

# New records of coccoid green algae in Korea

Yong Jae Kim\*

Department of Life Science, Daejin University, Pocheon 11159, Republic of Korea

\*Correspondent: yjkim@daejin.ac.kr

Coccoid green algae collected from March to November 2015 from 79 freshwater ecosystem sites throughout South Korea, including lakes, ponds, swamps, streams, and rivers, were identified using light microscopy. A total of 218 taxa were identified, among which 11 were new species records in Korea; these 11 species were found at four sites (Hanagang River, Chukdong reservoir, Chukdong fishery, and Deokjin reservoir). The new species recorded were *Fotterella tetrachlorelloides*, *Trochiscia naumannii*, *Keriochlamys styriaca*, *Placosphaera opaca*, *Siderocystopsis fusca*, *Siderocelis oblonga*, *Siderocelis estheriana*, *Pachycladella umbrina*, *Pachycladella zatoriensis*, *Crucigenia mucronata* and *Scenedesmus sempervirens*.

Keywords: coccoid green algae, new recorded species, South Korea

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## INTRODUCTION

The Chlorococcales is one the major green algal orders. The order is broadly defined as coccoid green algae that occur in unicellular or colonial form (Bold and Wynne, 1985). The coccoid green algae, which occur in planktonic and benthic habitats in eutrophic waters, belong to the division Chlorophyta. In summer and fall their increased abundance can form blooms that confer green coloration to affected water systems (Hindak, 1977). This coccoid algal flora includes 15 families, 148 genera, and 1025 species (Komárek and Fott, 1983), which was the climax of the morphological species concept for the coccoid green algae (Krientiz and Bock, 2012).

Coccoid taxa included in Chlorophyceae by Komárek and Fott (1983) and John and Tsarenko (2002). In the recently, however, the coccoid taxa in the division Chlorophyta divided in three different classes; the Chlorophyceae, Trebouxiophyceae and Prasinophyceae (Krientiz and Bock, 2012). The coccoid taxa in the Chlorophyceae are separated in two orders (the Chlorococcales *sensu stricto* and Sphaeropleales), with the only taxa remaining in the order Chlorococcales *sensu stricto* being the genus *Chlorococcum* and some taxa still under revision (Krientiz and Bock, 2012). Many nonmotile unicellular or colonial taxa including *Ankyra*, *Pediastrum*, *Scenedesmus*, and *Selenastrum* are included in the order Sphaeropleales (Krientiz *et al.*, 2001; 2003). Two major orders of coccoid taxa (Trebouxiales and Chlorellales) are classified

in the class Trebouxiophyceae. Some genera (*Trebouxia*, *Chloroidium*, and *Myrmecia*) have been included in the order Trebouxiales, and several other genera including *Chlorella*, *Dictyosphaerium*, and *Micractinium* have been placed in the order Chlorellales (Krientiz and Bock, 2012).

The samples in this study were collected from lakes, ponds, and rivers at 79 sites in South Korea. This study provides the first report of coccoid green algal taxa from South Korea.

## MATERIALS AND METHODS

Planktonic algae were obtained from samples collected using 10 µm or 20 µm mesh-sized plankton nets towed vertically and/or horizontally through the water, and benthic or soil algae were obtained from samples collected using a spade or brush. The samples are immediately fixed using Lugol's iodine solution (0.5%), which immobilized the cells to facilitate microscopic examination. To examine the fine structure and cellular shapes, and to identify and classify the coccoid species, temporary microscope slides of the algae were made by mixing the phytoplankton samples with glycerin in micro tubes, transferring drops of the mixture to glass slides, and covering with cover slips. Permanent slides were made by mixing phytoplankton samples with liquid glycerol gelatin, transferring drops of the mixture to histochemical slides (Sigma), covering with cover slips,

and sealing the margins of the cover slips with nail polish. (Thecashop). The temporary and permanent slides were observed at  $\times 200$ -1000 magnification using light microscopy (Axioskop 20 and Axio Imager A2; Zeiss, Germany); an attached digital camera (Zeiss AxioCam HRC, Germany) was used to capture images. The scale bars in the illustrations represent 10  $\mu\text{m}$ .

At each site the water temperature (WT:  $^{\circ}\text{C}$ ), electrical conductivity (EC:  $\mu\text{S}/\text{cm}$ ), and pH were measured during the sampling period using a U-50 multiparameter water quality meter (Horiba, Japan).

## RESULTS AND DISCUSSION

In total, 218 taxa of green algae were identified and classified from among the 79 sampling sites. These included 11 species of green coccoid algae obtained from four sites (Seogangdaegyo, Han River, Chukdong reservoir, Chukdong fishery, and Deokjin reservoir), which represent new species records for Korea. These species were *Fotterella tetrachlorelloides*, *Trochiscia naumannii*, *Keriochlamys styriaca*, *Placosphaera opaca*, *Siderocystopsis fusca*, *Siderocelis oblonga*, *Siderocelis estheriana*, *Pachycladella umbrina*, *Pachycladella zatoriensis*, *Crucigenia mucronata* and *Scenedesmus sempervirens*.

