J. Plant Biol. 37(2) : 131~139 (1994)

Unreported Fresh-water Algae in Korea

Kim, Han Soon, Yong Jae Kim, Chung Won Park and Jun Chung*
Department of Biology, Kyungpook National University, Taegu 702-701, Korea

An investigation of the freshwater algal flora of Nakdong river estuary, Jinyang Lake and Danjang stream was carried out from May to November in 1993. This paper deals with a total 16 taxa belonging to 5 genera which are recorded for the first time in Korean freshwater algal flora. Among them, the 5 genera *Coronastrum* Thompson, *Echinosphaeridium* Lemmermann, *Dichotomococcus* Korsikov, *Dicloster* Jao *et al.* and *Siderocystopsis* Swale are newly added to the freshwater algal flora of Korea.

Key words : fresh-water algae, *Coronastrum*, *Echinosphaeridium*, *Dichotomococcus*, *Dicloster*, *Siderocystopsis*

An algal flora of the different regions and dam lakes has been described of several taxonomic and ecological studies by a number of authors (Chung, 1975, 1976, 1981; Chung, 1962; Chung and Kim, 1991, 1992, 1993; Chung *et al.*, 1972a, b; Kim *et al.*, 1991), but a few reports are available from Nakdong river estuary dam (Kim and Lee, 1991; Cho *et al.*, 1993; Chung *et al.*, 1987) and none has studied the freshwater algae of Namgang dam and Danjang stream. Nakdong river estuary dam was built to the supply of the agricultural irrigation, industrial water and drinking water in November 1987 and Namgang dam was built to the supply of the drinking water, agricultural irrigation, industrial water and produce electric power. Danjang stream is the first tributary of Milyang river, flowing through the Onyang county and Milyang county and an artificial dam is building at present (Fig. 1). An attempt was to explore the algal flora of Nakdong river estuary dam, Namgang dam and Danjang stream. We identified 16 taxa including 5 genera which had not previously been recorded from Korea and the results are presented in this paper.

MATERIALS AND METHODS

The samples were collected from Nakdong river estuary dam (NRED), Namgang dam (ND) and Danjang stream (DS) from May to November in 1993. The materials were obtained by plankton net (mesh size 40 μm), immediately fixed with 5% formaldehyde solution. Collected samples were examined with Nikon LABOPHOT microscope under X600. Drawings of all the recognised taxa were made by camera lucida and were taken a photograph of photomicroscope. Dillard (1989), Hindak (1977, 1980, 1984, 1988), Komarek and Fott (1983) and Yamagishi, and Akiyama (1986, 1987, 1988, 1989) were mainly refered for the identification. All the materials cited in the present work have been deposited in the Department of Biology, Kyungpook National University.

*Corresponding author : Fax +82-53-954-6806

TAXONOMIC DESCRIPTIONS

Phylum Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Fam. Characiaceae

***Ankyra paradoxioides* Cirik** (Pl. 1, Figs. 1-4)
Komarek and Fott, 1983. p. 234, Pl. 68, Fig. 1

Cells free floating, solitary, cudgel form, apical rounded, base attenuated, basal end has an anchor; cell wall with fine, long numerous spine; apical 2-3 stout spines, in updown one third 2 split, straight stout spines, slant in 45-50℃ toward the anchor; ch-

