Contribution to the knowledge of algae of Nigeria. I. Desmids from the Warri/Forcados Estuaries. Part II. The elongate baculiform desmids

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ABSTRACT

The freshwater zones of the Warri/Forcados Estuaries contain a rich and diverse flora of tropical desmids, which compare favourably and show strong affinities with desmids from other parts of Africa, tropical South America, Southeast Asia, tropical Australia and the Indian sub-continent. In this study, ninety (90) taxa belonging to seventeen (17) elongate baculiform and colonial genera are described. Fifty (50) of the taxa have been described for the first time for Nigeria, while nineteen (19) of them are new to Africa. Part I in this series of studies was devoted to the desmid genera Euastrum and Micrasterias. Based on new findings, a new taxon, Pleurotaenium subcoronulatum (Turner) W. West & G.S. West var. spinulosum Opute var. nova. has been proposed.

Key words: algae, desmids, phytoplankton, freshwater, estuaries, tropical, Nigeria

1. INTRODUCTION

The author, between 1984-87, investigated the phytoplankton flora of the Warri/Forcados Estuaries and in his preliminary publication (Opute 1985) reported the presence of a number of desmids in the potamoplankton of the freshwater zones of the estuaries. Fascinated by the sheer beauty and symmetry of these plants, a more detailed study of the desmids was embarked upon. The first part of this detailed study, which focused on the two desmids genera Euastrum and Micrasterias, was reported in Opute (1992). Hitherto desmid studies in Nigeria had received little attention. The only reported works of interest were those of Khan (1984), who described some desmids from the Jos Plateau of Northern Nigeria, Kadiri (1987, 1988) who reported on the desmids of Ikpoba Reservoir, and Kadiri & Opute (1989) on the Micrasterias species of the Ikpoba Reservoir.


A close scrutiny of the African studies clearly shows that the regions covered are mostly in Central and Eastern Africa. The West Coast with a somewhat different geography and geology has not been critically and exhaustively investigated. The present study, which aims at contributing to closing this gap, is devoted to the ten elongate baculiform genera of Gonatozygon (6), Geinicularea (1), Spirotaenia (1), Cylindrocystis (2), Neptrium (1), Penium (3), Closterium (39), Pleurotaenium (18), Triploceras (1) and Tetmemorus (1), as well as the seven elongate colonial genera of Sphaerozosma (2), Spondylosum (2), Onychonema (1), Hylotheca (2), Phymatodocis (1), Bambusina (2) and Desmidium (6), including the colonial genus Cosmocladium (1). The figures in bracket indicate the number of taxa.

2. THE STUDY AREA

Figure 1a represents the Warri/Forcados Estuaries of Southern Nigeria. Located between latitude 5° and 6° North and longitude 5° and 6° East, the study area forms part of the anastomosing creeks traversing the Southern coastline of Nigeria. It is derived from the merging and convergence of the Warri and Forcados rivers and their tributaries. From an average width of about 100 m in the narrowest parts, it spans over 3 km in the widest regions before emptying into the Atlantic Ocean at South Point within the Bight of Benin.

The drainage basin is typically of rain forest formation and covers approximately 2627 km². The entire waterway, which is over 80 km long, is affected by strong tidal action especially in the dry season months. Apart from the typical mangrove trees, the other fringing vegetation included swamp trees interspersed with...
grasses, ferns and various emergent macrophytes. The area enjoys a tropical climate, with well demarcated rainy and dry seasons. The dry season stretches from November to April while the rainy season is usually from May to October. The average annual rainfall is 2500 mm, while the mean maximum hourly rainfall is 100 mm (S.P.D.C. 1988). The minimum air temperature recorded is 18 °C, while the maximum is 35 °C, with a mean minimum ambient of 23 °C and a mean maximum ambient of 31 °C.

The 500 µS cm⁻¹ conductivity isopleth, roughly approximating to 0.5‰ salinity, served to demarcate the true freshwater zone from brackish water. The freshwater zone was further divided into two sub-zones – an area of less than 100 µS cm⁻¹ and another between 100 and 500 µS cm⁻¹. A mixing zone of between 500 and 1000 µS cm⁻¹ formed the transition band between freshwater and brackish water (Fig. 1b).

The extent of distribution of freshwater along the estuaries at any time of the year was found to be variable and closely correlated with the geographical position of the transition zone between the saline and freshwater zones. This zone is affected by the interplay between the tidal range and the volume of water discharge or runoff. The transition zone is near the mouth of the estuary when there is a relatively small tidal range and a large runoff; it is near the headwaters or source where there is a large tidal range and a small runoff. As the rains come with higher precipitation, the volume of river discharge increases and the transition zone gradually moves downstream until over 80% of the estuary are occupied by freshwater between the months of July and October.

Although the freshwater zone is limited to areas below 500 µS cm⁻¹ conductivity, the major sectors in which desmids were found were limited largely to waters below 100 µS cm⁻¹. These areas stretched from Udu Bridge to Ejere in the Warri River (Stations II, III, IV, & V) and from Burutu to B/B/W (stations X-XII) in the Forcados River (Stations X, XI, & XII) (Fig. 1b).

3. MATERIALS AND METHODS

Plankton collections were carried out in the peak of the rainy season (months) between July and October 1985-1987 when water discharge was at its highest and the rivers were fully flooded with minimal current flow.
Collections were made in the open water with phyto-plankton tow nets of 55 µm mesh. The net catches were transferred into collection bottles and immediately preserved with 4% formalin.

Aliquots of the samples were examined, and photomicrographs and illustrations made with both a Leitz Orthoplan Wide field Research Microscope equipped with a Vario-Orthomat Camera and tracing device, and a Zeiss Research Microscope with an MC63 automatic camera and a drawing tube. Identifications were made, by reference to standard works especially the following monographs - Krieger (1937, 1939), Ruzicka (1977, 1981), Prescott, Croasdale & Vinyard (1975), Prescott et al. (1981, 1982), Lind & Brook (1980) and G. Huber-Pestalozzi (1982) and numerous journal publications.

4. LIMNOLOGY OF THE ESTUARIES

The physico-chemical parameters of the estuaries varied typically from month to month depending mainly on the season and the tidal influence. However, in the rainy season, conditions were relatively stable in the experimental stations. Water level was at its peak with the river current at its minimal flow rate. Conductivity values, measured at ambient temperature, were between 18 and 60 µS cm⁻¹; dissolved oxygen varied between 2.5 and 4.5 mg l⁻¹ while total alkalinity values as CaCO₃ were as low as 4.0 mg l⁻¹ in the headwaters (Udu Bridge) and as high as 22 mg l⁻¹ downstream at Burutu. Water transparency in all stations except in Udu Bridge was below 50 cm.

Recorded pH values were between 5.5 and 7.3. Total nitrogen and dissolved nitrate were generally low and in all cases were below 0.1 mg l⁻¹ throughout the period of study. The daytime temperatures fluctuated between 25 and 34 °C throughout the period. In the rainy season the water body was more oligotrophic than the rather eutrophic characteristic in the dry season. The averages of some physico-chemical values are given in the table 1.

The Warri/Forcados Estuaries constitute a major distributary of the River Niger which experiences high flood season between June and October each year. The silt laden flood has been shown to depress water conductivity to levels below 90 µS cm⁻¹ and reduce water transparency to less than 50 cm (John 1986). In addition to low conductivity of the waters, pH is usually acidic to neutral. From a chemical point of view, the waters of the estuaries showed peculiarly low levels of dissolved oxygen (Tab. 1). The low oxygen concentration may be due to either or a combination of the following factors:

- low primary production caused by low water transparency and low nutrient load or
- increased and rapid organic decomposition of plant debris enhanced by high temperatures.

It has been suggested that plankton of oligotrophic water bodies are characterised by a large number of desmid species (Brook 1965). The abundance and variety of desmid species found in the Warri/Forcados Estuaries is therefore not surprising.

5. TAXONOMY AND DESCRIPTION OF SPECIES

All dimensions are given in micrometer (µm). L = length of cell; W = maximum width of cell; Wa = width at apex; I = width of isthmus. The magnifications are as indicated in the plates for photomicrographs, while they are represented by bar lines under the figures, each bar line equal to 20 µm. Taxa indicated by an asterisk are reported for Nigeria for the first time while double asterisks represent those new to Africa.

5.1. Key to desmid genera of Warri/Forcados Estuaries reported in this paper

1a Cells solitary and cylindrical
2a. Cell wall always in one piece, without pores and ornamentation; without median constriction.
3a. Cells with parietal spirally wound chloroplast ............................................ Spirotaenia
3b. Chloroplast either plate-like or star-like; typically two in each cell.
4a. Cells small and short, less than 3x longer than broad; chloroplast without notched ridges .................................. Cylindrocystis
4b. Cells large and elongate, more than 3x longer than broad; chloroplast with notched ridges ........................................... Netrium
2b. Cell wall always in 2 or more pieces; wall with pores and sometimes ornamentation.
5a. Cells mostly more than 3x longer than broad;

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<th>Tab. 1. Some physical and chemical parameters of the freshwater zones of the Warri/Forcados Estuaries.</th>
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cell wall unconstricted in the middle.

6a. Cells mostly lunate or curved and usually tapered to the apices; wall smooth and striate .......................................... Closterium

6b. Cells straight; walls often granular.

7a. Cells mostly in loose filament; cells more than 7x longer than broad; apices usually broadened or expanded.

7b. Cells not in filaments, mostly 3-15x longer than broad; apices not expanded ............... Penium

5b. Cells constricted in the middle

8a. Chloroplasts single and axile .............. Gonatozygon

8b. Chloroplasts 2-3, parietal and spiralled ............................................ Genicularea

7a. Cells mostly in loose filament; cells more than 7x longer than broad; apices usually broadened or expanded.