Class Chlorophyceae  
Order Chlorococcales  
Family Oocystaceae  
Genus *Fotterella* Buck 1978

### *Fotterella tetrachlorelloides* Buck (Fig. 2a-c)

**References:** Komárek and Fott 1983: 484, pl. 143, fig. 1.

**Synonym:** *Crucigenia irregularis* var. *pyrenogera* Chodat *sensu* Huber-Pestalozzi.

*Scenedesmus arcuatus* var. *irregularis* Flint.

*Oocystis submarina* var. *mucosa* Wawrik.

*Tetrachlorella tetrachlorelloides* (Buck) Hindak.

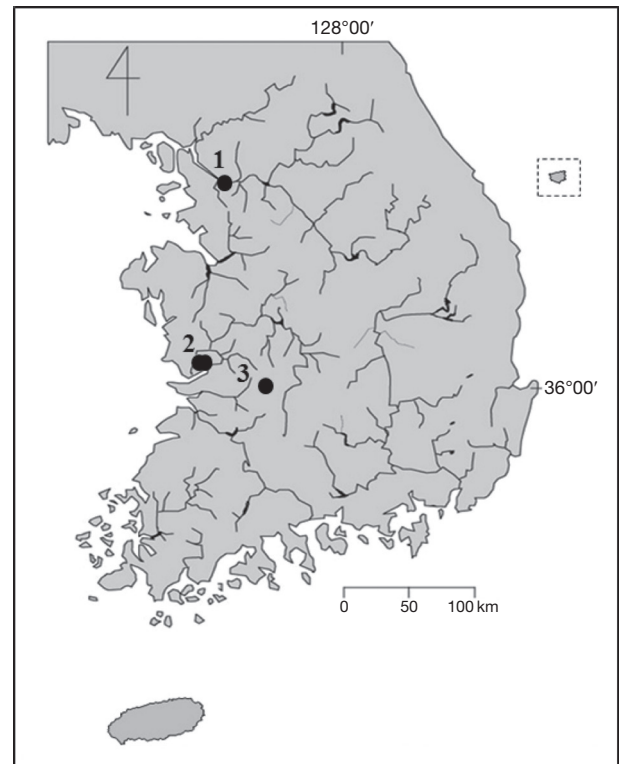
**Occurrence site:** Seogangdaegyo, Han River (WT 30 $^{\circ}\text{C}$ , EC 376  $\mu\text{S}/\text{cm}$ ).

**Description:** Colonies composed of 2, 4, 6, 8 or 16 cells, apparently lacking a mucilaginous sheath, but with a persistent mother cell wall. Cells ellipsoidal or oval, surrounded by a distinct mother cell wall, 12-16  $\mu\text{m}$  in length and 8-13  $\mu\text{m}$  in width.

**Distribution:** Eutrophic lakes of England, Austria, Switzerland (Komárek and Fott, 1983).

**Specimen:** NIBRCL0000112291; DAJIN-201500709-1.

**Remark:** This species was included in the family Oocystaceae, order Chlorococcales by Komárek and Fott (1983), but was moved to the family Oocystaceae, order Chlorellales, class Trebouxiophyceae by Guiry and



**Fig. 1.** Location of sampling sites of new recorded taxa in South Korea. 1. Seogangdaegyo, Han River (37 $^{\circ}$ 32'03", 126 $^{\circ}$ 55'18"), 2. Chukdong reservoir and fishery (36 $^{\circ}$ 06'34", 126 $^{\circ}$ 47'57"), 3. Deokjin reservoir (35 $^{\circ}$ 50'55", 127 $^{\circ}$ 07'15").

Guiry (2016). Hindak (1980) included this species in *Tetrachlorella* Korshikov as a synonym, but Komárek and Fott (1983) transferred it into *Fotterella* from *Tetrachlorella*, which has solitary or architectonic of cells in colonies.

