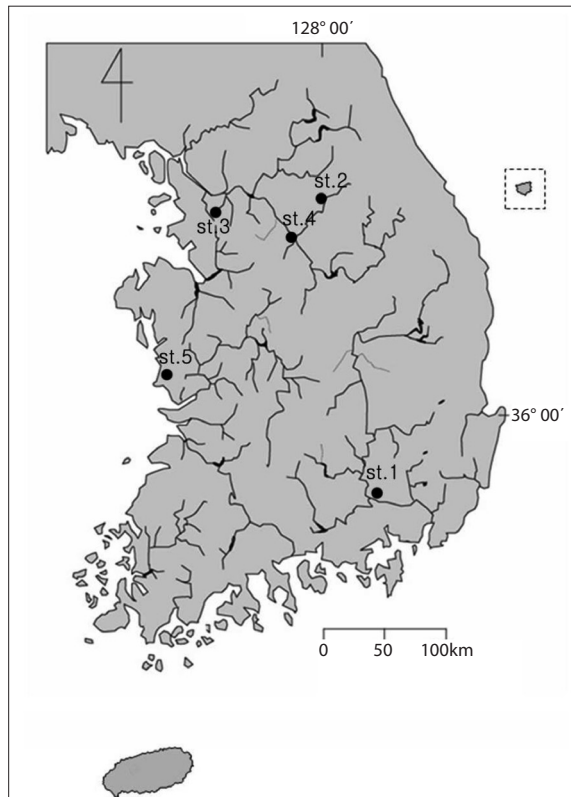


Fig. 1. The map showing the sampling sites for genus *Cosmarium* in Korea from June 2012 to October 2014.

Park and Lee 2004, Lee et al. 2007, NIBR 2010). By adding more Korean newly recorded species, this study contributes to the floristic research of Korean *Cosmarium*.

MATERIALS AND METHODS

The samples were collected at lowland swamps, reservoirs, mountainous wetlands, and sphagnum bogs from 2012 to 2014 (Fig. 1). Station 1 was Beongae Lake in Yeongsan-myeon, Changnyeong-gun, Gyeongsangnam-do. Station 2 was Gosan Reservoir in Gosan-ri, Hohjeomyon, Wonju-si, Gangwon-do. Station 3 was Sindae Reservoir in Ha-dong, Yeongtong-gu, Suwon-si, Gyeonggi-do. Station 4 was a small stream that flowed into the Namhan River in Dangwu-ri, Buknae-myeon, Yeosu-gun, Gyeonggi-do. Station 5 was Weolgae Reservoir in Weoljeon-ri, Nampo-myeon, Boryeong-si, Chungcheongnam-do.

Freshwater algae were collected from phytoplanktonic and periphytic samples by using a phytoplankton net and a soft brush or by squeezing submerged macrophytes. Each sample was sealed and refrigerated in a light-tight container with sterilized distilled water and transferred to

the laboratory. Some of the samples were fixed and stored in 1% formalin. Enriched cultures of algae were made in Bold's basal medium (Stein 1973), maintained in the algal culture collection of Kyonggi University (ACKU), and deposited at the National Institute of Botanical Resources (NIBR) in Korea.

The taxonomic classification system used was based on John et al. (2002) and Algaebase (Guiry and Guiry 2015). The taxa were identified based on the work of West and West (1908), West et al. (1923), Krieger and Gerloff (1962), Prescott et al. (1972, 1981), Hirose et al. (1977), Chung (1993), and Coesel and Meesters (2007). The samples were examined at $\times 400$ – $1,000$ magnification under an Axio Imager A2 Microscope (Carl Zeiss, Oberkochen, Germany), and photomicrographs were taken with an AxioCam HRC camera (Carl Zeiss).

RESULTS AND DISCUSSION

The followings were newly recorded in Korea: two species, three varieties, and one form, including six taxa of the genus *Cosmarium*. The newly recorded Korean species were *Cosmarium bioculatum* var. *hians*, *C. bireme*, *C. nitidulum* var. *pseudorectangulare*, *C. pseudobiremum*, *C. trilobulatum* f. *retusum*, and *C. trilobulatum* var. *depressum*.