7b. Cells not in filaments, mostly 3-15x longer than broad; apices not expanded ............... Penium

5b. Cells constricted in the middle

9a. Apex truncate or rounded ................. Pleurotaenium

9b. Apex excavae, notched or incised

10a. Apex excavae; wall with whorls of simple or cleft spines ........................................ Triploceras

10b. Apex notched or incised; whorls of spines absent .............................................. Tetemorus

1b. Cells in colonies

11a. Colonies filamentous; cells united by special apical interlocking processes ...................................... Sphaerozosma

12a. Processes overlapping adjacent cells ......................................................... Onychonema

12b. Colonies filamentous; cells not united by special apical processes

13a. Cells without infolded thickening at point of division

14a. Semicells not lobed in end view

15a. Cells deeply constricted ............... Spondylosum

15b. Cells not deeply constricted; usually about as long as broad; chloroplast stellate ............................................ Hylotecha

13b. Cells with an infolded thickening at the point of division

16a. Cells elongate and cylindrical ............ Bambusina

16b. Cells short, fusiform triangular or quadrangular in vertical view .................. Desmidium

14b. Semicells 4-lobed in end view .......... Phymatodocis

11b. Colonies not filamentous; Cosmarium-like cells not in contact but joined by gelatinous strands .................................. Cosmocladium

Genus GONATOZYGON De Bary (1856)

Gonatozygon aculeatum Hastings (1892)

L. 354-359; W. 25-28; Pl. 1: 1; Fig. 5: 1.

Cells elongate-cylindrical, straight with slightly dilated apices, 15-18 times longer than broad; cell wall covered by long needle-like spines; chloroplasts of two parietal bands with a number of pyrenoids. Cf. Forster (1969, Pl. 1: 30-32), Forster (1982, Pl. 2, Figs 1-4), Croasdale & Flint (1986, Pl. 2, Figs 1, 2) and Gerrath & John (1988, Pl. 2, Fig. 21).

**Gonatozygon kinahanii** (Archer) Rabenhorst. var. interruptum Forster (1969)

L. 389-412; W. 26-30; Pl. 1: 2, 3

Cells subcylindrical, relatively stout, rarely straight, usually crooked or bent; 13-16 times longer than broad, slightly dilated at the apex; chloroplast flat with a number of constrictions and a string of pyrenoids. Cf. Forster (1969, Pl. 1, Figs 15, 16).

**Gonatozygon monotaenium** (Archer) Rabenhorst f. minor Forster (1969)

L. 163-173; W. 11-16; Pl. 1: 4, 5; Fig. 5: 4

Cells cylindrical and relatively short, about 12 times longer than broad; chloroplast, ribbon-like and some what twisted; 7-9 pyrenoids in each semi-cell; cell wall hyaline and smooth. The present plants are similar to the forms described by Forster (1969, Fig. 1:10,11).

*Gonatozygon monotaenium* De Bary (1856) W. & G.S. West (1904)

L. 334-340; Wc. 19-20; Wa. 21-22. Pl. 1: 6

Cells elongate and usually straight and narrow, about 18 times longer than broad and slightly dilated at the apices. The Warri/Forcados specimens are much larger than most reported plants. Cf. Forster (1969, Fig. 1:18, 19); Scott & Prescott (1961). The latter authors however found a single large specimen from their Java collections similar in size to the present plants.

**Gonatozygon monotaenium** De Bary var. angustum Forster (1969)

L. 239-262; W. 12-13; Pl. 1: 7, 8; Fig. 5: 5

Cells elongate, subcylindrical and narrow, virtually straight, 20-23 times longer than broad; chloroplast, flat and ribbon-shaped. Cf. the plant described by Forster (1969, Pl. 1, Figs 20, 21) for desmids from the Amazon.

*Gonatozygon pilosum* Wolle (1882)

L. 330-396; W. 15-18; Fig. 5: 2, 3.

Cells long and slender, rarely straight, usually bent, 23-25 times longer than broad; neither tapered nor dilated at the truncate rounded apices; chloroplast ribbon-like and stringed with pyrenoids; wall densely covered with small, straight, hair-like spines. Cf. Forster (1969, Pl. 1: 28, 29), Forster (1982, Pl. 2, Fig. 9) and Croasdale & Flint (1986, Pl. 2, Figs 12, 13).

Genus GENICULARIA De Bary 1858

*Genicularea elegans* W. & G.S. West (1859)

L. 350-548; W. 33-35. Pl. 1: 9

Cells cylindrical, 10-17 times longer than broad; apices truncate and slightly broadened; cells either solitary or sometimes remain attached end to end in filaments, but separating and becoming geniculate before conjugation; walls granulate; chloroplasts of two continuous parietal bands, usually making 1-2 spiral turns, each band with numerous pyrenoids. Cf. Ruzicka (1977, Pl. 2: 26, 27) and Forster (1982, Pl. 3, Figs 3, 4).

Family MESOTAENIACEAE

Genus SPIROTAENIA Brebisson 1844
**Penium spinulosum** (Wolle) Gerrath (1969)
L. 374-475; W. 40-44; Pl. 1: 11; Fig. 6: 10
Cells cylindrical and elongate, about 10 times longer than broad, slight median constriction; semi-cell strongly crenate, with two basal inflations, a number of undulations and slightly tapered at the apex; girdle bands present; cell wall with dense prominent needle-like spines and reddish brown in colour. This interesting desmid was limited in distribution to between Udu Bridge and Ejere on the Warri River Estuary. The plant was first described by Wolle (1881) as *Docidium spinulosum* and later changed to *Pleurotaenium spinulosum* by Brunnel (1949). Based on ultrastructural studies using electron microscopy, Gerrath (1969, fig. 4) showed that the taxon belonged to the genus *Penium* and so renamed it. The present find is the first report of the desmid in mainland Africa, a varietal form having been earlier reported from Madagascar by Brunnel (1949) as *Pleurotaenium spinulosum*. This is a rare desmid, in localities where this species has been reported in the United States, Canada, and Madagascar and recently in Australia, only a few specimens were seen. A significant difference between Gerrath's plants and those in this collection is the number of undulations per semi-cell; Gerrath's plants had 7 undulations while the Warri River plants had between 10 and 14 undulations per semi-cell, thus resembling more closely the Australian form reported by Thomasson (1973, Figs 1, 2). Like the Australian desmid the spines of the present plants are shorter, denser and triangular.

**Penium cylindrus** (Ehrenberg) Brebisson in Ralfs (1848)
L. 68-70; W. 17-19; I. 14-15; Pl. 1: 10
Cells short and cylindrical, about 4 times longer than broad, with a slight median constriction; semi-cell with parallel sides, broadening slightly towards a truncate apex; cell wall reddish brown in colour. My plants are larger than the species described by Scott & Prescott (1958, Pl. 1, Fig. 20), Scott & Prescott (1961, Pl. 1, Fig. 11), Forster (1969, Pl. 2: 2-3-6), Forster (1982, Pl. 2, Figs 15-17) and Ling & Tyler (1986, Pl. 6: 13, 14). Cf. the plant described by Thomasson (1965, Fig. 5:4) as *P. marginaticeae* (Ehrenberg) Brebisson.

**Penium margaritaceum** (Ehrenberg) ex Brebisson in Ralfs (1848)
L. 150-153; W. 29-31; I. 27-28; Pl. 1: 12; Fig. 5: 10
Cells subcylindrical, of medium size, about 5 times longer than broad; slightly discernible median constriction; semi-cells tapering gradually towards truncately rounded apices; transverse girdle bands present. Cf. Grönblad et al. (1968, Fig. 7), Lind (1967, Pl. 1, Figs 1, 2), Forster (1982, Pl. 2, Fig. 14) and Croasdale & Flint (1986, Pl. 3, Figs 13-15).

**Genus CYLINDROCYSTIS** Menegh. (1838)

*Cylindrocystis brebissonii* Menegh. (1838)
L. 42-64; W. 15-25; Fig. 4: 12, 13
Cells showing variation in size and shape with many intergrading forms; cylindrical with broadly rounded apices; about 2.5 times longer than broad; chloroplast axis, usually with a few large rays, and a central elongate pyrenoid. Cf. Scott & Prescott (1961, Pl. 1, Fig. 3), Croasdale & Grönblad (1964, Pl.1, Figs 8-11), Scott et al. (1965, Fig. 1), Grönblad et al. (1968, Fig. 1), Forster (1982, Pl. 1, Figs 1-3), Croasdale & Flint (1986, Pl. 1, Figs 15, 16) and Gerrath & John (1988, Pl. 2, Fig. 1).

**Genus NETRIUM** (Naegeli) Itzigsohn & Rothe (1856)

*Netrium digitus* (Ehr.) Itzigsohn & Rothe var. *lamellosum* (Brebisson) Grönblad (1920)
L. 260-263; W. 43-44; Pl. 1: 13; Fig. 4: 16.
Cells large, naviculoid or elliptic-fusiform, about 6 times longer than broad; lacks median constriction; lateral margins retuse in the mid-region, attenuating to truncately rounded apices; cell wall smooth; two large chloroplasts, one in each half of the cell, strongly dissected at the margins with a single elongate pyrenoid. Cf. Croasdale & Grönblad (1964, Pl. 1, Fig. 21), Grönblad et al. (1968, Fig. 3), Islam & Haroon (1980, Pl. 2, Fig. 27), Forster (1982, Pl. 1, Fig. 8), Croasdale & Flint (1986, Pl. 4, Fig. 1) and Ling & Tyler (1986, Pl. 6:7).