Genus *Trochiscia* Kützing 1834

### *Trochiscia naumannii* Kol (Fig. 2d, e)

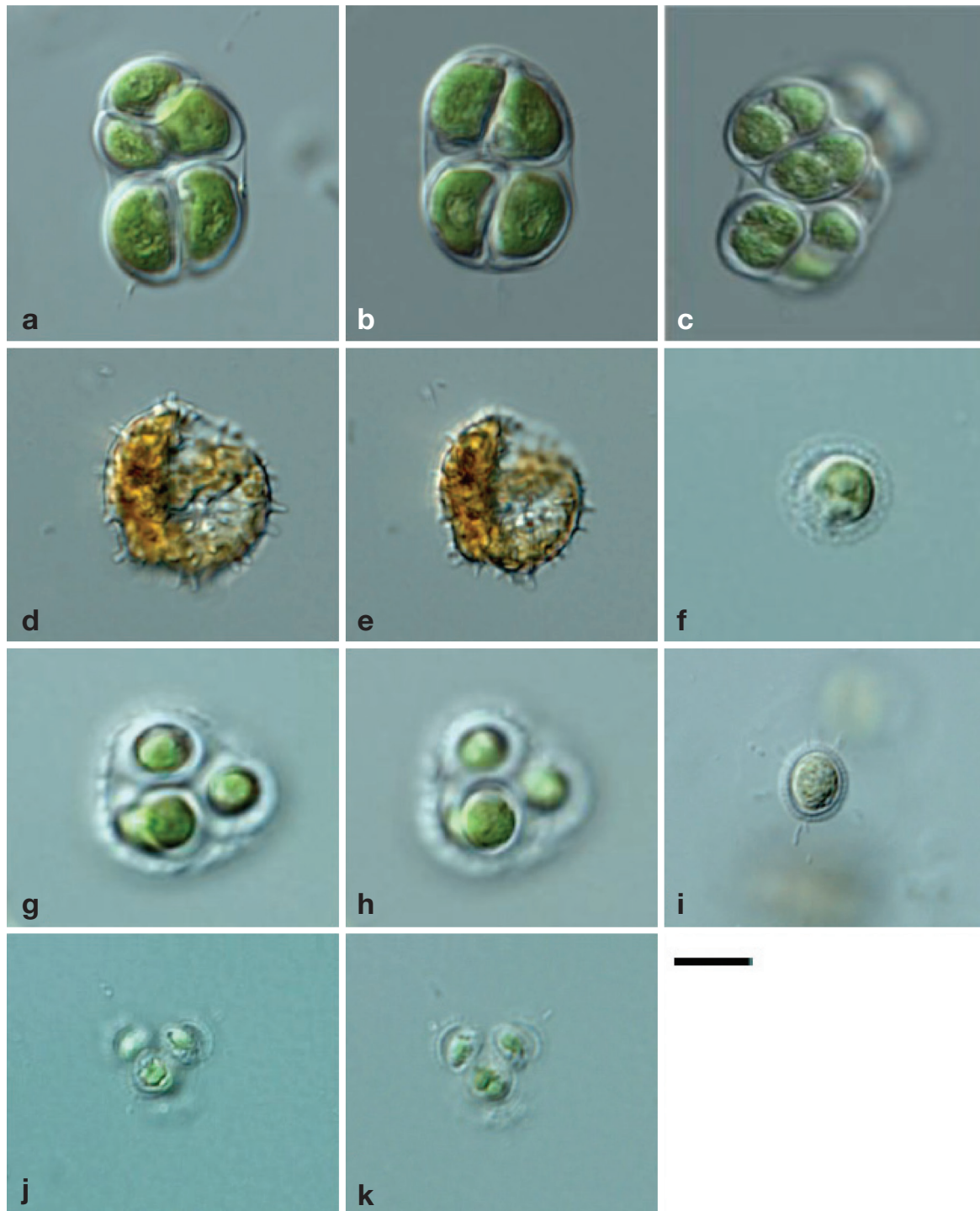
**References:** Komárek and Fott 1983: 456, pl. 136, fig. 5.

**Occurrence site:** Chukdong reservoir (WT 28.3 $^{\circ}\text{C}$ , pH 8.3. EC 213  $\mu\text{S}/\text{cm}$ ).

**Description:** This species is unicellular or solitary, and has a spherical to subspherical shape. The cell walls are thick, with numerous short projections. The cells have a single chloroplast containing a pyrenoid, and are 20-30  $\mu\text{m}$  in diameter.

**Specimen:** DAEJIN-20150603-1.

**Remark:** This species was first described by Kol (1937), but has not subsequently been clearly identified. Komárek and Fott (1983) reported this species but did not provide descriptions or original figures (only presented the figure of Kol, 1968). This species was initially clas-



**Fig. 2.** a-c. *Fotterella tetrachlorelloides*, d, e. *Trochiscia naumannii*, f-h. *Keriochlamys styriaca*, i-k. *Placosphaera opaca*. Scale bar is 10  $\mu$ m.

sified in the family Oocystaceae, order Chlorococcales by Komárek and Fott (1983), but Guiry and Guiry (2016) included it in the family Oocystaceae and order Chlorellales in the class Trebouxiophyceae.