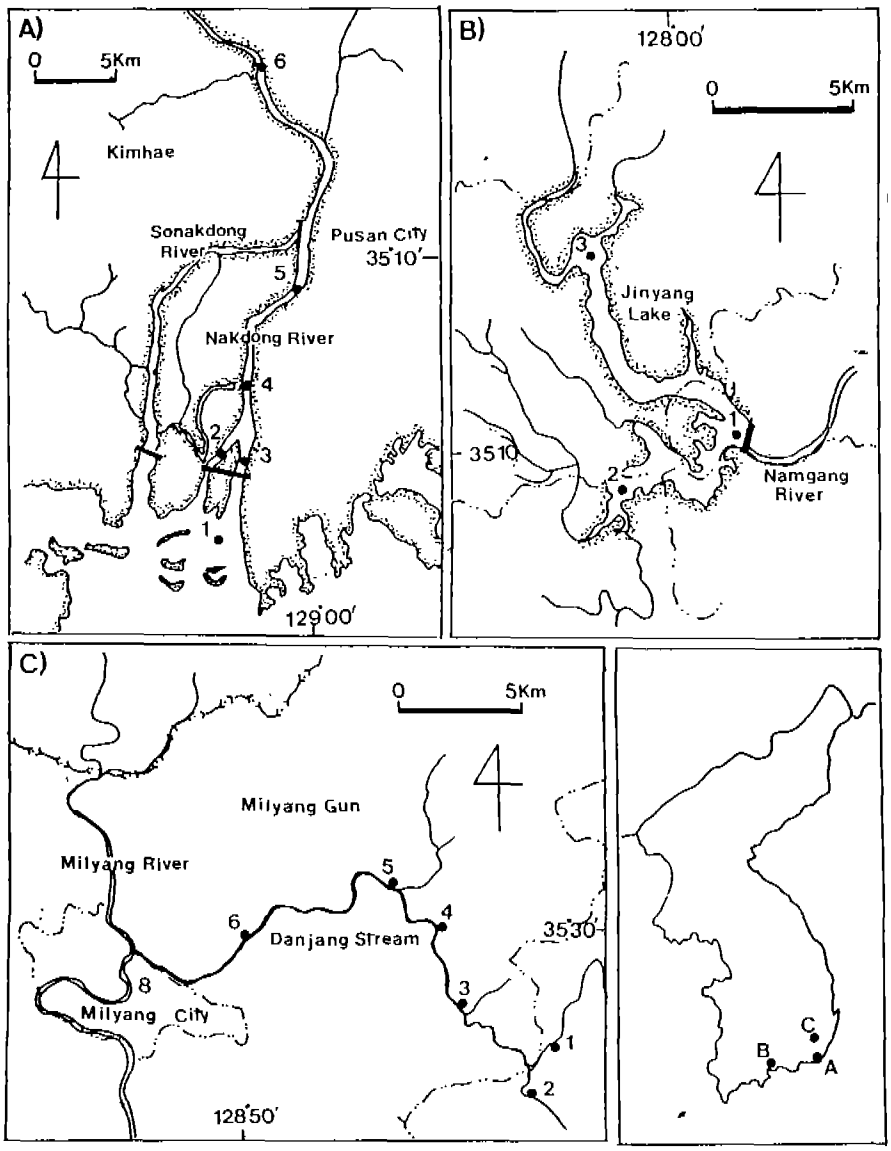

Fig. 1. Map showing the sampling stations. (A) Nakdong river estuary dam. (B) Namgang dam. (C) Danjang stream.

loroplast parietal, with a pyrenoid; cells 4-7 μm breadth, 17-24 μm long, spine 13-18 μm, anchor 3-5 μm.

Occurrence: ND (J1, J2, J3, N1, N2, N3)

Fam. Micractiniaceae

Micractinium quadrisetum (Lemm.) G.M. Smith

(Pl. 3, Figs. 1-4)

Dillard, 1989. p. 90, Pl. 24, Fig. 5; Hortobagyi, 1962. p. 32, Pl. 44, Fig. 532; Komarek and Fott, 1983. p. 326, Pl. 97, Fig. 2; Prescott, 1962, p. 288, Pl. 68, Fig. 1; Yamagishi and Akiyama, 1987, 7:39

Colony free-floating, 4-celled, cruciately, quadrately arranged in aplane with small rectangular open space at the center; sometimes connected with 26 cells compound colonies; cells ovoid to nearly globose, in contact with one other by the basal part, with 1-4 long delicate tapering setae on the expored face; cells 5-7 μm in diameter, setae 20-50 μm long.

Occurrence: NRED (N2, N3, N4, N5)

Siderocystopsis Swale 1954

Komarek and Fott, 1983. p. 334; Hindak, 1977. p. 60

Cells solitary, oval to widely oval, with numerous

fine spines on the surface. with a granule at the basc of spines. Cell wall usually brown, chloroplast parietal, with a pyrenoid. Reproduction by autospores. Genus with a single species *S. fusca* (Kors.) Swale.

***Siderocystopsis fusca* (Kors.) Swale** (Pl. 1, Figs. 9, 10)

Komarek and Fott, 1983. p. 336, Pl. 101, Fig. 4; Hindak, 1977. p. 60, Pl. 25, Figs. 1-10; 1980; p. 80, Pl. 32, Figs. 1-15

Characters same as described for the genus. This species occurred relatively frequent in eutrophic waters according to Hindak (1977). Cells 8-15 μm breadth, 10-20 μm long, spines 15-23 μm long.

Occurrence: NRED (M1, M2, M4, M6)

Fam. Golenkiniaceae

***Echinosphaeridium* Lemmermann 1904**

Komarek and Fott, 1983. p. 277

Cells free-floating, solitary, spherical, cell wall beset conspicuously symmetrical fine long setae, the base of setae with conical gelatinous sheath; chloroplast parietal, with one ovoid or reniform pyrenoid.

***Echinosphaeridium hexacantha* Tell** (Pl. 1, Figs. 5, 6)

Komarek and Fott, 1983. p. 277, Pl. 82, Fig. 4; Yamagishi and Akiyama, 1989, 10:26

Cells free-floating, solitary, spherical with 6 setae symmetrical arranged; setae straight, fine, long with a slender, conical sheath at the base; chloroplast a single parietal, with one ovoid or reniform pyrenoid; cells 8-15 μm in diameter, setae 20-25 μm long.