**Family DESMIDIAEAE**

**Genus PENIUM** (Brebisson) Ralfs (1848)

*Penium cylindrus* (Ehrenberg) Brebisson in Ralfs (1848)
L. 166-180; W. 17-20; Pl. 1: 14; Fig. 4: 11
Cells long and cylindrical, slightly curved, rarely straight; 8-10 times longer than broad; margins parallel, circular in cross-section; apex tapering to a rounded end; membrane smooth without pores; chloroplast unique, a broad parietal band consisting of about 12 close spirally wound turns; pyrenoids few to many. The present plants are much larger than the ones reported by Forster (1969, Pl. 1, Fig. 1), Forster (1982, Pl. 1, Figs 15, 16) and Croasdale & Flint (1986, Pl. 1, Figs 11, 12).

*Penium margaritaceum* (Ehrenberg) Brebisson in Ralfs (1848) L. 150-153; W. 29-31; I. 27-28; Pl. 1: 12; Fig. 5: 10
Cells subcylindrical, of medium size, about 5 times longer than broad; slightly discernible median constriction; semi-cells tapering gradually towards truncately rounded apices; transverse girdle bands present. Cf. Grönblad et al. (1968, Fig. 7), Lind (1967, Pl. 1, Figs 1, 2), Forster (1982, Pl. 2, Fig. 14) and Croasdale & Flint (1986, Pl. 3, Figs 13-15).

**Genus CYLINDROCYSTIS** Menegh. (1838)

*Cylindrocystis brebissonii* Menegh. (1838)
L. 42-64; W. 15-25, Fig. 4: 12, 13
Cells showing variation in size and shape with many intergrading forms; cylindrical with broadly rounded apices; about 2.5 times longer than broad; chloroplast axis, usually with a few large rays, and a central elongate pyrenoid. Cf. Scott & Prescott (1961, Pl. 1, Fig. 3), Croasdale & Grönblad (1964, Pl.1, Figs 8-11), Scott et al. (1965, Fig. 1), Grönblad et al. (1968, Fig. 1), Forster (1982, Pl. 1, Figs 1-3), Croasdale & Flint (1986, Pl. 1, Figs 15, 16) and Gerrath & John (1988, Pl. 2, Fig. 1).

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**Family DESMIDIAEAE**

**Genus PENIUM** (Brebisson) Ralfs (1848)

*Penium cylindrus* (Ehrenberg) Brebisson in Ralfs (1848)
L. 68-70; W. 17-19; I. 14-15; Pl. 1: 10
Cells short and cylindrical, about 4 times longer than broad, with a slight median constriction; semi-cell with parallel sides, broadening slightly towards a truncate apex; cell wall reddish brown in colour. My plants are larger than the species described by Scott & Prescott (1958, Pl. 1, Fig. 20), Scott & Prescott (1961, Pl. 1, Fig. 11), Forster (1969, Pl. 2: 2-3-6), Forster (1982, Pl. 2, Figs 15-17) and Ling & Tyler (1986, Pl. 6: 13, 14). Cf. the plant described by Thomasson (1965, Fig. 5:4) as *P. marginaticeae* (Ehrenberg) Brebisson.

*Penium margaritaceum* (Ehrenberg) ex Brebisson in Ralfs (1848)
a large terminal vacuole containing one to many crystals, recently identified as barium sulphate (Brook et al. 1980), and exhibiting Brownian movement. Curvature, important in identification, is given in degrees of arc and is measured by superimposing a "Closterio-curvimeter", a device of Hemians (1946), over a drawing or photograph of the Closterium cell.

*Closterium acerosum* (Schroeder) Ehrenberg (1828)
L. 222-407; W. 20-47. Pl. 2: 10, 11; Fig. 3: 8, 9
Cells fusiform, variable in size, almost straight with rounded truncate apices; curvature 30-36° of arc; wall finely striate, yellowish-brown or colourless; chloroplasts ridged with 7-8 pyrenoids. Cf. van Oye (1953, Finely striate, yellowish-brown or colourless; chloroplast with 4-6 pyrenoids. Cf. Scott & Prescott (1958, Fig. 1: 7), Forster (1958, Pl. 1: 3), Croasdale & Grönblad (1964, Pl. 3, Fig. 17), Ling & Tyler (1986, Pl. 8: 5-7) and Gerrath & John (1988, Pl. 9, Fig. 1).

**Closterium dianae** Ehrenberg (1838)
L. 263-298; W. 19-26. Pl. 2: 13; Fig. 4: 3
Cells 15-17 times longer than broad; strongly curved, 110-120° of arc; ventral margin concave, in most cases slightly tumid in the mid-region, tapering to obliquely truncate apices; cell wall smooth; chloroplast with 5-7 pyrenoids per semi-cell. Cf. Scott & Prescott (1958, Pl. 1: 3), Croasdale & Grönblad (1964, Pl. 3, Fig. 3), Forster (1969, Pl. 3: 4, 5), Islam & Haroon (1980, Pl. 2, Figs 29, 30), Croasdale & Flint (1986, Pl. 7, Figs 3, 4) and Gerrath & John (1988, Pl. 4, Fig. 1).

**Closterium dianae** Ehrenberg var. *arcuatum* (Brebisson) Rabenhorst (1868)
L. 270-320; W. 17-36. Pl. 2: 15; Fig. 3: 10
Cells strongly curved, 115-145° of arc; ventral margin concave, gradually attenuated towards the obliquely truncated apices; cell wall smooth and pale yellow in colour; chloroplast with 5-9 pyrenoids. Cf. Scott & Prescott (1958, Pl. 1: 3), Croasdale & Grönblad (1964, Pl. 3, Fig. 3), Forster (1969, Pl. 3: 4, 5), Islam & Haroon (1980, Pl. 2, Figs 29, 30), Croasdale & Flint (1986, p. 58) and Ling & Tyler (1986, Pl. 5: 22).

**Closterium dianae** Ehrenberg var. *pseudodianae* (Roy) Krieger (1937)
L. 256-299; W. 15-20. Pl. 2: 14
Cells differ from earlier reported forms in its lesser curvature, from 105-115° of arc, and being narrower and tapered at the apices; chloroplast 8-10 pyrenoids. Cf. Scott & Prescott (1961, Pl. 2, Fig. 7), Forster (1982, Pl. 9, Figs 10, 11) and Croasdale & Flint (1986, Pl. 7, Fig. 6).

**Closterium eboracense** (Ehrenberg) Turner (1892)
L. 308-320; W. 67-72. Fig. 3: 11
Cells very stout and tumid, 4-5 times longer than broad; moderately curved, about 90° of arc; ventral margin concave, cell gradually attenuated to broadly rounded apices; chloroplast with a number of ridges, each con-
Closterium ehrenbergii Meneghini ex Ralfs (1848) L. 407-480; W. 70-74. Pl. 3: 9,10; Fig. 3: 4, Fig. 4: 1,2

Cells stout and large, strongly curved, 115-140° of arc; tumid at the mid-region, narrowing progressively to broadly rounded apices; dorsal margin broadly convex; wall smooth, chloroplast with many scattered pyrenoids. Cf. Scott & Prescott (1961, Pl. 2, Fig. 2), Forster (1969, Pl. 3: 1), Lind (1971, Pl. 1, Fig. 12), Islam & Haroon (1980, Pl. 1, Fig. 9) and Croasdale & Flint (1986, Pl. 6, Figs 11: 12).

Closterium gracile Brebisson (1839)

L. 267-380; W. 7-13. Pl. 1:19, 20; Fig. 2: 1-4

Cells very slender, straight and cylindrical with parallel margins gracefully incurved and slightly tapered towards obtuse apices which are rounded-truncate; walls smooth and colourless; chloroplast with 7-9 pyrenoids. Cf. Scott & Prescott (1961, Pl. 2, Figs 16, 17), Croasdale & Grönblad (1964, Pl. 3, Fig. 12), Forster (1969, Pl. 2: 18, 19) and Croasdale & Flint (1986, Pl. 8, Figs 3, 4, 6).

Closterium incurvum Brebisson (1856)

L. 44-47; W. 8-9. Pl. 1: 21

Cells small, very strongly curved, 160-180° of arc; ventral margin concave, strongly attenuated to narrow, acutely rounded apices. This species is differentiated from Cl. venus Kützing by its smaller size, greater degree of curvature, and sharper apices (Cook, 1963, p. 9, Figs 8, 18). Cf. Forster (1982, Pl. 8, Figs 11, 12), Croasdale & Flint (1986, Pl. 6, Figs 1, 2) and Ling & Tyler (1986, Pl. 5: 20).

Closterium kuetzingii Brebisson (1856)

L. 386-665; W. 16-19. Pl. 2: 6, 7; Fig. 2: 14, 15

Cells 24-35 times longer than broad, mostly straight, the middle portion fusiform with ventral and dorsal margins almost equally convex, gradually attenuated into long cylindrical processes which are incurred towards the slightly swollen apices. Chloroplast with 5-8 pyrenoids. Cf. Scott & Prescott (1958, Fig. 1:4), Scott & Prescott (1961, Pl. 1, Fig. 23), Croasdale & Grönblad (1964, Pl. 4, Figs 11, 12), Scott et al. (1965, Figs 21, 22), Lind (1967, Pl. 1, Figs 6, 7), Forster (1969, Pl. 4: 7-11), Islam & Haroon (1980, Pl. 1, Fig. 16), Croasdale & Flint (1986, Pl. 11, Figs 6, 7), Ling & Tyler (1986, Pl. 7:1) and Gerrath & John (1988, Pl. 9, Figs 5-7).