Family Chlorellaceae  
Genus *Keriochlamys* Pascher 1943

***Keriochlamys styriaca* Pascher (Fig. 2f-h)**

**References:** Komárek and Fott 1983: 607, pl. 170, fig. 4; Shubert 2003: 288, fig. 15E.

**Occurrence site:** Chukdong reservoir.

**Description:** This species is free floating and globular or semiglobular in shape. It is readily identified by the thick wall, which has alveoli that refract light. Each cell has a parietal chloroplast containing a pyrenoid. The cells are 8-10 µm in diameter.

**Distribution:** Southeastern United States (Dillard, 1989), India (Komárek and Fott, 1983). Austria (Komárek and Fott, 1983).

**Specimen:** NIBRCL0000112292; DAEJIN-20150603-2.

**Remark:** This species is unicellular or solitary, but has four autospores in a thick mother cell wall formed during asexual reproduction. Shubert (2003) reported this species in phytoplankton, and Komárek and Fott (1983) reported it from a highland bog. The alveoli in the thick wall is a distinctive characteristic for identification of this species. It was initially classified in the family Chlorellaceae, order Chlorococcales in the class Chlorophyceae, but Guiry and Guiry (2016) moved this species to the family Oocystaceae, order Chlorellales in the class Trebouxiophyceae.

Genus *Placosphaera* Dangeard 1889

#### *Placosphaera opaca* Dangeard (Fig. 2i-k)

**References:** Komárek and Fott 1983: 606, pl. 170, fig. 3; Showalter 1952: 113, fig. 1.

**Occurrence site:** Chukdong reservoir (WT 28.3°C, pH 8.3. EC 213 µs/cm).

**Description:** This species is unicellular, nonmotile, and spherical to slightly tetrahedral or elliptical in shape. The cell wall appears to radiate, and has a thick layer of platelet-like calcite crystals imbedded in a gelatinous sheath. A chloroplast located in center of the cell contains a pyrenoid. The cells are 20-30 µm in diameter.

**Distribution:** Caen, France (Dangeard, 1889), Muskrat swamp and Lake View, Kansas (Showalter, 1952), India (Komárek and Fott, 1983).

**Specimen:** NIBRCL0000112293; DAEJIN-20150603-3.

**Remark:** This species was first described from a swamp in Caen, France by Dangeard (1889). Showalter (1952) also collected this species from filamentous algae and other submerged or floating aquatic plants in lakes and ponds in Kansas, USA (not from the plankton). In the present study it was collected in plankton nets at shallow depths off the shore of Chukdong reservoir. This species was included in the family Chlorellaceae, order Chlorococcales, class Chlorophyceae by Komárek and Fott (1983), but Guiry and Guiry (2016) placed it in the family Tetrasporaceae, order Chlamydomonadales in the class Chlorophyceae. In this study it is classified accord-

ing to Komárek and Fott (1983).

Genus *Siderocystopsis* Swale 1964

#### *Siderocystopsis fusca* (Korshikov) Swale (Fig. 3a, b)

**References:** Hindak 1977: 60, pl. 25, figs. 1-10; Komárek and Fott 1983: 336, pl. 101, fig. 4.

**Synonym:** *Siderocystis fusca* Korshikov.

**Occurrence site:** Chukdong reservoir (WT 28.3°C, pH 8.3. EC 213 µs/cm).

**Description:** This species is unicellular and solitary, with oval or widely oval shape. Cell walls granulated on the surface as spine base and with numerous fine spines on the surface. A chloroplast is located in the center of each cell, and contains a pyrenoid. The cells are 6-10 0e in length and 4-8 4e in width.

**Distribution:** Slovakia (Hindak, 1977), England, Poland, Russia (Komárek and Fott, 1983).

**Specimen:** NIBRCL0000112294; DAEJIN-20150603-4.

**Remark:** This species has similarities with the genus *Franceia*, which has several fine spines on the cell surface, but it differs in having a granulated cell wall surface. The genus *Siderocystopsis* also differs from the genus *Siderocelis* both by the presence of numerous fine and long spines, and by the presence of unique fine spines at the periphery of parts of the cell wall of the mother cell, following the release of autospores (Hindak, 1977).