Occurrence: ND (J3, S3)

***Echinosphaeridium nordstedtii* Lemmermann** (Pl. 1, Figs. 7, 8)

Komarek and Fott, 1983. p. 277, Pl. 82, Fig. 3

Cells free-floating, solitary, spherical with numerous setae; setae straight, fine long, conical sheath at the base; chloroplast a single parietal, with reniform pyrenoid; cells 10-20 μm in diameter, setae 20-30 μm long.

Occurence: ND (J1, J2, J3)

Fam. Botryococcaceae

***Dichotomococcus* Korsikov 1923**

Komarek and Fott, 1983. p. 360

Colony free-floating, more or less radiately arranged cells, connected with the bicelled coenobia form by the basal ends to the gelatinous remnant of the old mother cell wall. Daughter cell often 2-celled group, a pseudodichotomous branch system built. All the colonies enveloped into a thin, inconspicous, mucilagenous matrix. Cell long ovoid, cylindric or irregular spindleform. Chloroplast parietal, without pyrenoid.

***Dichotomococcus curvatus* Korsikov** (Pl. 2, Figs. 1, 2)

(Syn: *Gloeoactinium limneticum* G.M. Smith)

Komarek and Fott, 1983. p. 362, Pl. 109, Fig. 1

Colony only 2-36 celled, free-floating, enveloped into a colorless gelatinous matrix, cells 3-5 μm breadth, 5-10 μm long; dichotomous branched system from the old mother cell wall was covered by the mucilagenous matrix or sometimes completely obvious; cells long ovoid or ellipsoid, sometimes concave, chloroplast 1-2 parietal, cells 3-5 μm in breadth, 5-10 μm long.

Occurrence: NRED (M1, M4, M5, M6), ND (M1, M2, M3, J1, J2, J3, S1, S2, S3, N1, N2, N3)

Fam. Oocystaceae

Cells free-floating, soliatry, curved, slender crescent-shaped, sigmoid, with acuted ends; chloroplast a single parietal, laminate on convex side of the cell, with a pyrenoid; cells 1-2 μm breadth, distance between both the ends 3-5 μm.

Occurrence: ND (J3, S1)

***Kirchneriella aperta* Teil.** (Pl. 2, Figs. 5, 6)

(Syn: *K. obesa* var. *aperta* (Teil) Brunnth.)

Komarek and Fott, 1983. p. 670, Pl. 187, Fig. 5; Smith, 1962, p. 259, Pl. 58, Figs. 6, 7; Yamagishi and Akiyama, 1989, 9:43

Colony 4, 8 or 16 celled, free-floating, enclosed by a hyaline, gelatinous envolope; cells flattened, rounded crescent formed, ends broadly rounded, sometimes one end wider; outer margin roundly convex, inner margin concave and broadly V-shaped; chloroplast single, filling the entire cell, with a pyrenoid; cells 5-10 μm breadth, distances between both the ends 5-10 μm.

Occurrence: NRED (M3, N2, N3, N4, N5)

Fam. Coelastraceae

***Coelastrum astroideum* De-Notaris** (Pl. 3, Figs. 7, 8)

Komarek and Fott, 1983. p. 725, Pl. 202, Fig. 4; Yamagishi and Akiyama, 1988, 8:15

Coenobia spherical, 4-32 celled; cells ovoid to triangular with rounded ends in lateral view; wall smooth, often thickened at the apical end; cells connected to adjacent ones by the basal part, but without clear connecting strands between the cells; intercellular spaces large, quadrangular to pentagonal; chloroplast a parietal laminate, with a single pyrenoid; cells 5-10 μm in diameter, 7-12 μm long.

Occurrence: ND (N1, N2, N3)

***Coelastrum polychordum* (Kors.) Hindak** (Pl. 3, Figs. 9, 10)

Komarek and Fott, 1983. p. 738, Pl. 206, Fig. 3; Yamagishi and Akiyama, 1988, 8:18

Coenobia spherical, 8-64 celled; cells spherical, with a small wart-like process and long, narrow, finger-like strands radiately protruded at the outer face; cells widely separated each other and connected to adjacent surrounding cells by the 1-3 strands; cell wall thick, usually dark brown in color; chloroplast a parietal laminate with a single pyrenoid; cells 10-15 μm in diameter, coenobia up to 100 μm in diameter.