**Closterium kuetzingii f. croasdaleae.** Forster (1969)

L. 400-460; W. 12-15. Pl. 2: 8; Fig. 2: 21

Cells only slightly swollen in the mid-region; evenly tapered to narrow incurved apices; chloroplast with 7-9 pyrenoids in each semi-cell. This plant is synonymous with Cl. kuetzingii Brebisson, forma described by Scott et al. (1965, Pl. 1: 22). Cf. also Forster (1969), Pl. 4: 12; 1982, Pl. 12, Fig. 8).

Closterium lanceolatum (Kützing.) in Ralfs (1848)

L. 486-510; W. 70-75. Pl. 3: 8; Fig. 4: 8

Cells broad, fusiform and straight, about 7 times longer than broad; ventral and dorsal margins almost equally convex, and gradually and smoothly attenuated from the mid-region towards truncate rounded obtuse apices; wall smooth, pyrenoids scattered. Cf. Grönblad & Croasdale (1971, Fig. 6) and Croasdale & Flint (1986, Pl. 9, Figs 1, 2).

*Closterium leibleinii* Kützing (1847)

L. 263-286; W. 53-57. Fig. 3: 12, 13

Cells strongly curved. 155-170° of arc; ventral margin concave, slightly tumid in the mid-region, tapering toward narrow acutely rounded apices; cell wall smooth. Cf. Islam & Haroon (1980, Pl. 1, Figs 6, 7). Croasdale & Flint (1986, Pl. 6, Figs 9, 10) and Gerrath & John (1988, Pl. 3, Figs 10, 11).

Closterium libellula Focke var. interruptum (W. West & G.S. West) Donat (1926)

L. 139-145; W. 23-25. Pl. 1: 17; Fig. 4: 10

Cells stout, relatively straight and slightly 5-6 times longer than broad, apices broad, truncate and rounded; chloroplast plates interrupted at about the middle of each semi-cell. One of the very few straight *Closteria*; wall smooth, 4-5 pyrenoids in each semi-cell. Cf. Krieg (1932-33, Pl. V, Fig. 4), Scott & Prescott (1958, Fig. 1: 6), Scott et al. (1965, Fig. 10), Forster (1969, Pl. 2: 15) and Lind & Tyler (1986, Pl. 5: 4, 5). Some authors also refer to this plant as *Closterium cloteroides* (Ralfs) Louis & Peeters (see Forster (1982, Pl. 3, Figs 11-13) and Croasdale & Flint (1986, Pl. 4, Figs 7, 8).

Closterium lineatum Ehrenberg ex Ralfs(1848)

L. 296-674; W. 14-20. Pl. 1: 23; Fig. 2: 5-9

Cells long and linearly narrow, 21-40 times longer than broad; median portion straight and cylindrical, gradually tapered to incurred obliquely truncate apices; walls striate, reddish-brown in colour. Cf. Scott & Prescott (1961, Pl. 1, Fig. 26), Croasdale & Grönblad (1964, Pl. 4, Fig. 10), Lind (1971, Pl. 1, Fig. 15), Forster (1982, Pl. 5, Fig. 9). Croasdale & Flint (1986, Pl. 11, Figs 1-4) and Gerrath & John (1988, Pl. 9, Fig. 3).

Closterium lineatum (Ehrenberg) Ralfs var. curvatum Thomasson (1966)

L. 420-438; W. 13-1. Pl. 2: 3

Cells slender, narrow and curved with about 85-90° of arc; this variety differs from the normal species in its curved shape. Other features, such as size and the subparallel sides of the cells are those of *Cl. lineatum* (Ehr.) Ralfs. Thomasson (1966, Pl. IV, Fig. 5) described a similar plant from samples collected from Lake Shiwa Ngandu.

Closterium lunula (Müller) Nitzsch. ex Ralfs (1848)

L. 554-620; W. 96-106. Pl. 3: 5

Cells large and stout, 6-7 times longer than broad, almost straight, moderately curved, 40-60° of arc; ventral margin slightly convex in the median part and gradually...
narrowed to conical, bluntly, rounded, slightly recurved apices; chloroplast with 8-10 ridges; pyrenoids many and scattered; cell wall smooth and colourless. Cf. van Oye (1953, Fig. 9), Scott, Grönblad & Croasdale (1965, Fig. 19) and Croasdale & Flint (1986, Pl. 7, Figs 8-10).

*Closterium lunula* (Müller) Nitzsch var. *maximum* Borge (1906) L. 500-625; W. 111-126. Pl. 3: 6; Fig. 3: 3 Cells very large, 4-5 times longer than broad; ventral margin strongly tumid in the mid-region, thereafter gradually attenuated to conical, bluntly rounded apices; moderately curved, 65-105° of arc; chloroplast with many ridges, pyrenoids scattered. Cf. Grönblad & Croasdale (1971, Fig. 9).

*Closterium lunula* (Müller) Nitzsch var. *maximum* Borge f. *crassissimum* Croasdale (1971) L. 634; W. 197. Pl. 3: 7; Fig. 3: 2 Cells large, of exceptionally great breadth, 3.2 times longer than broad; ventral margin strongly swollen in the mid-region before tapering to broad widely truncate rounded apices. This specimen, the only one found is larger than that reported by Grönblad & Croasdale (1971, Fig. 10) from Namibia.

*Closterium monoliferum* (Bory) Ehrenberg ex Ralfs (1848) L. 480-720; W. 64-93. Pl. 3: 11; Fig. 3: 6 Cells generally large and strongly curved, 105-150° of arc; ventral margin slightly swollen in the median portion, and strongly attenuated to truncate acute rounded apices; cell wall smooth; 7-12 pyrenoids in the central chloroplast ridge; in some forms pyrenoids are many and scattered. Cf. Bourrely (1957, Fig. 15), Croasdale & Grönblad (1964, Pl. 3, Fig. 1), Forster (1969, Pl. 2: 30), Islam & Haroon (1985, Pl. 1, Figs 7-10), Gerrath & John (1988, Pl. 4, Figs 2, 3).

*Closterium porrectum* Nordstedt var. *borgei* (Borge) Forster (1964) L. 450-566; W. 56-66. Fig. 3: 5 A large plant characterised by its lesser degree of curvature (130-145°) and relatively wide tumid diameter than is presented by the typical species. Cf. Forster (1964, Fig. 1: 15), Scott et al. (1965, Fig. 16), Thomson (1971, Fig. 8: 10, 11). Similar plants were also reported by Borge (1903, Fig. 1: 20).

*Closterium pronum* Brebisson (1856) L. 300-360; W. 9-12. Pl. 1: 22 Cells bigger than most reported species; almost straight, ventral margin slightly tumid in the mid-region and curved at the apices; sometimes sigmoid; 40-45 times longer than broad; cell wall smooth and colourless. Cf. Scott & Prescott (1958, Pl. 2, Fig. 42), Ling & Tyler (1986, Pl. 8: 1, 2).

**Closterium pseudolunula** Borge var. *concavum* Forster & Eckert (1963) L. 340-390; W. 37-50. Pl. 3: 4; Fig. 3: 7 Cells almost straight, 30-40° of arc; ventral margin virtually straight, gradually narrowed into wide blunt obtusely rounded apices; chloroplast with 5-9 pyrenoids. Cf. Forster (1963, Pl. 1: 8), Forster (1969, Pl. 4: 16-18) and Islam & Haroon (1980, Pl. 1, Fig. 13).

*Closterium ralfsii* Brebisson (1844) L. 420-596; W. 36-38. Pl. 2: 12, 16 Cells from 12-16 times longer than broad, slightly curved, 35-50° of arc; ventral margin more inflated than the dorsal, strongly attenuated to narrow slightly incurved apices; cell wall finely striate and reddish-brown. Cf. Croasdale & Grönblad (1964, Pl. 4, Fig. 7) and Croasdale & Flint (1986, Pl. 10, Fig. 8).

*Closterium ralfsii* Breb. var. *hybridum* Rabenhorst (1863) L. 480-504; W. 30-33. Pl. 2: 9; Fig. 2: 13 A variety more slender than most reported forms, 15-17 times longer than broad; cells nearly straight, 35-45° of arc; ventral margin slightly tumid in the mid-region and strongly tapered towards acutely truncate apices; walls finely striate, yellowish-brown in colour. Cf. Scott & Prescott (1958, Fig. 1: 13), Scott & Prescott (1961, Pl. 1, Fig. 25), Croasdale & Grönblad (1964, Pl. 4, Fig. 8), Forster (1982, Pl. 11, Fig. 2), Croasdale & Flint (1986, Pl. 10, Figs 10, 11), Ling & Tyler (1986, Pl. 7: 2) and Gerrath & John (1988, Pl. 7, Fig. 5).

**Closterium rectimarginatum** Scott & Prescott (1961) L. 280-301; W. 33-46. Pl. 1: 18 Cells flat and spindle shaped, of medium size, about 6-9 times longer than broad; lateral margins almost perfectly straight from the mid-region to the narrowly rounded apices; cell wall smooth and reddish-brown; chloroplast with 5-7 pyrenoids. The present plants which do not appear to have been reported for Africa are much larger than the original species described by Scott & Prescott (1961, Pl. 1, Figs 27, 28) from Indonesia and also the specimen reported by Ling & Tyler (1986, Pl. 5: 31) from Australia.

*Closterium rostratum* Ehrenberg (1828) L. 400-428; W. 43-47. Pl. 3: 3; Fig. 4: 7 Cells large, about 9 times longer than broad; slightly curved, 35-45° of arc; ventral margin strongly tumid in the mid-region and more convex than the dorsal margin; strongly attenuated to produce narrow, slender extremities with parallel sides, terminated by incurved obliquely rounded apices; wall smooth and striate in the mid-region. Cf. Grönblad et al. (1968, Fig. 21), Agarker & Agarker (1977, Fig. 3), Forster (1982, Pl. 12, Fig. 1) and Croasdale & Flint (1986, Pl. 11, Figs 11-14).