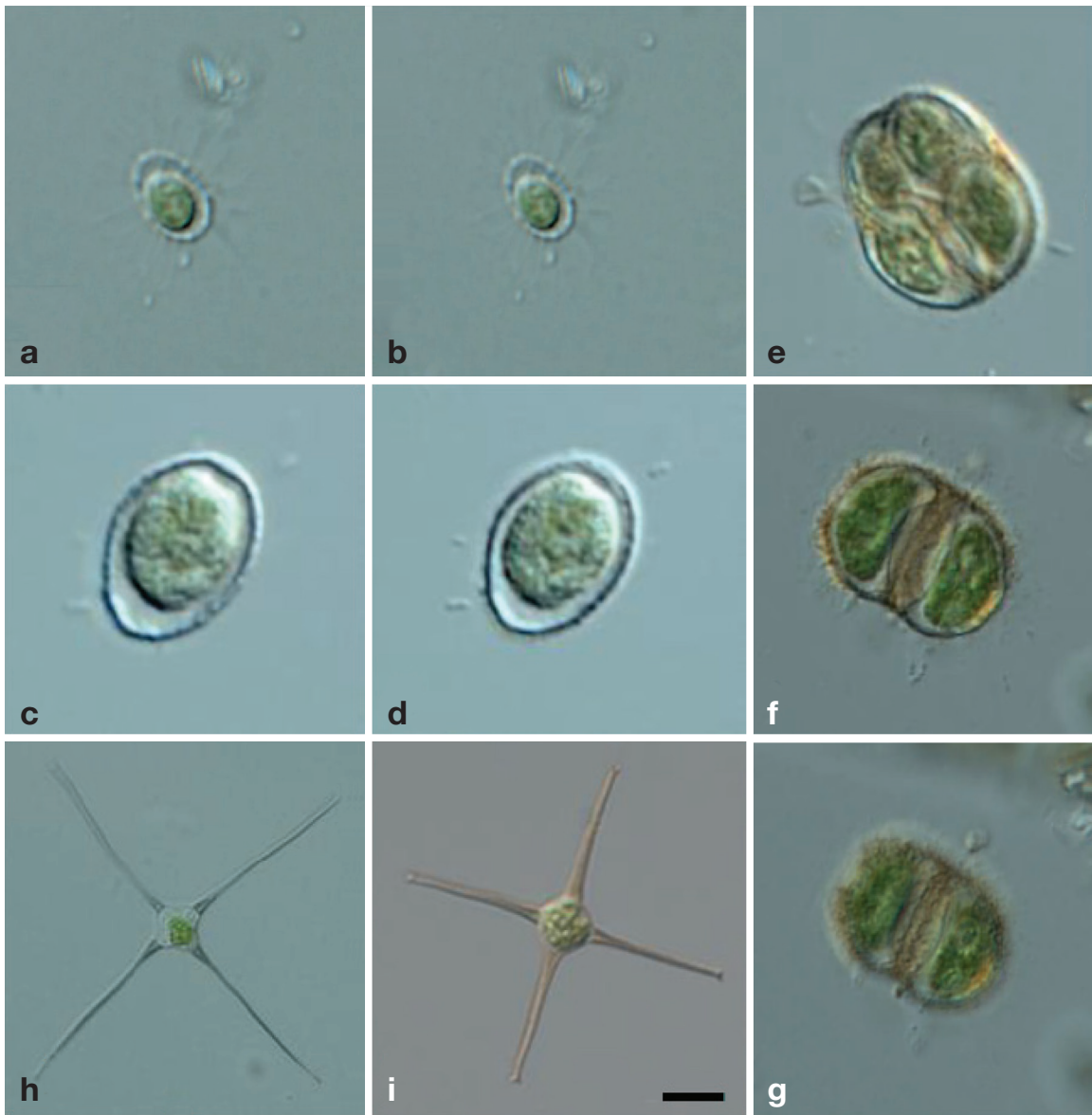
*Siderocystis fusca* was described by Korshikov (1953) and placed in the family Oocystaceae. Swale (1964) replaced the invalid genus name *Siderocystis* by *Siderocystopsis*, and Ettl and Komárek (1982) transferred the alga to the family Micractiniaceae. The bristles and cell wall structure of *Siderocystopsis* are different from *Micractinium* that *Siderocystopsis* were not due to a cell wall structure having intersecting cellulose fibrils, and in older cells having two chloroplasts each containing a single pyrenoid. (Hegewald and Schnepf, 1984). The description of *Golenkinia punctifera* by Bolochonzew (1903) is similar to the description and illustration of *Siderocystopsis fusca*. However, Hegewald and Schnepf (1984) merged *G. punctifera* into *Siderocystopsis punctifera* as a basionym. Guiry and Guiry (2016) noted that this species is currently regarded as *S. punctifera*. It is need to rearrangement from *S. fusca* to *S. punctifera*.

Genus *Siderocelis* (Naumann) Fott 1934

#### *Siderocelis oblonga* (Naumann) Fott (Fig. 3c, d)

**References:** Fott 1934: 117, fig. 5; Naumann 1921: 6, fig. 3; Komárek and Fott 1983: 566, pl. 163, fig. 3.

**Basionym:** *Chlorella (Siderocelis) oblonga* Naumann



**Fig. 3.** a, b. *Siderocystopsis fusca*, c, d. *Siderocelis oblonga*, e-g. *Siderocelis estheriana*, h, i. *Pachycladella umbrina*. Scale bar is 10  $\mu\text{m}$ .

1921.