Occurrence: NRED (N1, N2, N3, N4, N5, N6)

Fam. Scenedesmaceae

***Coronastrum* Thompson 1938**

Komarek and Fott, 1983. p. 750; Hindak, 1977. p. 126; Smith, 1950. p. 277

Coenobia 4-celled, free-floating. Cell ovoid, ovate, spherical, 4-cells of coenobium set up into a quadrate inside coenobium, connected by hyaline processes of the cell wall in the shape of connecting bridge and at one end they have a lobe-like appendage derived from the mother cell wall. Chloroplast parietal, with a pyrenoid. As the feature which the genus *Coronastrum* is the connection of cells inside the coenobium by processes of the cell wall that originate inside the mother cell wall differs from the genus *Lauterborniella* Schmidle sensu Korsikov (1953) in which the cells similary oppose each other crosswise, but only touch or are coalesced. Komarek and Fott (1974) designate the species *L. appendiculata* Korsikov 1953 as a synonym to the species *Coronastrum lunatum* Thompson. We belive, however, these two species differ from each other, namely the mode of the connection of adjacent cells in the coenobium.

***Coronastrum lunatum* Thompson** (Pl. 3, Figs. 1-4)

Komarek and Fott, 1983. p. 752, Pl. 209, Fig. 5; Hindak, 1977. p. 127, Pl. 52. Figs. 1; Yamagishi and Akiyama, 1989, 9:15

Coenobia of 4-celled arranged radiately, joined by broad and short processes of the cell walls at median of the dorsal sides; cells widely lunate, slightly bent, with broadly rounded ends and colorless appendage remnants of the mother cell wall at one end. chloroplast a single, parietal, with one pyrenoid; cells 3-4 μm breadth, 12-20 μm long.

Occurrence: ND (J1, J2, J3)

***Tetrastrum alpinum* (Schm.) Schmidle** (Pl. 3, Figs. 5, 6)

Yamagishi, 1985, p. 23, Pl. 1, Figs. 19-22; Yamagishi and Akiyama, 1986, 5:95

Coenobia free-floating, flat, of 4-celled, eight-sided; cells semicircular in face view, connected with the rounded inner side and quadrately arranged, with a rather large open space in the center; free side of the cells flat and papillated; 4 papillae on the free side, other 4 papillae corners and connected with the corner papillae of the adjacent cells; cells circular to broad-ellipsoidal in side view, visible 4 papillae on the free side, 2 on corner; chloroplast a single, filling entire cell, with a pyrenoid; cells 5-10 μm in diameter, coenobia 10-18 μm in diameter.

Occurrence: DS (N1, N2)

***Tetrastrum elegans* Playfair** (Pl. 2, Figs. 11, 12)

Komarek and Fott, 1983, p. 770, Pl. 214, Fig. 5; Hindak, 1977, p. 168, Pl. 68, Fig. 9, 1984, p. 285, Pl. 104, Figs. 12-15; Yamagishi and Akiyama, 1987, 7:88

Coenobia 4-celled, flat, in the outline rhombic, 10-15 μm in diameter, without a central opening or with a small rectangular opening, free-floating; cells spherical, triangular to ovoid, quadrated arranged, outer margins of cells rounded, with a long spine; chloroplast parietal, with a pyrenoid. cells 2.5-5 μm

in diameter, spine 10-15 μm long.

Occurrence: ND (M2, M3)

***Didymogenes palatina* Schmidle** (Pl. 3, Figs. 11-13)
Dillard, 1989, p. 97, Pl. 26, Fig. 6; Komarek and Fott, 1983. p. 776, Pl. 216, Fig. 3; Yamagishi and Akiyama, 1989, 9:32

Coenobia 4 celled, free floting, often 8 cells syncoenobia arranged into 2 rows of 4 celled coenobia; cells lunate, rounded without spines; 2 cells pair in contact with each other at the median part of the dosal side; cell pairs connnected by the poles of each cell to other pair in 4 celled coenobia; cell wall smooth; chloroplast a single, parietal, with a pyrenoid; cells 3-5 μm in diameter, 8-10 μm long.

Occurrence: NRED (M1)

***Tetradesmus wisconsinensis* f. *sibirica* (Printz) Fott and Komarek** (Pl. 2, Figs. 13, 14)
(Syn: *S. sibiricus* (Printz) Chod.; *T. sibiricus* Printz) Hegewald and Silva, 1988. p. 553, Fig. 891; Komarek and Fott, 1983. p. 805, Pl. 223, Fig. 2

Cocnobia 4-celled, free-floating; cells acuted or crescent shape, and sharply pointed long spine at poles, cells adjoined with their long axis paralled in side view and radially arranged in top view; chloroplast a single parietal and laminated, with a pyrenoid. Cells 3-5 μm in diameter, 25-32 μm long. Our speciemns are larger than the range of dimentions of type species (Printz, 1916, 3-4×15-20 μm).

Occurrence: ND (J1)

***Dicloster* Jao *et al.*, 1976**
Komarek and Fott, 1983. p. 812

Coenobia 4-celled, sporadically 2 or 8 cells, free-floating. Cells lunate, in pair contacting with one another at median part of the convex face, and with sharply pointed long spines at each pole. The cell pairs contacted by the poles of the cells to other pair in 4-celled coenobia. Chloroplast a single parietal, always with two conspicuous pyrenoids. Reproduction autospore. This genus reported only one species in China (Shanghai, Chekiang, Hupeh) and Japan in the world and very rare.