The morphological and ecological characteristics of the seven taxa were as follows:

Phylum Charophyta
Class Conjugatophyceae
Order Desmidiiales
Family Desmidiaceae
Genus *Cosmarium* Corda ex Ralfs 1848: 91

***Cosmarium bioculatum* var. *hians* West and West 1897 (Fig. 2)**

Reference: West and West 1897, p. 486, pl. 6, fig. 24.

The cells are small, and the length is 1.12 to 1.13 times longer than the width. The median constriction is deeply constricted, and the sinus is more open, somewhat conical, and subacute at the apex. The lower margins of the semicells are convex, and the apices are straight. The cell walls are distinctly but minutely punctate. The length is 18–19 μm , the width is 16–17 μm , and the isthmus is 3–4 μm .

Distribution: England (West and West 1905), US (Michigan, New York), Europe, Asia, and Arctic (Prescott et al. 1981).

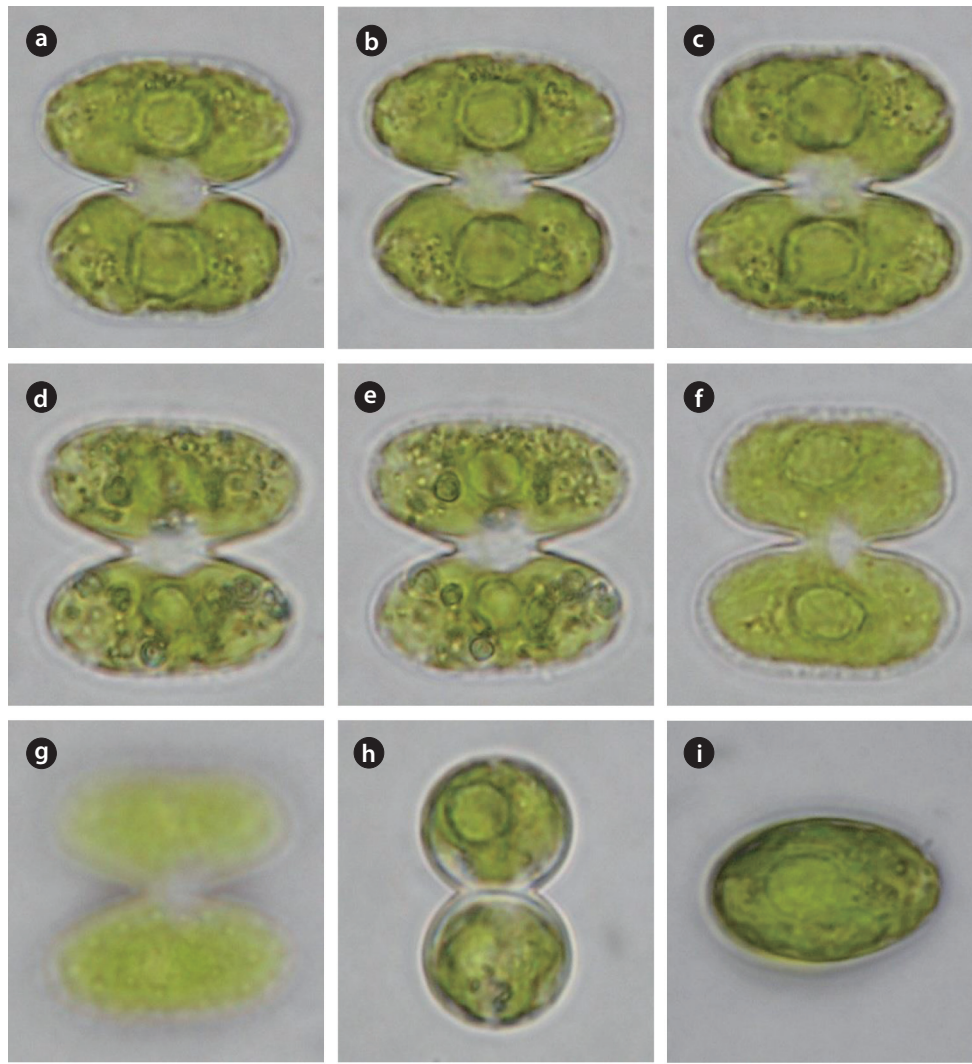


Fig. 2. The photographs are the facial views (a-g), the lateral view (h) and the vertical view (i) for *Cosmarium bioculatum* var. *hians* West and West, taken with the cultured samples from the algal culture collection of Kyonggi University. The scale bar represents 10 μ m.