**Synonym:** *Siderocelopsis oblonga* (Naumann) Hindak.

**Occurrence site:** Chukdong reservoir fishery (WT 28.3°C, pH 8.3, EC 213  $\mu\text{s/cm}$ ).

**Description:** This species is unicellular and solitary, having an oval or ellipsoidal shape. The cell walls are relatively thick, hyaline to dark brown, and covered with granules on the surface. A chloroplast is located in the center of each cell, and contains a pyrenoid. The cells are 10-15  $\mu\text{m}$  in length and 4-8  $\mu\text{m}$  in width.

**Distribution:** Slovakia (Hindak, 1988), Poland, Hungary (Komárek and Fott, 1983), Deutschland (Heynig, 2003).

**Specimen:** DAEJIN-20150603-5.

**Remark:** *Siderocelis oblonga* is firstly described by Naumann (1921) as *Chlorella (Siderocelis) oblonga*. Fott (1934) merged *C. oblong* into *Siderocelis oblonga* as a basionym. Hindak (1988) reported the new species *Siderocelopsis oblonga* as a basionym that is *C. oblonga*, and merged *Siderocelis oblonga* into *Siderocelopsis oblonga* as a synonym. Guiry and Guiry (2016) suggest that *Siderocelis oblonga* is currently accepted taxonomically and *Siderocelopsis oblonga* is regarded as a taxonomic synonym of *Siderocelis oblonga*. Therefore, it is classified to *Siderocelis oblonga* in this study. Naumann (1921), Fott (1934), Komárek and Fott (1983), and Hindak (1988) classified to the family Chlorellaceae, order

Chlorococcales in class Chlorophyceae, but Guiry and Guiry (2016) replaced to the family Chlorellaceae, order Chlorellales in class Trebouxiophyceae. It needs to rearrangement that this species place into class Chlorophyceae or Trebouxiophyceae.

***Siderocelis estheriana* Hortobagyi (Fig. 3e-g)**

**References:** Komárek and Fott 1983: 561, pl. 162, fig. 2; Hajdu 1975: 29, Hortobagyi 1957: 341, fig. 1.

**Synonym:** *Coenocystis estheriana* (Hortobagyi) Budapest.

**Occurrence site:** Seogangdaegyo, Han River (WT 30°C, EC 376 µs/cm).

**Description:** This species occurs as unicells or groups of four cells. The cells are oval or ellipsoidal in shape, and slightly concave at the sides. The cell wall is relatively thick, light brown, and the surface is covered with fine granules. A chloroplast is located in the center of each cell, and contains a pyrenoid. The cells are 11-16 µm in length and 7-14 µm in width.

**Distribution:** Hungary (Hortobagyi, 1957; Hajdu, 1975; Komárek and Fott, 1983).

**Specimen:** DAEJIN-20150709-2.

**Remark:** This species is first reported by Hortobagyi (1948). Hajdu (1975) reported *Coenocystis estheriana* as the new species and merged *S. estheriana* into *C. estheriana*. However, any other species in the family Radiococcaceae were not granules on the cell wall surface. Therefore Komárek and Fott (1983) replaced *C. estheriana* into *S. estheriana*.

Genus *Pachycladella* Silva 1970

***Pachycladella umbrina* (G.M. Smith) Silva (Fig. 3h, i)**

**References:** Komárek and Fott 1983: 270, pl. 80, fig. 3; Reymond and Hegewald 1990: figs. 1-27; Silva 1970: 943; Smith 1950: 258, fig. 172; Shubert 2003: 292, fig. 19E.

**Basionym:** *Pachycladon umbrinus* Smith 1924.

**Synonym:** *Treubaria umbrina* (Smith) Fott and Kovacik.

**Occurrence site:** Chukdong reservoir and fishery (WT 28.3°C, pH 8.3. EC 213 µs/cm).

**Description:** This species is unicellular and solitary, has a spherical cell shape enclosed by a thin wall lacking a gelatinous envelope. The cell walls have four stout radiating appendages, tapering to blunt or bifurcated apices. The bases of the appendages are situated roughly in one plane. A chloroplast is located in the center of each cell, and contains a pyrenoid. The cells are 7-13 µm in diameter and the appendages are 20-50 µm in length.

**Distribution:** New York, North Carolina and Kentucky in USA (Smith, 1950), Austria, Ukraine and Hungary

(Komárek and Fott, 1983), Bangladesh (Islam and Alfasane, 2005).