**Closterium rostratum** Ehrenberg var. *brevirostratum* W. West (1904) L. 280-286; W. 46-50. Pl. 1: 15, 16; Fig. 4: 9 Cells shorter than the normally reported species; about 6 times longer than broad; ventral margin strongly tumid and attenuated to produce short slender extremities. Cf.
Closterium setaceum Ehrenberg ex Ralfs (1848)
L. 357-420; W. 13-17. Pl. 2: 4, 5; Fig. 2: 18
Cells slender, median portion fusiform; 25-27 times longer than broad, tapers abruptly into long slender and cylindrical processes longer than the swollen median portion and nearly straight except at their incurved obtuse apices; chloroplast with 2-3 pyrenoids restricted to portion and nearly straight except at their incurved obtuse apices sometimes slightly capitate with thickened swollen, gradually attenuated to broadly truncate apices. Cf. Scott & Prescott (1961, Pl. 1, Fig. 21), Lind (1967, Pl. 1, Figs 10, 11), Grönblad et al. (1968, Fig. 19), Forster (1969, Pl. 4: 13-15), Lind (1971, Pl. 1, Fig. 17), Croasdale & Flint (1986, Pl. 11, Figs 15, 16), Gerath & John (1988, Pl. 9, Fig. 4).

*Closterium spetsbergense* Borge var. *laticeps* Grönblad f. *maius* Grönblad. (1921)
L. 760; W. 80. Fig. 3: 1
Cells stout and very large, about 9.5 times longer than broad; almost straight, 40° of arc; ventral margin virtually straight; tapered at the poles into broadly truncate rounded apices. This plant in all respects, appears identical with that reported by Grönblad & Croasdale (1971, Fig. 11) from Namibia. It is much larger than the variety described by Grönblad (1921, Pl. 5:43) as *Cl. spetsbergense* var. *laticeps*. Krieger (1937, p. 305) puts this species under *Cl. pseudolumula* Borge, but this does not seem appropriate on account of the fact that Borge (1911, Fig. 5) had given the name *Cl. spetsbergense* to the species and his original figures show them to be very different.

Closterium striosum Brebisson (1856)
L. 227-234; W. 19-23. Fig. 2: 19
Cells 11-12 times longer than broad; slightly bent, 20-30° of arc; ventral margin straight or very slightly tumid; poles slightly incurved with narrow subacute apices. Cf. Ruzicka (1977, Pl. 22: 5), Compere (1977) from Lake Chad and Croasdale & Flint (1986, Pl. 8, Figs 1, 2).

Closterium striolatum Ehrenberg in Ralfs (1848)
L. 290-354; W. 29-36. Pl. 2: 12
Cells moderately large, about 10 times longer than broad; a little curved, 35-80° of arc; the median portion of ventral origin sometimes straight, or else slightly swollen, gradually attenuated to broadly rounded truncate apices sometimes slightly capitate with thickened wall; cell wall striate and brownish. Cf. Van Oye (1953, Fig. 19), Scott & Prescott (1958, Fig. 1:11), Scott & Prescott (1961, Pl. 2, Fig. 22), Croasdale & Grönblad (1964, Pl. 4, Figs 5, 6), Islam & Haroon (1980, Pl. 2, Fig. 25), Forster (1982, Pl. 6, Figs 11, 12), Croasdale & Flint (1986, Pl. 10, Figs 1, 2) and Ling & Tyler (1986, Pl. 7: 6-8).

**Closterium subalatum** (Kützing) Brebisson var. *maius* Krieger (1937)
L. 320; W. 20. Fig. 2: 17
Cells 16-18 times longer than broad; almost straight, 20-30° of arc; middle portion tumid and fusiform; ventral margin more convex and attenuated into slender slightly incurved apices. Cf. Krieger (1937, Pl. 13:9), Croasdale & Grönblad (1964, Pl. 2, Fig. 9) and Forster (1969, Pl. 4: 6).

Closterium turgidum Ehrenberg var. *borgei* (Borge) Deflandre (1924)
L. 703-1391; W. 47-89. Pl. 3: 2; Fig. 4: 4, 5
Cells very large, 15-17 times longer than broad; slightly curved, 38-45° of arc; ventral margin slightly concave; the variety is distinguished from the typical species by the proportional increase in length and breadth and the appearance of the extremities which are obtuse and somewhat angular; cell wall yellowish-brown, finely striate with about 10-12 striae in 10 µm; chloroplasts with ridges and scattered pyrenoids. Plants widely distributed and cosmopolitan. Cf. Van Oye (1953, Fig. 22), Scott & Prescott (1961, Pl. 1, Fig. 24), Grönblad & Croasdale (1964, Fig. 4), Lind (1967, Pl. 1, Figs 13, 16) Lind (1971, Pl. 1, Fig. 18), Grönblad & Croasdale (1971, Fig. 12), Islam & Haroon (1980, Pl. 2, Fig. 22) and Forster (1982, Pl. 8, Figs 7-9).

Genus PLEUROTAENIUM Naegeli 1849

Pleurotaenium baculoides (Roy & Bisset) Playfair (1907)
L. 562-846; W. 35-38 Pl. 4: 14; Fig. 5: 14, 15
Cells of varying length, 10-17 times longer than broad; semi-cell with one prominent basal inflation, broad in the middle and tapering towards a truncate apex; cell wall smooth. Cf. Scott & Prescott (1961, Fig. 5), Grönblad et al. (1964, Fig. 7), Lind (1971, Pl. 1, Fig. 1) and Forster (1982, Pl. 13, Fig. 8).

Pleurotaenium coronatum (Brebisson) Rabenhorst (1868)
L. 480-512; W. 42-45; Wa. 30-32; Pl. 4: 6; Fig. 6: 6
Cells narrow, about 12 times longer than broad; diameter of semi-cells much reduced above the basal swellings, and widest in the mid-region, tapering to a rounded apex. Cf. Forster (1969, Pl. 6: 12, 13); Forster (1982, Pl. 14, Fig. 6) and Ling & Tyler (1986, Pl. 12: 8).

Pleurotaenium coronatum (Brebisson) Rabenhorst var. coronatum Croasdale (1965)
L. 518-524; W. 40-43; Wa. 26-28 Pl. 4: 7
Semicells somewhat flexuous and slightly tapered to the rounded apices; distinct basal swelling with 2-3 undulations after it; wall apparently smooth. Cf. Scott, Grönblad & Croasdale (1965, Fig. 35)

Pleurotaenium coronatum (Brebisson) Rabenhorst var. fluctuatum W. West (1892)
L. 293-340; W. 22-24; Pl. 4: 4; Fig. 6: 7
Cells generally slender, shorter than the normal, about 16 times longer than broad, margins undulate throughout the length of the cell, with at least 12 undu-
lations per semi-cell; semi-cell dilated at the apex and terminated by a ring of teeth or tubercles. Cf. Lind (1971, Pl. 1, Fig. 2) and Forster (1982, Pl. 14, Fig. 7). This appears to be the same plant described by Scott & Prescott (1958, Fig. 2: 9, 10) and Ling & Tyler (1986, Pl. 12: 17) as \textit{Pl. burmense} (Joshua) Krieger (1937) var. \textit{curtum} Scott & Prescott. See also Thomasson (1971, Figs 4: 5, 6; 5: 3, 7; 7: 13-15).

**\textit{Pleurotaenium coronatum}** (Brebisson) Rabenhorst var. \textit{nodulosum} (Brebisson) W. West & G.S. West f. \textit{constrictum} Krieger (1937) L. 580-670; W. 42-46; Pl. 4: 5; Fig. 5: 12

Cells narrow and long, 16-17 times longer than broad; semi-cells have narrowest diameter above the isthmus and taper gradually towards the poles; apex flattened with a ring of tubercles. Cf. Krieger (1937, Pl. 49, Fig. 1) and Scott & Prescott (1958, Fig. 2:6).

*\textit{Pleurotaenium ehrenbergii}* (Brebisson) De Bary (1858) L. 420-450; W. 33-36 Pl. 4: 8

Plants stout and cylindrical, about 17 times longer than broad; semi-cells with widest diameters at the base above the isthmus, tapering gradually towards the poles; apex with faint terminal tubercules. Cf. West & West (1904, Pl. 29, Figs 9-11), Scott & Prescott (1958, Fig. 2: 2), Lind (1971, Pl. 1, Fig. 4), Prescott et al. (1975, Pl. 45: 1-5), Ling & Tyler (1986, Pl. 13: 15, 16) and Ger- Nath & John (1988, Pl. 10, Fig. 7).

*\textit{Pleurotaenium maculatum}* (Turner) Krieger (1939) L. 756-767; W. 53-56 Pl. 4: 8, 9

Cells large and robust, very long, about 16 times longer than broad, semi-cells of even diameter, with one distinct basal swelling above the isthmus and terminating in an expanded apex ornamented by a ring of 13-16 prominent conical tubercules. Lind (1971, Pl. 10, Figs 1, 1a) described a similar plant from the desmids collected in Uganda. On the other hand, the plant described by Bourrelly (1957, Pl. 1, Fig. 8) from the district of Mas- cina, West Africa, is a much shorter form.


Cells of this variety generally, as a rule, lack basal inflations but are angularly tapered at the apex; cells stout, 12-13 times longer than broad and considerably larger than the taxon described by Kaiser (1931). It resembles some form of \textit{Pl. trabecula} (Ehrenberg) Naegeli except that there is no trace of basal swellings. Cf. Scott & Prescott (1961, Pl. 121-122) and Ling & Tyler (1986, Pl. 13: 14).