Dicloster acuatus* Jao *et al. (Pl. 2, Figs. 11, 12)
Komarek and Fott, 1983. p. 812, Pl. 224, Fig. 4; Yamagishi, 1985. p. 21, Pl. 1, Figs. 12, 13; Yamagishi and Akiyama, 1986, 5:39

Characters same as described for the genus, cells 4-6 μm breadth, 40-55 μm long with spine.

Occurrence: NRED (M4, S2, S3), ND (M3)

LITERATURE CITED

Cho, K.J., I.K. Chung and J.A. Lee. 1993. Seasonal dynamics of phytoplankton community in the naktong river estuary. *Korean J. Phycol.* **8**: 15-28.

Chung, J. 1975. A study on the Euglenophyceae from Chun La Book Do Area. *Korean J. Bot.* **19**: 19-30.

Chung, J. 1976. A study on the fresh-water algae from Chungchong Book Do area. *Kor. J. Lim.* **12**: 41-53.

Chung, J. 1981. Fresh-water algae on Chang-yung County area (Around Bugok hot spring). *Bull. KACN.* **3**: 369-380.

Chung, J., S.D. Kim and K.S. Lee. 1972a. Fresh-water algae from Jaeju Island (1). *Kor. J. Lim.* **5**(1-2): 13-28.

Chung, J., S.D. Kim and K.S. Lee. 1972b. Fresh-water algae from Jaeju Island (1). *Kor. J. Lim.* **5**(3-4): 15-31.

Chung, J. and H.S. Kim. 1991. Fresh-water algae new to Korea (I). *Korean J. Phycol.* **6**: 113-121.

Chung, J. and H.S. Kim. 1992. Fresh-water algae new to Korea (II). *Korean J. Phycol.* **7**: 1713-183.

Chung, J. and H.S. Kim. 1993. Fresh-water algae new to Korea (III). *Korean J. Phycol.* **8**: 37-46.

Chung, Y.H. 1962. A study of fresh-water algae in Korea. *Seoul Univ. J.* **D**: 11-44.

Chung, Y.H., K.H. Noh and O.M. Lee. 1987. The flora and dynamics of phytoplankton in the estuary of Nakdong River. *Bull. KACN.* **9**: 5-30.

Dillard, G.E. 1989. Freshwater Algae of the Southeastern United States. Part 1. Chlorophyccae: Volvocales, Tetrasporales and Chlorococcales. J. Cramer, Berlin. 202 pp.

Hegewald, E. & P.C. Silva. 1988. Annotated Catalogue of *Scenedesmus* and Nomenclaturally Related Genera, Including Original Descriptions and Figures. J. Cramer. Berlin. 587 pp.

Hindak, F. 1977. Studies on the Chlorococcal Algae, Chlorophyceae 1. Slov. Acad. Sci. Publ., Bratislava. 190 pp.

Hortobagyi, T. 1962. Algen aus den Fischeichen von Buzak IV. Nova Hedwigia. IV(1+2): 21-53.

Huber-Pestalozzi, G. 1938. Das Phytoplankton des Suβwässers. Die Binnengewasser. 16 (1). E. Schweiz. Verl. Stuttgart. 342 pp.

Kim, J.W. and H.Y. Lee. 1991. A Study on phytoplankton communities in the reservoir of Nakdong River estuary. *Kor. J. Lim.* **24**: 143-151.

Kim, Y. J., H.S. Kim and J. Chung. 1991. Seasonal variation of phytoplankton in the Tokdong and Pomun lakes. *Kor. J. Lim.* **24**: 251-263.

Komarek, J. and B. Fott. 1983. Chlorophyceae (Grünalgen) Ordnung: Tetrasporales. (in G.H.-Pestolozzi) Das Phytoplankton des Süβwasser. Teil 6. E. Schweiz. Verl.

Stuutgart. 1044 pp.

Prescott, G.W. 1962. Algae of the Western Great Lakes Area. W.M.C. Braun, Iowa. 977 pp.

Smith, G.M. 1950. The Fresh-water Algae of the United States. 2nd Ed. Publ., New York. 719 pp.

Yamagishi, T. 1985. Plankton algae in Japan 3. *Gen. Educ. Rev. Coll. Agr. & Vet. Med. Nihon Univ.* **21**: 21-25.

Yamagishi, T. and M. Akiyama. 1986. Photomicrograph of the Fresh-water Algae. 5. Uchida Rokakuho. Tokyo. 100 pp.

Yamagishi, T. and M. Akiyama. 1987. Photomicrograph of the Fresh-water Algae. 7. Uchida Rokakuho. Tokyo. 100 pp.