Ecology: This species occurred in meso- and eutrophic lakes, especially acidic ponds (Coesel and Meesters 2007).

Site of collection: Small stream that flowed into the Namhan-River in Dangwu-ri, Buknae-myeon, Yeosu-gun, Gyeonggi-do (site 4).

Date of collection: June, 2012.

Specimen locality: ACKU1-407.

***Cosmarium bireme* Nordstedt 1870 (Fig. 3)**

Reference: Nordstedt 1870, p. 212, pl. 3, fig. 33.

The cells are small and about as long as they are broad. The median constriction is deep, and the sinus is closed linearly. The semicells are angular-elliptical with flattened apices, having strong papillae in the middle of the semi-

cells that are clearly seen in all views. In the lateral view, the semicells are subcircular; in the vertical view, the cells are elliptical. The wall is smooth and finely punctate. The length is 15–17 μ m, the width is 13–16 μ m, and the isthmus is 4.5–5.4 μ m.

Distribution: US (Indiana, Kentucky, Mississippi, Washington), England, Europe, Asia, Africa, and Arctic (Prescott et al. 1981).

Site of collection: Weolgae Reservoir in Weoljeon-ri, Nampo-myeon, Boryeong-si, Chungcheongnam-do (site 5).

Date of collection: October, 2014.

Specimen locality: ACKU1-230, NIBRCL0000109482.

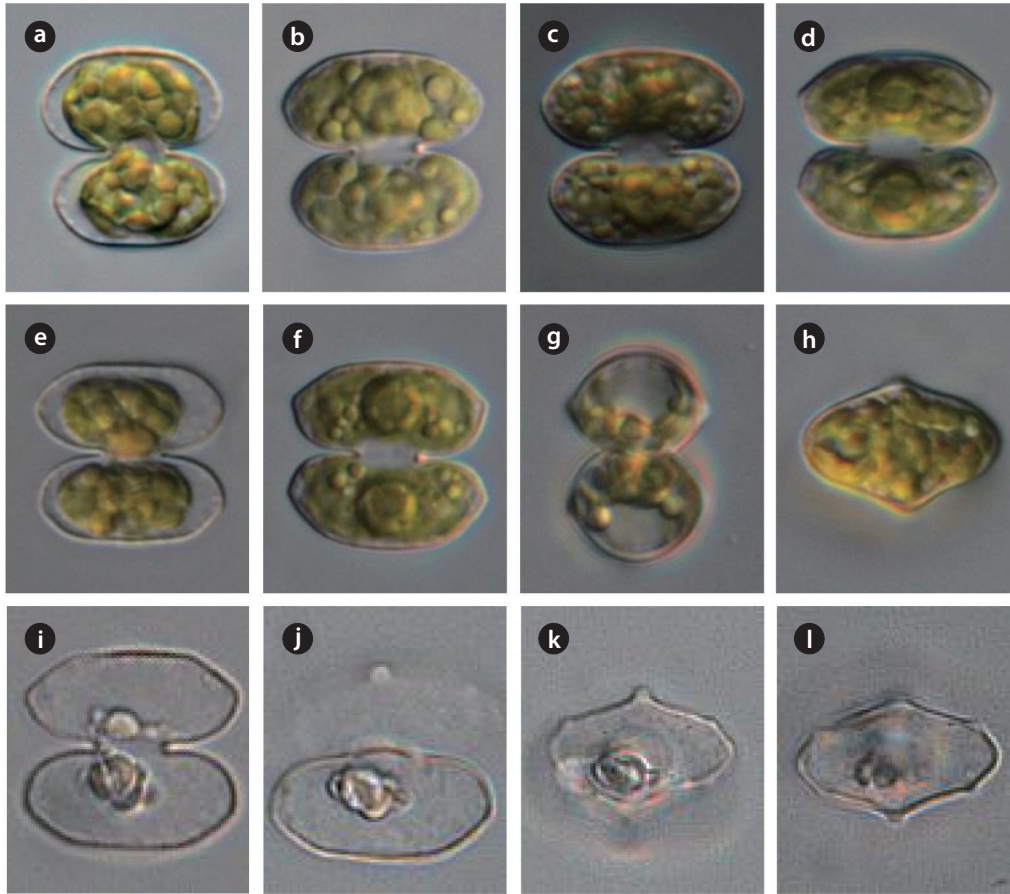


Fig. 3. The photographs are the facial view (a-f, i), the lateral view (g) and the vertical view (h, j-l) for *Cosmarium bireme* Nordstedt, taken with the cultured samples from the algal culture collection of Kyonggi University. The scale bar represents 10 μ m.