\textit{Pleurotaenium ovatum} Nordstedt (1877) L. 370-410; W. 86-93; I. 70-74; Pl. 4: 15; Fig. 6: 1

Cells large and robust, about 4 times longer than broad; semi-cells without a basal swelling, gradually dilated to about one quarter of the length of the cell, then tapering evenly towards the apices; apex flat and broad bearing a ring of tubercules, 5-7 of them visible in face view; chloroplast parietal with ribbon-like ridges, each with numerous pyrenoids. Cf. Scott & Prescott (1961, Pl. 6, Figs 1, 2), Thomasson (1965, Fig. 5: 5), Lind (1971, Pl. 1, Fig. 5), Hirano (1972, Pl. 1, Fig. 7), Islam & Haroon (1980, Pl. 4, Fig. 63). The desmid \textit{Pleurotaenium ovatum} Nordstedt belongs to large group of desmids whose distribution had hitherto been said to be limited to the tropical and sub-tropical regions of Africa, Asia, Au- stralia and South America. Recently, Croasdale & Flint (1986, Pl. 13, Figs 3-8) reported the presence of the plants in New Zealand.

*\textit{Pleurotaenium ovatum} Nordstedt var. \textit{elephantinum} (Cohn) Krieger (1937) L. 596-660; W. 109-112; I. 81-83; Pl. 5: 4; Fig. 6: 3

Cells longer than the typical species, about 4 times longer than broad. The plant reported by Krieger (1937) had smooth apices while Cohn (1879) had drawings with small apical teeth. The Tanzanian desmids reported by Lind (1967, Pl. 2, Figs 1, 2 & Photo 1) had small, rounded apical tubercles of which 7-8 were visible in front view. The present plants are similar to Krieger’s in having smooth apices.

**\textit{Pleurotaenium ovatum} Nordstedt var. \textit{inermius}** Mo- bius (1894) L. 256-310; W. 77-89; I. 48-52; Pl. 5: 3; Fig. 6: 5

Cells shorter and broader than the typical species; re- semble variety \textit{tumidum} but with smooth ends; 3 times longer than broad. Cf. Mobius (1894, Pl. 2: 18-19), Krieger (1937, Pl. 50: 5), Scott & Prescott (1961, Pl. 6, Figs 3, 4), Islam & Haroon (1980, Pl. 24, Fig. 375) and Ling & Tyler (1986, Pl. 13: 11). This is the first report of this taxon for Africa.

*\textit{Pleurotaenium ovatum} Nordstedt var. \textit{tumidum}** (Maskell) G.S. West (1907) L. 254-420; W. 86-126; I. 76-82; Pl. 5: 1, 2; Fig. 6: 2, 4

Cells relatively short, thicker and broad, 3 times longer than broad; semi-cell with an abrupt swelling above the isthmus and tapering in a smooth curve to a truncate apex ornamented with conspicuous tubercles or teeth. Cf. Hardy (1906, Pl. 21), Krieger (1937, Pl. 50: 2, 3), Grönblad & Croasdale (1971, Fig. 13), Croasdale & Flint (1986, Pl. 13, Figs 5-8) and Ling & Tyler (1986, Pl. 13: 10).

*\textit{Pleurotaenium simplissimum}** Grönblad var. \textit{simplicis- simum} Krieger (1937) L. 864; W. 42; Pl. 4: 13; Fig. 5: 7

Cells very long and narrow, about 20 times longer than broad; semi-cell with narrowest diameter a little below the apex; apex a little dilated with 12-14 tubercules; cell wall with no visible undulations.

\textit{Pleurotaenium subcoronulatum} (Turner) W. West & G. S. West (1895) L. 366; W. 36; Pl. 4: 1; Fig. 5: 13

Cells narrow and long, forming chains of short filaments, usually of up to 4 cells in length; semi-cell with
one distinct basal swelling, followed by a series of undulations; attenuated towards the poles; apex expanded and crowned with a ring of between 10 and 12 distinct conical tubercules. Dichotytic forms in which the semi-cells are markedly different in length are not uncommon, the illustrations here (Pl. 4: 1 & Fig. 5:13) being some examples. Cf. Turner (1892, Pl. 3: 1), W. West & G.S. West (1895, Pl. 5: 13), Scott & Prescott (1961, Pl. 4, Figs 1, 2), Lind (1967, Pl. 1, Fig. 21), Prescott et al. (1975, Pl. 49: 2-5) and Ling & Tyler (1986, Pl. 12: 12, 19-24).

*Pleurotaenium subcoronulatum* (Turner) W. West & G. S. West var. *africanum* Schmidle (1902)

L. 350-530; W. 28-32; Pl. 4: 2, 3; Fig. 5: 6

Cells narrow and long and of different lengths, most of them forming chains of varying number of cells; semi-cell with a distinct basal inflation, above which there are no visible undulations as is characteristic of reported forms; apex dilated and terminated by a ring of tubercles; 2-4 ribbon-like chloroplasts in each semi-cell. Cf. Grönblad et al. (1958, Pl. 1), Lind (1971, p. 539) and van Oye (1953, Figs 29, 30).

**Pleurotaenium subcoronulatum** (Turner) W. West & G.S. West var. *spinulosum* Opte var. *nova*

L. 480-512; W. 47-52; Pl. 5: 11.

Cells about ten times longer than broad; occurs singly or in short chains of 2-4 cells in a filament; semi-cell with one distinct basal inflation and no further undulations; apex expanded and crowned with characteristic conical tubercles, 12-14 in number; cell wall covered with a tuft of fine hairs or spines. In consideration of the prominent tubercles and the filamentous habit, this taxon approximates to the species subcoronulatum, but differs from any reported form in the possession of copious stout spines covering the entire cell surface. A new variety is therefore suggested.

**DIAGNOSIS:** Haec varietas proxime et similis ad Pleurotaenium subcoronulatum sed differt ab illum cum membrana spinis multo possidero. Long. 480-512 μm, lat. 47-52 μm, lat. cum spin, 52-56 μm.

Pleurotaenium trabecula (Ehrenberg) Naegeli (1849)

L. 460-498; W. 24-28; Pl. 4: 9; Fig. 5: 16

Cells 15-18 times longer than broad; semi-cells widest in the mid-region, then tapering to truncate rounded apex without ornaments; each semi-cell has a distinct basal inflation with 1-3 slight undulations beyond; cell wall smooth, chloroplasts parietal with longitudinal bands containing numerous pyrenoids. Cf. Scott & Prescott (1958, Fig. 2: 4), Scott & Prescott (1961, Pl. 3, Fig. 4), Forster (1969, Pl. 6: 3); 1982, Pl. 13, Figs 11-13), Islam & Haroon (1980, Pl. 4, Fig. 58), Islam & Haroon (1985, Pl. 1, Fig. 18) and Gerrath & John (1988, Pl. 10, Fig. 4).

*Pleurotaenium trabecula* (Ehrenberg) Naegeli var. *crassum* Ruzicka (1977)

L. 480-590; W. 44-48; Pl. 4: 11.

Cell relatively large and broad; 10-12 times longer than broad; semi-cell with a slight basal inflation and 1-2 hardly discernible undulations beyond; a little swollen in the mid-region, then tapering to a rounded truncate apex devoid of tubercles; chloroplast parietal with longitudinal bands each with 5-7 pyrenoids. Cf. Ruzicka (1977, Pl. 38: 6, 7).


L. 420-436; W. 23-26; Pl. 4: 10; Fig. 6: 8

Cells 14-15 times longer than broad; a variety more slender and of nearly uniform width; slightly tapering at the apices; each semi-cell has a single basal inflation, smooth cell wall and a truncated rounded smooth apex. Cf. Scott & Prescott (1958, Fig. 2: 5), Forster (1969, Pl. 6: 4-6) and Gerrath & John (1988, Pl. 10, Fig. 6).

Genus TRIPLOCERAS Bailey (1851)

*Triploceras gracile* Bailey var. *bidentum* Nordstedt (1888)

L. 475-600; W. 42-56; Pl. 6: 9; Fig. 6: 9

Cells about 14 times longer than broad; this is a stout variety with more elaborate ornamentations, arranged in whorls about 12 of them in each semi-cell; each whorl has a circle of acute thickened projections or teeth; semi-cells tapering to a 2-lobed apex, each lobe tipped with 3 spines. Cf. Bourrelly (1957, Pl. 1, Fig. 10), Scott et al. (1965, Fig. 42) and Forster (1969, Pl. 7: 4, 5); 1982, Pl. 16, Figs 4-6.

Genus TETMEMORUS Ralfs (1844)

Tettemorus brebissonii (Meneghini) Ralfs (1844)

L. 120-286; W. 24-66; Pl. 3: 12, 13; Fig. 4: 14, 15

Cells cylindrical or fusiform, 5-6 times longer than broad, with a conspicuous median constriction; distinguishable from other similar looking genera by its broad apices with moderately deep median incisions; semi-cell in face view only slightly tapered, in side view strongly tapered; cell wall with rows of punctae or scrobiculae; separated from the closely related *Euastrum* by its axial chloroplast with a central row of pyrenoids. Cf. Scott & Prescott (1958, Fig. 20: 11), Forster (1982, Pl. 39, Fig. 10) and Ling & Tyler (1986, Pl. 5: 15, 16).

Genus SPHAEROZOSMA Corda in Ralfs (1848)

*Sphaerozosma aubertianum* W. West var. *compressum* Rich (1932)

L. 20-22; W. 33-36; I. 7-8; Pl. 6: 1

Cells large, about 1.5 times broader than long, with deep median constriction; sinus narrow and linear, isthmus narrow; semi-cells compressed and oblong-elliptical; lateral margins rounded and slightly notched with two papillae or granules one on each side of the notch. The present plants are bigger than those described by Rich (1932, Fig. 17-A). Cf. Thomasson (1963, Fig. 34: 1, 2),
Thomasson (1965, Fig. 4: 5) and Thomasson (1966, Fig. 10: 12).

