FRESHWATER ALGAE FROM YUKIDORI ZAWA, NEAR SYOWA STATION, ANTARCTICA

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Abstract: The present paper deals with the freshwater algal flora of Yukidori Zawa near Syowa Station in Antarctica. The samples examined were collected by Dr. M. OHNO in January 1975. Fifty-eight taxa of the freshwater algae are identified. It is found out that the blue-green algae species amount to about 70 per cent of the whole. The desmid species are rather common in the samples examined. One new species of *Cosmarium yukidoriense* and three new varieties of *Cosmarium clepsydra* are described. The sexual reproduction of an unidentified *Oedogonium* sp. is recorded.

Dr. Masao OHNO of Kochi University, a member of the 16th Japanese Antarctic Research Expedition, 1974–1975, kindly entrusted the author with his collection of freshwater algae (excluding diatoms) of Yukidori Zawa (Valley) of the Antarctic Continent. The material consists of 41 vials of specimens (Table 1).

Yukidori Zawa is located in the ice-free area about 30 kilometers from Syowa Station and consists of a pond and streams. The general view is shown in Photos 1 and 2. The main stream, Yukidori Zawa, runs off from the Yukidori Ike (*ca.* 100 m long and *ca.* 50 m wide) and discharges into Lützow-Holm Bay. It attains about 4 kilometers in length. Another small stream, Yatude Zawa, joins the main stream halfway. The streams and the pond have abundant water in the summer season.

The middle and lower parts of the Yukidori Zawa stream may be polluted by the excrement of snow petrel because there is a large habitat of them at the rocky height near the middle course of the stream. Table 2 shows the data of the physico-chemical analysis of water taken from the 13 stations in Yukidori Zawa and was analyzed by Drs. OHNO and SUE. As will be seen in the table, the degrees of alkalinity and hydrogen-ion concentration of water show somewhat higher level and exhibit a tendency of gradual increase from the source to the mouth of the stream (pH 7.25–7.57 at the Yukidori Ike, 7.75–8.09 at Yukidori Zawa stream, and 8.41 at the mouth of the stream, respectively). At the mouth of the stream, the chlorine content may reach 60 times as much as the other stations. Some other nutrient substances also increase a little (*ca.* 3 times in the ammonia-salts, and *ca.* 5 times in the phosphate-salts), while the content of the nitrate-salts decreases

at the lower course of the stream.

Only the freshwater algal species were found in Yukidori Zawa including the mouth of the stream where the sea water gets mixed at high tide. No marine forms of algae were collected there. According to the ecological nature, Yukidori Zawa may be divided into 7 areas; *i.e.*, 1) the bottom of the Yukidori Ike, 2) the littoral zone of the pond, 3) the uppermost part of Yukidori Zawa stream, 4) the upper part of the stream, 5) the middle part of the stream, 6) the lower part of the stream, and 7) the mouth of the stream (see Table 1).

Fifty-one species of algae which were identified by the author are arranged tabularly according to their 7 main localities (Table 3). Most of the freshwater algal species of Yukidori Zawa belong to the blue-green algae (Cyanophyceae). In this respect no difference is found between the present and the previous studies on the algal flora of the Antarctic region. Among 51 identified species, 19 taxa of them belong to the family Oscillatoriaceae. Although the species of the genera *Gloeocapsa* and *Nostoc* are rather limited in numbers, they are very common in many stations of the present material examined. Undoubtedly, they may occupy a distinguished position in the blue-green algal flora of Antarctica.

It is noteworthy that one *Dichothrix* species and two *Stigonema* species were identified in the present study. These species seem to be rather common in Antarctica. Their occurrence was not recorded in such previous papers as WEST (1911), FRITSCH (1912) and others. Yet they were frequently mentioned in the recent papers based upon the materials of the Japanese Antarctic Research Expedition without precise identification.

In the green algae, several species of desmids are found very dominant. *Cosmarium cucurbita*, a species recorded in FRITSCH's (1912) report under the name of *Penium* sp. and recorded also by AKIYAMA (1967) from Ongul Island where Syowa Station is located, is common in Yukidori Zawa. The species seems to be widely distributed in Antarctica. Other desmid species, *Cosmarium clepsydra*, is also found rather common. The species examined by the author has a high degree of morphological variations, so that it can be classified into 4 varieties: *Cosmarium clepsydra* var. *dissimile, C. c.* var. *undulatum* var. nov., *C. c.* var. *granulatum* var. nov. and *C. c.* var. *depressum* var. nov. The original description of the 3 new varieties will be given on pages 22 and 23. In some localities these 4 varieties are found mingled with each other.

Oedogonium sp. is found common in the samples taken from the littoral zone of the Yukidori Ike. Among the previous reports on the Antarctic algal flora, the occurrence of this green algae is found only in AKIYAMA's short note on the material from the vicinity of Syowa Station. Unfortunately, the true identification of the form was impossible because intact specimens were not sufficient. However, it is very interesting that the evidence of the sexual reproduction of this form under the rigorous cold climate was observed in the samples from Antarctica. The

specimens in some of the samples examined seem to be the volvocacean and the chlorococcacean species. Because of the lack of the live specimens, their specific identification is impossible.