***Cosmarium nitidulum* var. *pseudorectangulare* Messikommer 1938 (Fig. 4)**

Synonym: *Cosmarium pseudorectangulare* Gronblad 1921.

Reference: Gronblad 1921, p. 40, Pl. 7, Figs. 47, 48; Messikommer 1938, p. 172, pl. III, figs. 24-26; Krieger and Gerloff 1962, p. 238, Pl. 42, Fig. 4; Fuzinato et al. 2011, pp 77-95.

The cells are small to medium-sized, and the length is 1.25 times longer than the width. The median constriction is deep, and the sinus is narrow and linear. The semicells are hexagonal, the lower angles are angled, the lateral margin is convex, divergent toward the apex, and the apex is narrowly truncate. The lateral view cells are circular, and the vertical view cells are elliptical with a median convex. The length is 19–27 μ m, the width is 14–19.5 μ m, and the isthmus is 4–5.5 μ m.

Distribution: US (California, Massachusetts) (Prescott et al. 1981) and Serbia (Fuzinato et al. 2011).

Site of collection: Beongae Lake in Yeongsan-myeon,

Changnyeong-gun, Gyeongsangnam-do (site 1).

Date of collection: July, 2014.

Specimen locality: ACKU1-036, NIBRCL0000109483.

***Cosmarium pseudobiremum* Boldt 1885 (Fig. 5)**

Reference: Boldt 1885, p. 102, Pl. 5, Fig. 6; De Toni 1889, p.1042.

The cells are small and about as long as they are broad. The median constriction is deep, and the sinus is narrow. The semicells are transversely hexagonal elliptical, the lateral angles are obtuse, the superior angles are broadly rounded, and the apex is wide and almost truncate (faintly convex). The lateral view of the semicells is subcircular, while the vertical view is narrowly elliptical, with a rather broad protuberance at the middle on each side. The cell wall has puncta. The length is 14.6–21.2 μ m, the width is 14–22 μ m, and the isthmus is 4.2–6.9 μ m.

Distribution: Greenland and Siberia (West and West 1905).

Site of collection: Sindae Reservoir in Ha-dong, Yeong-



Fig. 4. The photographs are the facial views (a-d), the lateral view (e) and the vertical view (f) for *Cosmarium nitidulum* var. *pseudorectangulare* Messikommer, taken with the cultured samples from the algal culture collection of Kyonggi University. The scale bar represents 10 μ m.