*Sphaerocosma granulatum* Roy & Bisset (1886)

L. 12-14; W. 8-10; L. 6-7; Pl. 5: 9, 10

Cells *Cosmarium*-type, a little longer than broad; sinus shallow, with well-defined median isthmus; united to form permanent filaments by short apical appendages; lateral margins granulate with symmetrically arranged warts. Cf. Krieger (1932, Pl. 26:4), Grönblad *et al.* (1958, p. 44), Grönblad (1960, Figs 183, 184), Lind (1967, p. 382) and Forster (1969, Pl. 53, Figs 1-3).

**Genus Spondylosum** Brebisson. (1844).

*Spondylosum planum* (Wolle) W. & G. S. West (1912).

L. 11-13; W. 10-12; L. 8-10; Fig. 7: 6

Cells slightly longer than broad; in some cases as long as broad, moderately constricted; sinus shallow and open; cells joined together by mucilaginous pads; no appendages on cell apices; semi-cells transversely oblong with broadly rounded angles and flattened apices; cell wall smooth and unornamented. Cf. Scott & Prescott (1961, Pl. 60, Figs 6-8), Lind (1967, p. 381) and Forster (1969, Pl. 53, Figs 1-3).

**Genus Spondylosum** Brebisson. (1844).

*Spondylosum pulchrum* (Bailey) Archer in Smith (1924).

L. 15-16; W. 21-22; L. 7-8; Fig. 7: 7

Cells compressed and broad, 1.5 times to twice wider than long, median constrictions deep; sinus widely open from a rounded apex; semi-cells very broad and transversely oblong-elliptic with rounded angles; apical ends widely truncate with the central portion slightly elevated; cell wall smooth. Cf. Scott *et al.* (1965, Fig. 236).

**Genus Onychonema** Wallich (1860)

*Onychonema laeve* Nordstedt var. *latum* W. & G. S. West (1896)

L. 16-18; W. 33-38; L. 4-6; Pl. 6: 3, 4; Fig. 7: 14

Cells about 2 times broader than long, median constrictions deep, with narrow isthmus; sinus narrow and linear before opening out; semi-cells compressed and transversely oblong-elliptic; lateral sides produced into short stout incurved spines; apical ends broadly rounded and convex, equipped with two widely spaced diagonally arranged fusiform inter-locking processes or appendages, terminated in small rounded knobs; cells united into filaments through these appendages. The variety *perlatum* described by Grönblad *et al.* (1958, Fig. 327 & photo 392) is characterised by very broad and depressed cells; spines are short, acute and parallel. Cf. Scott & Prescott (1958, Fig. 21: 2), Scott & Prescott (1961, Pl. 60, Fig. 13), Forster (1969, Pl. 53: 8-11) and Lind (1971, Pl. 6, Fig. 5).

**Genus Onychonema** Wallich (1860)

*Onychonema laeve* Nordstedt var. *latum* W. & G. S. West (1896)

L. 16-18; W. 33-38; L. 4-6; Pl. 6: 3, 4; Fig. 7: 14

Cells about 2 times broader than long, median constrictions deep, with narrow isthmus; sinus narrow and linear before opening out; semi-cells compressed and transversely oblong-elliptic; lateral sides produced into short stout incurved spines; apical ends broadly rounded and convex, equipped with two widely spaced diagonally arranged fusiform inter-locking processes or appendages, terminated in small rounded knobs; cells united into filaments through these appendages. The variety *perlatum* described by Grönblad *et al.* (1958, Fig. 327 & photo 392) is characterised by very broad and depressed cells; spines are short, acute and parallel. Cf. Scott & Prescott (1958, Fig. 21: 2), Scott & Prescott (1961, Pl. 60, Fig. 13), Forster (1969, Pl. 53: 8-11) and Lind (1971, Pl. 6, Fig. 5).

**Genus Phydimococis** Nordstedt (1877)

*Phydomococis irregularis* Schmidle var. *intermedia* Gutwinski (1902)

L. 27-29; W. 57-60; L. 40-43; Pl. 6: 2; Fig. 7: 16

Cells asymmetrical, united into short filaments, about twice as broad as long; median incision not so deep; sinus narrow and linear; semi-cells of irregular shape; facial view reveals clumps of cell material which Gutwinski (1902, Pl. 36, Fig. 4e) referred to as “zygotes”. Scott & Prescott (1961) explained that the structure referred to by Gutwinski are stages in vegetative division before the formation of the cross-wall. This is the same plant referred to by Scott & Prescott (1961, Pl. 61, Figs 11-15) as *Ph. irregularis* Schmidle var. *intermedia* Gutwinski. Cf. also Fritsch & Rich (1937, Fig. 28-A, B). Bourrelly (1957, Pl. 18, Fig. 157), Forster (1969, Pl. 56:9, 10), Lind (1971, Pl. 6, Figs 9, 10) and Islam & Haroon (1980, Pl. 12, Fig. 158).

**Genus Desmidium Agardh 1824**

*Desmidium tetragonum* Breb. var. *tetragonum* W. & G. S. West (1902)

L. 18-20; W. 37-38; L. 32-33; Fig. 7: 9

Cells filamentous, nearly twice as broad as long, median constriction shallow; sinus with a rounded apex and flared sides and a broad isthmus; semi-cell apices broad with a deep, wide semi-elliptical to sub-rectangular depression forming an open space between two adjacent cells. The filaments when long show a twist, about one turn every 15-22 cells. Twisting is not usually apparent in lengths shorter than 5 or 6 cells, which are frequently seen. Cf. Scott & Prescott (1958, Fig. 21: 4), Scott & Prescott (1961, Pl. 62, Figs 5-7) and Lind (1971, Pl. 6, Fig. 2).
Desmidium baileyi (Ralfs) Nordstedt. f. tetragonum
Nordstedt (1888)
L. 19-20; W. 22-23; Pl. 5: 8; Fig. 7: 12
Cells a little broader than long, united to form long un-twisted filaments; faintly constricted producing a hardly discernable sinus; semi-cells tapered towards the apices; apex with a deep broad sub-rectangular depression yielding an open space between adjoining cells like in D. apigontium; lateral margin with two slight undulations.
Cf. Bourrelly (1957, Pl. 15, Fig. 137; Pl. 17, Figs 154, 155), Scott & Prescott (1958, Pl. 21: 6), Scott & Prescott (1961, Pl. 62, Figs 8, 9), Scott et al. (1965, Fig. 247), Thomasson (1966, Pl. 20, Fig. 10) and Forster (1969, Pl. 56: 12).

*Desmidium coarctatum* Nordstedt var. cambicrum W. West (1890)
L. 22; W. 25; I. 19 Pl. 5, 6; Fig. 7: 13
Cells sub-spherical, broader than long, slightly constricted; sinus a little open notch, isthmus very broad; semi-cells wide at the base, tapering strongly towards the apices; chromatophores axile, one in each semi-cell. Cf. Fritsch & Rich (1937, Fig. 29-C), van Oye (1953, Fig. 85), Scott & Grönblad (1957, Pl. 36, Figs 4, 5), Scott & Prescott (1958, Fig. 21: 10, 11) and Lind (1971, Pl. 6, Fig. 6).

**Desmidium grevillei** (Kützing) De Bary (1858)
L. 24-25; W. 24-26; 19-20 Fig. 7: 15
Cells filamentous, about as long as broad, median constriction shallow; semi-cell with a rounded lateral lobe that tapers abruptly towards the poles; apical margin truncate with diameter about half the size of maximum cell diameter; chloroplasts 4-6 lobes, each lobe with a pyrenoid. Colony filamentous with a mucilage sheath, 5-6 short cells regularly alternating with every 3 large cells. Cf. Scott & Prescott (1961, Pl. 62, Figs 15, 16), Scott et al (1965, Figs 250, 251), Forster (1969, Pl. 55: 7, 8) and Islam & Haroon (1980, Pl. 5, Fig. 76).

*Desmidium quadratum* Nordstedt (1873)
L. 15-17; W. 28-29 Pl. 5: 5; Fig. 7: 8
Cells quadrangular and filamentous, a little over 1.5 times broader than long, very faintly constricted; apices of semi-cells flat to slightly curved; two adjoining cells joined by a pad of mucilage, cell wall smooth. Cf. Scott & Prescott (1961, Pl. 63, Figs 5, 6) and Forster (1969, Pl. 54:15).

*Desmidium swartzii* Agardh (1824)
L. 17-18; W. 31-33; I. 27 Pl. 5: 7; Fig. 7: 10, 11.
Cells 2 or more times broader than long; median constriction shallow with broad isthmus; semi-cells broadly trapezoidal with lateral margins acutely upturned in the median portion; vertical view triangular; cell wall smooth; cells united as permanent spirally twisted filaments (1 turn every 10-20 cells); enclosed in a gelatinous sheath. Cf. Scott & Grönblad (1957, Pl. 37, Fig. 4), Scott & Prescott (1958, Fig. 21: 13), Scott & Prescott (1961, Pl. 63, Fig. 8), Lind (1971, Pl. 6, Fig. 4) and Islam & Haroon (1980, Pl. 16, Figs 224, 225).

Genus BAMBUSINA Kützing 1845
*Bambusina brebissonii* Kützing. (1845)
L. 30-32; W. 17-18; Pl. 6: 5
Cells barrel-shaped, united in long permanent filaments, cells twice as long as broad with a slightly median constriction; sinus, a small depression, isthmus very broad; lateral margins of semi-cells with a distinct acute basal bulge and concave sides tapered and converging to a truncate apex; cell apices without protuberances; chloroplasts plate-like. Cf. Scott & Prescott (1961, Pl. 62, Fig. 1), Scott et al. (1965, Fig. 256), Forster (1969, Pl. 53, Figs 19-21), Lind (1971, Pl. 6, Fig. 1) and Islam & Haroon (1980, Pl. 5, Fig. 75).