**Specimen:** NIBRCL0000112295; DAEJIN-20150603-6

**Remark:** The genus *Pachycladon* was originally described from Palisades Interstate Park in New York by Smith (1924). Smith (1924) described *Pachycladon umbrinus* as a new species, but Silva (1970) renamed the genus *Pachycladon* to the new genus *Pachycladella*, and merged *Pachycladon umbrinus* into *Pachycladella umbrina* as a basionym. Fott and Kovacik (1975) included *P. umbrina* into *Treubaria umbrina* as a synonym. *Treubaria umbrina* has similarities to the genus *Treubaria*, but differs in cell shape, the nature of the appendages, and the chloroplast (Smith, 1950). Therefore, it is classified as *Pachycladella umbrina* because there is no controversy with respect to the differences between the two genera.

***Pachycladella zatoriensis* (Bednarz and Mrozinska-Webb) Komárek (Fig. 4a-c)**

**References:** Komárek and Fott 1983: 270, pl. 80, fig. 2; Fučíková 2015: 19-27, fig. 1; Reymond, Yamagishi and Druart 1992: 93-107, figs. 1-27; Reymond, Bircham and Boutinard Rouelle-Rossier 1993: 51-63, figs. 1-6.

**Basionym:** *Pachycladon zatoriensis* Bednarz and Mrozinska-Webb 1971.

**Occurrence site:** Deokjin reservoir (WT 28.2°C, pH 8.3. EC 101.8 µs/cm).

**Description:** This species is unicellular and solitary, free floating, and with spherical cell shape and enclosed by a thin wall without a gelatinous envelope. Cell walls bear four long, stout tetrahedral appendages, tapering to blunt or two-forked apices. The base of the appendages situated roughly tetrahedrally. A chloroplast distributed in center of cells, with a pyrenoid. Cells are 7-13 µm in diameter and appendages are 20-50 µm in length.

**Distribution:** Bangladesh (Islam and Alfasane, 2005), France (Reymond *et al.*, 1993), New England (Fučíková, 2015).

**Specimen:** NIBRCL0000112296; DAEJIN-20140819-1.

**Remark:** This species was originally classified as *Pachycladon zatoriensis* by Bednarz and Mrozinska-Webb (1971), but was transferred to the genus *Pachycladella* and merged with *Pachycladon zatoriensis* into *Pachycladella zatoriensis* as a basionym by Komárek (1979). Reymond *et al.* (1992) described that this species is very morphologically similar to *P. umbrina*, but differentiated because the four bifurcated appendages decorating this unicell are located in a cruciate or tetrahedral position. The original description of the genus and its type species *Pachycladella umbrina* by Smith (1924) is very clear in showing that the cell bears four quadrately (very rarely pyramidally) arranged appendages. This indicates that

all species belonging to this genus have appendages arranged in a cruciate position, and rarely tetrahedrally. Reymond *et al.* (1992) suggested that this is a species- rather than genus-level feature: only *Pachycladella umbrina* has appendages in a cruciate disposition, whereas *Pachycladon zatoriensis* has appendages located tetrahedrally. Reymond *et al.* (1992; 1993) also showed clearly that these taxa separate into two main categories: cells having appendages located in a cruciate position (*Pachycladella umbrina*), and cells having appendages located in a tetrahedral position (*Pachycladon zatoriensis*). It was also shown that the length of the appendages, and the cell shape and diameter varies markedly among specimens in the same collection, based on transmission electron microscopy (Reymond *et al.*, 1992; 1993).

Genus *Crucigenia* Morren 1830

***Crucigenia mucronata* (Smith) Komárek (Fig. 4d)**

**References:** Komárek and Fott 1983: 790, pl. 219, fig. 5; Yamagishi and Akiyama 1995: 15:30, figs. 1-5.

**Basionym:** *Crucigenia fenestrata* var. *mucronata* Smith 1926.

**Occurrence site:** Chukdong reservoir and fishery (WT 28.3°C, pH 8.3. EC 213 µs/cm).

**Description:** Free floating cells (4) arranged in coenobia, square to near circular in outline, having small and large square open spaces in the center. Often occurs as multi-

ple coenobia of 16 or more cells. Cells are ellipsoid to square and slightly bent outward, with a small wart-like projection at each end of the outer side. A chloroplast is located in the center of each cell, and contains a pyrenoid. The cells are 5-9 µm in length and 3-6 µm in width.