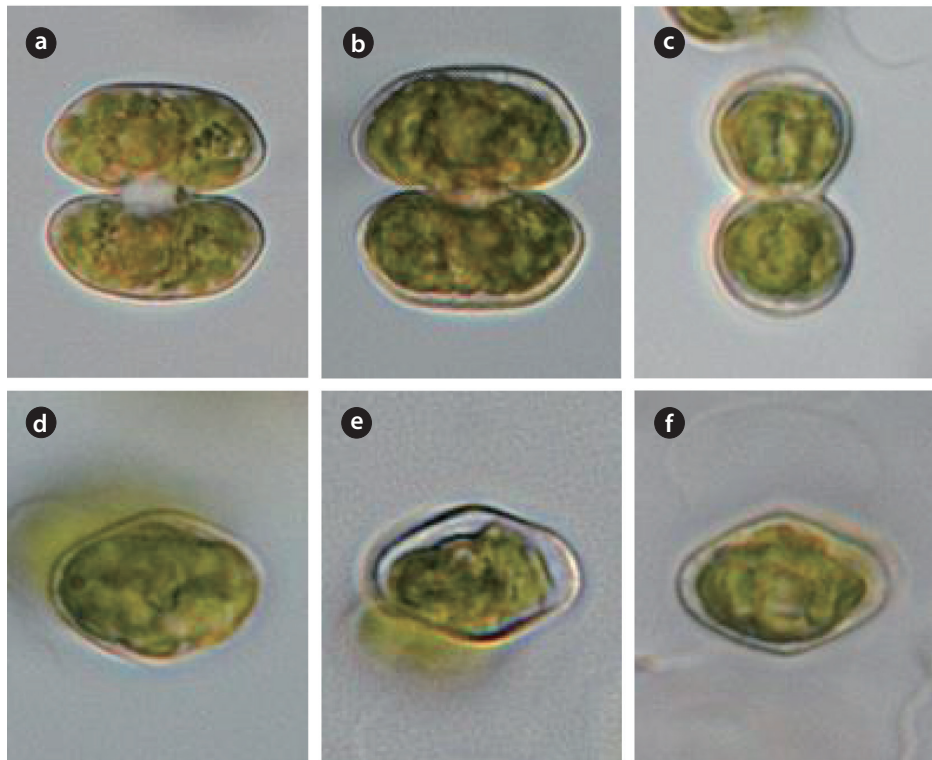


Fig. 5. The photographs are the facial views (a-b), the lateral view (c) and the vertical view (d-f) for *Cosmarium pseudobirenum* Boldt, taken with the cultured samples from the algal culture collection of Kyonggi University. The scale bar represents 10 μ m.

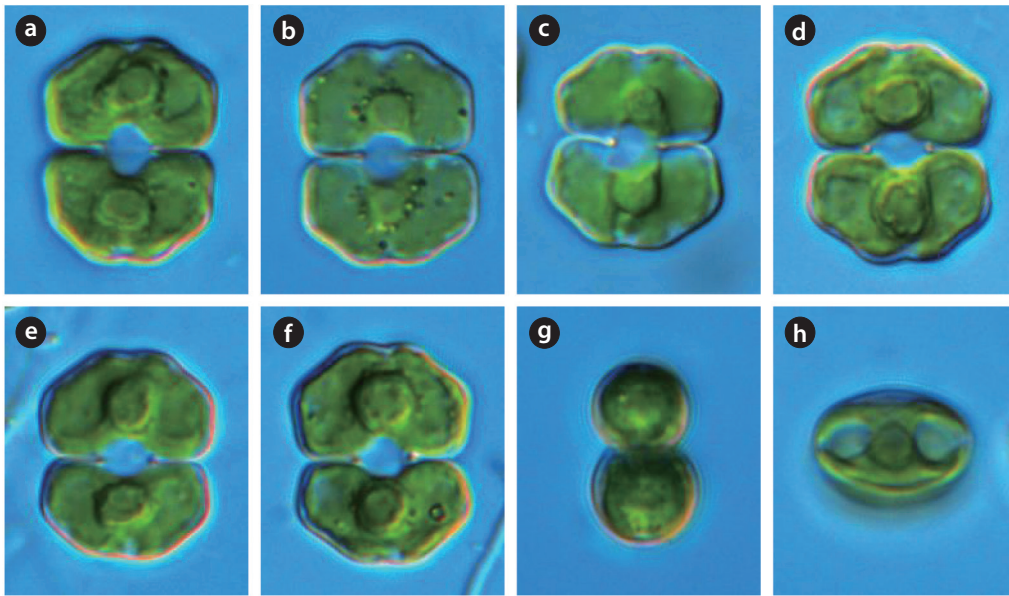


Fig. 6. The photographs are the facial views (a-f), the lateral view (g) and the vertical view (h) for *Cosmarium trilobulatum* var. *trilobulatum* f. *retusum* Gutwinski, taken with the cultured samples from the algal culture collection of Kyonggi University. The scale bar represents 10 μ m.