*Bambusina borreri* (Ralfs) Delpronte var. grassiliscens (Nordstedt) Wolle (1892)
L. 31-33; W. 18-20 Pl. 6: 6; Fig. 7: 2
Plants similar to *B. brebissonii* (Ralfs) Delpr. in being barrel-shaped, united in long permanent filamentous chains except that individual cells appear narrower and are about 1.5 times longer than broad. Cf. Thomasson (1966, Pl. xx, Figs 8, 9) from specimens from Lake Shiwa Ngandu.

Genus COSMOCGLADIUM Brebisson 1844
**Cosmocladium pulsillum** Hilse in Forster (1982)
L. 14-15; W. 10-11 Pl. 6: 10
Cells *Cosmarium*-like with deep median constriction; semi-cells elliptical; cells united into irregular colonies by bands of gelatinous material extruded from special pores in the cell wall; chloroplast axile, one in each cell. Cf. Forster (1982, Pl. 18, Figs 7, 8).

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Fig. 2.
1-4. Closterium gracile Breb.
5-9. Closterium lineatum Ehr.
10, 11. Closterium aciculare T. West
12. Closterium ralfsii Breb.
13. Closterium ralfsii Breb. var. hybridum Rabenh.
14, 15. Closterium kuetzingii Breb.
17. Closterium subulatum (Kütz.) Breb.var. maius Krieger
18. Closterium setaceum Ehr. in Ralfs.
19. Closterium strigosum Breb.
20. Closterium baillyanum Breb. in Ralfs.
21. Closterium kuetzingii Breb. var. kuetzingii f. croasdaleae Forster

Fig. 3.
2. Closterium lunula (Müll.) Nitsch. var. maximum Borge f. crassissimum Croasd.
3. Closterium lunula (Müll.) Nitsch. var. maximum Borge
4. Closterium ehrenbergii Menegh. Ex. Ralfs
5. Closterium porrectum Nordst. var. borgei (Borge) Forster
6. Closterium monoliferum (Bory) Ehr. ex. Ralfs
7. Closterium pseudolumula Borge var. concavum Forster & Eckert
8, 9. Closterium acerosum (Schr.) Ehr.
10. Closterium dianae Ehr. var. arcuatum (Breb.) Rabenh.
11. Closterium eboracense (Ehr.) Turner
12, 13. Closterium leiblenii Kütz.
Fig. 4.
1-2. Closterium ehrenbergii Menegh. Ex. Ralfs
3. Closterium dianae Ehr.
4, 5. Closterium turgidum Ehr. var. borgei (Borge) Defl.
6. Closterium acerosum (Schr.) Ehr. var. elongatum Breb.
7. Closterium rostratum Ehr.
8. Closterium lanceolatum Kütz. in Ralfs
9. Closterium rostratum Ehr. var. brevirostratum W. West
10. Closterium leibellula Focke var. interruptum (W. & G.S. West) Donat
11. Spirotaenia condensata Breb. in Ralfs
12, 13. Cylindrocystis brebissonii Menegh.
14, 15. Tetmemorus brebissonii (Menegh.) Ralfs
16. Netrium digitus (Ehr.) Itzigs. & Rothe var. lamellosum (Breb.) Grönbl.

Fig. 5.
1. Gonatozygon aculeatum Hast.
2, 3. Gonatozygon pilosum Wolle
4. Gonatozygon kinhanii (Arch.) Rabenh. f. minor Forster
5. Gonatozygon monotaenium De Bary var. angustum Forster
6. Pleurotaenium subcoronulatum (Turn.) W. & G.S. West var. africanum Schmid.
7. Pleurotaenium simplissimum Grönbl. var. simplissimum Krieger
8, 9. Pleurotaenium maculatum (Turn.) Krieger
10. Penium margaritaceum (Ehr.) ex Breb. in Ralfs
11. Pleurotaenium subcoronatum (Turn.) W. & G.S. West var. spinulosum var. nova
12. Pleurotaenium coronatum (Breb.) var. nodulosum (Breb.) W. & G.S. West f. constrictum Krieger
13. Pleurotaenium subcoronatum (Turn.) W. & G.S. West
14, 15. Pleurotaenium baculoides (Roy & Biss.) Playfair
16. Pleurotaenium trabercula (Ehr.) Naegeli in Krieger
Fig. 6.
1. Pleurotaenium ovatum Nordst.
2. Pleurotaenium ovatum Nordst. var. tumidum (Mask.) G.S. West
3. Pleurotaenium ovatum Nordst. var. elephantiunum (Cohn) Krieger
4. Pleurotaenium ovatum Nordst. var. tumidum (Mask.) G.S. West
5. Pleurotaenium ovatum Nordst. var. inermius Mobius
6. Pleurotaenium coronatum (Brebb.) Rabenh.
7. Pleurotaenium coronatum (Brebb.) Rabenh. var. fluctuatum W. West
8. Pleurotaenium trabecluma (Ehr.) Naeg. in Krieger var. rectum (Delp.) W. & G.S West
9. Triploceras gracile Bail. var. bidentum Nordst. in Krieger
10. Penium spinulosum (Wolle) Gerrath

Fig. 7.
1. Bambusiniae brebissonii Kütz.
2. Bambusiniae borneri (Ralfs) Delp. var. grassiliscens (Nordst.) Wolle
3. Hylotheca undulata Nordst. var. perundulata Gronbl.
4, 5. Hylotheca dissiliens (Smith) Brebb. in Ralfs
6. Spondylosmus planum (Wolle) W. & G.S. West
7. Spondylosmus pulcherum (Bail.) Arch. in Smith
8. Desodium quadratum Nordst.
9. Desodium aptogonium Brebb. var. tetragonum W. & G.S. West
10, 11. Desodium swartzii Agardh
12. Desodium baileyi (Ralfs) Nordst. var. tetragonum Nordst.
13. Desodium coarctatum Nordst. var. cambricum W. West
14. Onychonema laeve Nordst. var. latum W. & G. S. West
15. Desodium grevillei (Kütz.) De Bary
Plate 1.

1. Gonatozygon aculeatum Hast. (x555)
2. 3. Gonatozygon kinahanii (Arch.) Rabenh. var. interruptum Forster (2x231; 3x233)
4. 5. Gonatozygon kinahanii (Arch.) Rabenh. f. minor Forster (4x375; 5x287)
6. Gonatozygon monotaeniun De Bary (x 311)
7. 8. Gonatozygon monotaeniun De Bary var. angustum Forster (7x297; 8x312)
9. Genicularia elegans W. & G. S. West (x476)
10. Penium cylindrus (Ehr.) Breb. in Ralfs (x510)
11. Penium spinulosum (Wolle) Gerrath (x210)
12. Penium margaritaceum (Ehr.) Breb. in Ralfs (x460)
13. Netrium digitus (Ehr.) Itzigs. & Rothe var. lamellosum (Breb.) Grönlbl. (x346)
14. Spirotaenia condensata Breb. in Ralfs (x631)
15. 16. Closterium rostratum Ehr. var. brevirostratum W. West (15x286; 16x307)
17. Closterium libellula Focke var. interruptum (W. & G. S. West) Donat (x757)
18. Closterium rectimarginatum Scott & Pres. (x 299)
19. Closterium gracile var. Breb. (x529)
20. Closterium gracile Breb. (x223)
21. Closterium incurvum Breb. (x723)
22. Closterium pronum Breb. (x230)
23. Closterium lineatum Ehr. (x234)
Plate 2.

1, 2. Closterium aciculare T. W. West (1x143; 2x140)
3. Closterium lineatum Ehr. var. curvaturn Thom. (228)
4, 5. Closterium setaceum Ehr. in Ralfs (4x218; 5x206)
6, 7. Closterium kuetzingii Breb. (6x245; 7x208)
8. Closterium kuetzingii Breb. var. kuetzingii f. croasdale Forster (x211)
9. Closterium ralfsii Breb. var. hybridum Rabenh.
10, 11. Closterium acerosum (Schr.) Ehr. (9x250; 10x259)
12. Closterium striolatum Ehr. (x265)
13. Closterium dianae Ehr. (x608)
14. Closterium dianae Ehr. var. pseudodianae (Roy) Krieger (x300)
15. Closterium dianae Ehr. var. arcuaturn (Breb.) Rabenh. (x260)
16. Closterium cynthia De Not. (x605)
17. Closterium calosporum Wittr. (x552)
Plate 3.
1. *Closterium costatum* Corda var. westii Cush. (x300)
2. *Closterium turgidum* Ehr. var. borgei (Borge) Defl. (x133)
3. *Closterium rostratum* Ehr. (x252)
4. *Closterium pseudolunula* Borge var. concavum Forster & Eckert (x197)
5. *Closterium lunula* (Müll.) Nitsch ex Ralfs (x165)
6. *Closterium lunula* (Müll.) Nitsch var. maximum Borge (x190)
7. *Closterium lunula* (Müll.) Nitsch v. maximum Borge f. crassissimum Croasd. (x150)
8. *Closterium lanceolatum* Kütz. in Ralfs (x194)
9. 10. *Closterium ehrenbergii* Menegh. Ex Ralfs (9x145; 10x158)
11. *Closterium monosiferum* (Bory) Ehr. ex Ralfs (x155)
12. 13. *Tetmemorus brebissonii* (Menegh.) Ralfs (12x350; 13x348)


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