Yamagishi, T. and M. Akiyama. 1988. Photomicrograph of the Fresh-water Algae. 8. Uchida Rokakuho. Tokyo. 100 pp.

Yamagishi, T. and M. Akiyama. 1989. Photomicrograph of the Fresh-water Algae. 9. Uchida Rokakuho. Tokyo. 100 pp.

(Received December 22, 1993)

韓國產 未記錄 淡水藻類

金 漢 順 · 金 容 材 · 朴 正 源 · 鄭 濬
慶北大學校 自然科學大學 生物學科

적 요

낙동강 하구와 진양호 및 밀양강의 지천인 단장천의 담수조류를 1993년 5월부터 11월에 걸쳐 채집조사한 결과 *Coronastrum* Thompson, *Echinosphaeridium* Lemmermann, *Dichotomococcus* Korsikov, *Dicloster* Jao *et al.* 및 *Siderocystopsis* Swale 등 5속의 한국미기록속과 *Ankyra paradoxioides, Echinosphaeridium hexacantha, Echinosphaeridium nordstedtii, Siderocystopsis fusca, Dichotomococcus curvatus, Ankistrodesmus nannoselene, Kirchneriella aperta, Didymogenes palatina, Tetrastrum elegans, Dicloster acuatus, Tetradesmus sibiricus, Micractinium quadrisetum, Tetrastrum alpinum, Coelastrum asteroideum, Coelastrum polychordum, Coronastrum lunatum* 등 16분류군의 한국미기록종이 조사되어 이들의 도판과 현미경사진을 첨부하고 분류 및 형태적 기재를 하였다.

주요어: 담수조류, *Coronastrum*, *Echinosphaeridium*, *Dichotomococcus*, *Dicloster*, *Siderocystopsis*