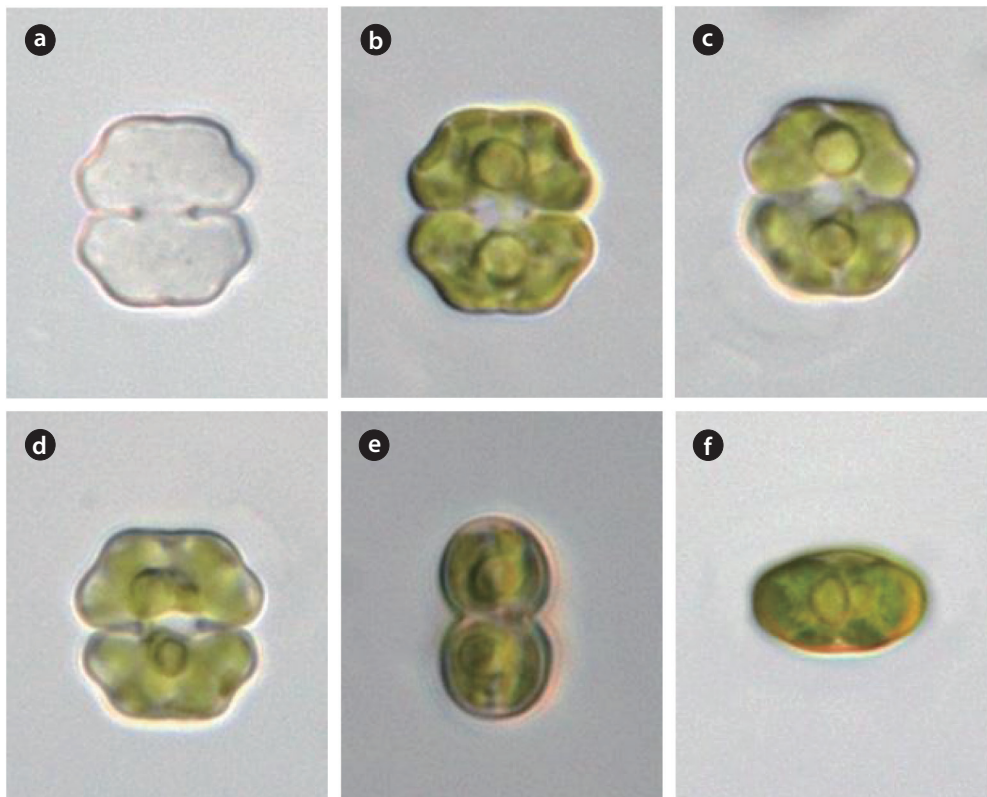


Fig. 7. The photographs are the facial views (a-d), the lateral view (e) and the vertical view (f) for *Cosmarium trilobulatum* var. *depressum* Printz, taken with the cultured samples from the algal culture collection of Kyonggi University. The scale bar represents 10 μ m.

tong-gu, Suwon-si, Gyeonggi-do (site 3).

Date of collection: June, 2013.

Specimen locality: ACKU1-503, NIBRCL0000109484.

Cosmarium trilobulatum* var. *trilobulatum* f. *retusum

Gutwinski 1892 (Fig. 6)

Synonym: *Cosmarium trilobulatum* f. *retusa* Reinsch, in Wade (1952).

Reference: Gutwinski 1892, p. 42. Pl. 1, Fig. 16; Wade 1952, p. 217, Pl. 16, Fig. 8.

This form differs from the typical in the lower lateral margins, and the apexes of the semicells are distinctly retuse. The length is 15.5–17.5 μm , the width is 12.7–14 μm , and the isthmus is 3.8–4.3 μm .

Distribution: US (Michigan), Europe, New Zealand, and Arctic (Prescott et al. 1981).

Site of collection: Small stream that flows into the Namhan-River in Dangwu-ri, Buknae-myeon, Yeosu-gun, Gyeonggi-do (site 4).

Date of collection: October, 2014.

Specimen locality: ACKU1-397.

***Cosmarium trilobulatum* var. *depressum* Printz 1915 (Fig. 7)**

Reference: Printz 1915, p. 22, Pl. 2, Fig. 42.

This variety is distinguished from the typical by its smaller size, convex lower lateral margins, and rounded lower angles. The apex is wide and truncate, sometimes with a slight notch in the mid-region. The length is 11.8–13.8 μm , the width is 10.8–12.6 μm , and the isthmus is 2.7–3.6 μm .

Distribution: Sweden (Krieger and Gerloff 1962).

Site of collection: Gosan Reservoir in Gosan-ri, Hohjeomyon, Wonju-si, Gangwon-do (site 2).

Date of collection: May, 2014.

Specimen locality: ACKU1-126, NIBRCL0000109485.

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