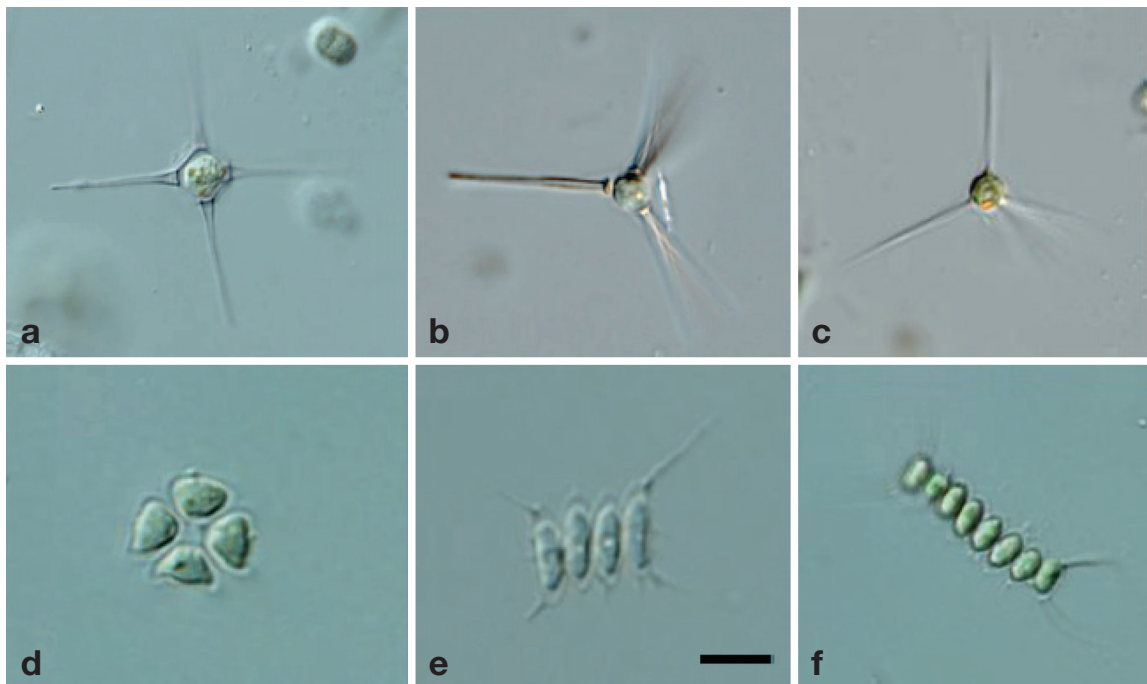
**Distribution:** USA (Smith, 1926); France, Guadeloupe, and India (Komárek and Fott, 1983).

**Specimen:** NIBRCL0000112297; DAEJIN-20150603-6.

**Remark:** Smith (1926) did not agree with the description by Schmidle (1900) that there was no gelatinous sheath surrounding the coenobia and filling the central space. He also described differences from the iconotype of the species, reporting cells being ellipsoid to square and slightly bent outward or concave, and lacking projections at the ends of the outer side. This species was originally described as *C. fenestrata* var. *mucronata* by Smith (1926). However, Komárek (1974) transferred *C. fenestrata* var. *mucronata* to *C. mucronata* as a basionym. Smith (1926), Komárek and Fott (1983) originally classified this species in the family Scenedesmaceae, order Chlorococcales in the class Chlorophyceae, but Guiry and Guiry (2016) placed in the family Trebouxiophyceae incertae sedi, order Trebouxiophyceae ordo incertae sedi, in the class Trebouxiophyceae. Its classification needs reexamination.

Genus *Scenedesmus* Meyen 1829

***Scenedesmus sempervirens* Chodat (Fig. 4e, f)**



**Fig. 4.** a-c. *Pachycladella zatoriensis*, d. *Crucigenia mucronata*, e, f. *Scenedesmus sempervirens*. Scale bar is 10 µm.

**References:** Komárek and Fott 1983: 915, pl. 246, fig. 6; Yamagishi and Akiyama 1995: 15:30, figs. 1-5.

**Synonym:** *Scenedesmus abundance* (Kirchner) Chodat sensu auct. Post. Sine type.

*Scenedesmus caudatus* var. *minor* Kützing.

*Scenedesmus spinosus* var. *crassispinosus* Hortobagyi.

**Occurrence site:** Chukdong reservoir (WT 28.3°C, pH 8.3. EC 213 µs/cm).

**Description:** Cells arranged in coenobia composed of 2-4(-8) cell arranged with sides contacting in a straight (or only rarely curved) line or slightly alternating row. The cells are long and ovoid or ellipsoidal, with conical or rounded poles. Small spines (1-2) occur at the poles of the inner cells. The marginal cells have a slightly curved or straight spine at the poles. The outer side wall of the marginal cells is straight or slightly convex, with 1-2 spines in the center. Each cell has a chloroplast containing a pyrenoid. The cells are 10-20 µm in length and 5-8 µm in width.

**Distribution:** Switzerland (Chodat, 1913), cosmopolitan (Komárek and Fott, 1983).

**Specimen:** NIBRCL0000112298; DAEJIN-20150603-6.

**Remark:** Komárek and Fott (1983) merged *S. abundance*, *S. caudatus* var. *minor* and *S. spinosus* var. *crassispinosus* into this species as a synonym. *S. abundance* probably described a group of several types, as noted by Chodat (1926). According to Komárek and Fott (1983), Theses taxon is included in *S. sempervirens*.

## ACKNOWLEDGEMENTS

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