*교신저자: Fax (053) 954-6806

Plate 1

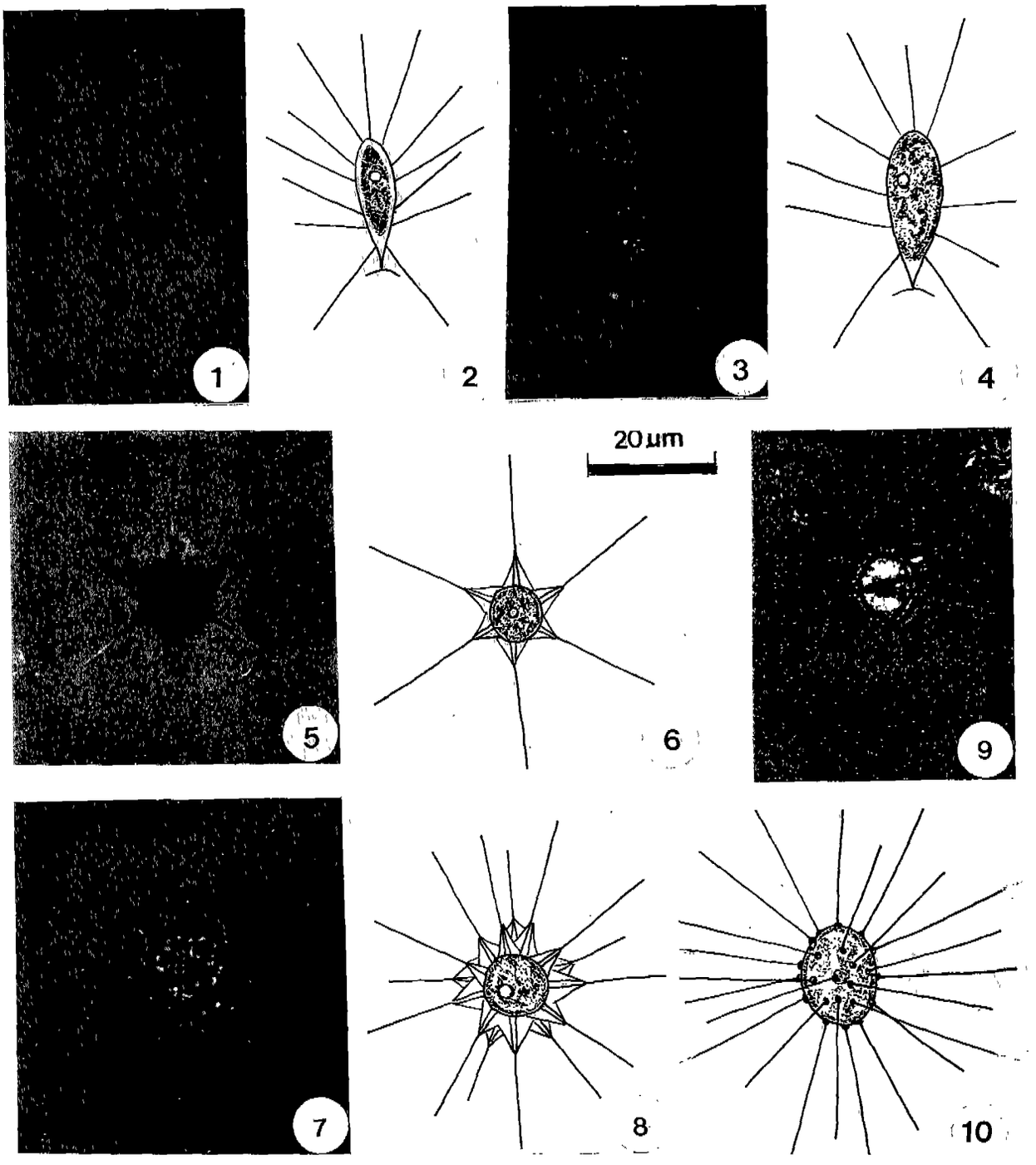

Plate 1. Figs. 1-4: *Ankyra paradoxioides*; Figs. 5, 6: *Echinosphaeridium hexacantha*; Figs. 7, 8: *Echinosphaeridium nordstedtii*; Figs. 9, 10: *Siderocystopsis fusca*.

Plate 2

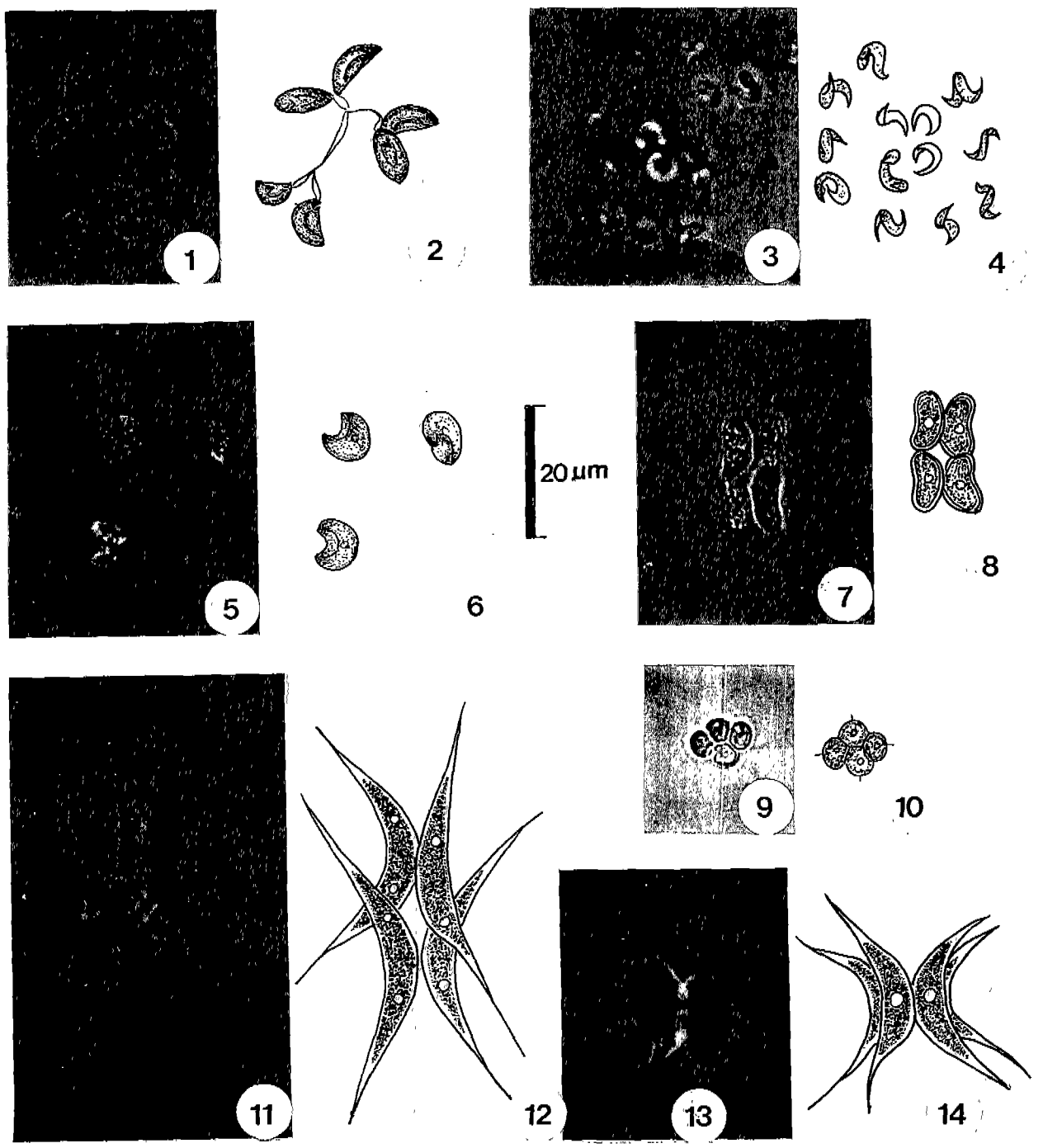

Plate 2. Figs. 1, 2: *Dichotomococcus curvatus*; Figs. 3, 4: *Ankistrodesmus nannoselene*; Figs. 5, 6: *Kirchneriella aperta*; Figs. 7, 8: *Didymogenes palatina*; Figs. 9, 10: *Tetrastrum elegans*; Figs. 11, 12: *Dicloster acuatus*; Figs. 13, 14: *Tetradesmus wisconsinensis* f. *sibirica*.

Plate 3

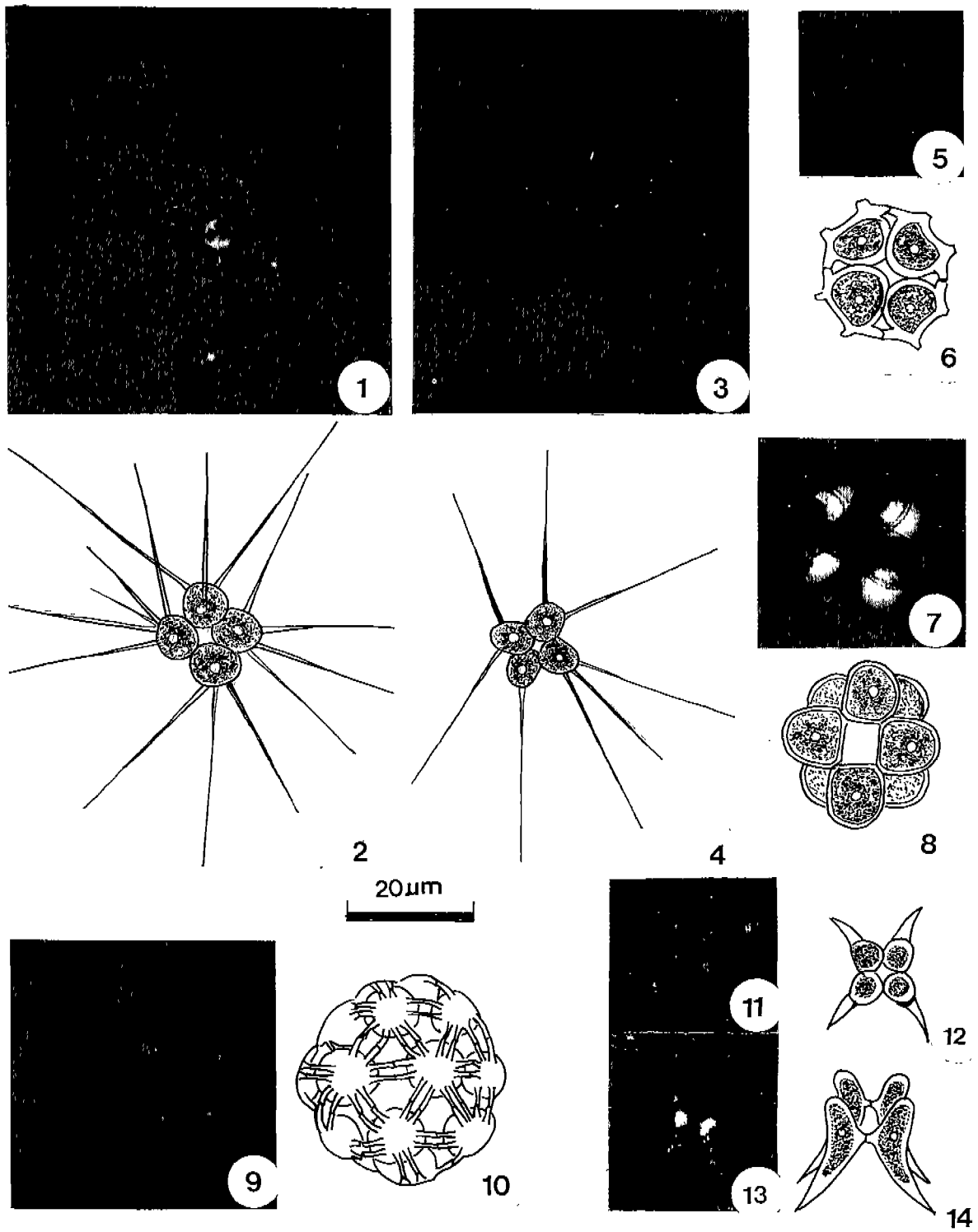

Plate 3. Figs. 1-4: *Micractinium quadrisetum*; Figs. 5, 6: *Tetrastrum alpinum*; Figs. 7, 8: *Coelastrum asteroideum*; Figs. 9, 10: *Coelastrum polychordum*; Figs. 11-13: *Coronastrum lunatum*.