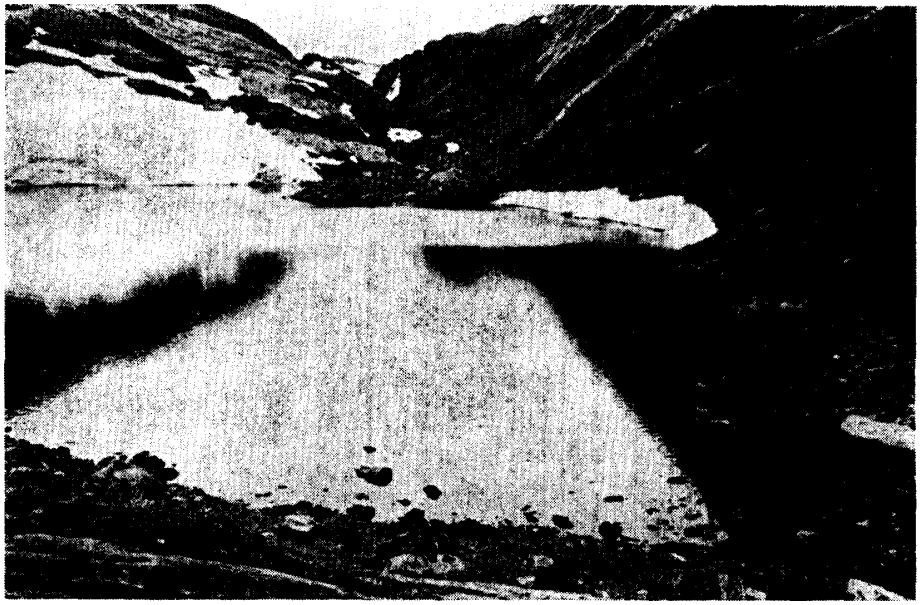


Photo 1. Yukidori Ike, photo by OHNO.

Photo 2. Yukidori Zawa stream, photo by OHNO.

Table 1. The data of the samples collected from Yukidori Zawa in Antarctica classified according to the ecological nature.

Station No.	Vial No.	Date of collection	Locality	Note observed by the collector
1	40	Jan. 15, 1975	Bottom of the Yukidori Ike	Mud (*Nostoc* sp.)
	41	—	—	—
2	18	Jan. 15, 1975	Littoral zone of the Yukidori Ike	Under surface of stones; green algae
	19	—	—	—
	20	—	—	Upper surface of stones; black, blue-green algae
	21	—	—	—
	22	—	—	Floating *Nostoc* sp.
	23	—	—	—
	24	—	—	Sand
	25	—	—	—
	26	—	—	Mosses
	27	—	—	—
	28	—	—	Surface water
	29	—	—	—
3	30	Jan. 15, 1975	Outlet of the Pond (Uppermost part of Yukidori Zawa stream)	Filiformed algae
	31	—	—	—
	32	—	—	Upper surface of stones
	33	—	—	—
	34	—	—	Mosses
4	1	Jan. 14, 1975	Upper part of Yukidori Zawa stream	Blue-green algae; water temp. 7.2°C
	2	—	—	Upper surface of stones (blue-green algae)
	3	—	—	Sand; blue-green algae
	4	—	—	Sand
5	5	Jan. 14, 1975	Confl. of the Yatude Zawa stream; middle part of Yukidori Zawa stream	Sand; blue-green algae; water temp. 7.7°C
	6	—	—	Mosses
	7	—	—	Filiformed green algae
	8	—	—	Upper surface of stones
	9	—	—	Filiformed green algae
	10	—	—	Blue green algae
	11	—	—	Upper surface of stones; blue-green algae?
6	12	Jan. 14, 1975	Lower part of Yukidori Zawa stream	Sand; filiformed green algae
	13	—	—	—
	14	—	—	—
	15	—	—	Upper surface of stones (blue-green algae)
	16	—	—	—
	17	—	—	—
7*	35	Jan. 15, 1975	Mouth of Yukidori Zawa stream	Surface of sand; brown algae
	36	—	—	—
	37	—	—	Surface of sand; orange algae
	38	—	—	—
	39	—	—	Surface of stones; green algae

* The sea water gets mixed at high tide.

Table 2. Results of the physico-chemical analysis of water from Yukidori Zawa in Antarctica (after SUE and OHNO).

Stations of the samples obtained	Date of the sample obtained	Weather	Depth of water (m)	Air temp. (°C)	Water temp. (°C)	*pH	PO_4–P μg at/l	SiO_3–Si μg at/l	NO_3–N μg at/l	NO_2–N μg at/l	NH_3–N μg at/l	Dissolved oxygen (ml/l)	**Chlorine contents (‰)	Electric conductivity (μΩ/cm)	Chlorophyll contents (mg/m³)
Inlet of a small stream flowing into the Yukidori Ike	Jan. 15, 1975	⊖◎	0	5.0	2.8	—	0.24	24	7.0	0.01	0.3	8.48	*0.01	20>	0.526
Yukidori Ike	Jan. 14, 1975	⊖	0		5.0	7.32	0.18	29	0.9	0.06	0.8	8.38	*0.01	26.0	0.261
			1		5.0								*0.01	25.7	
			2		4.9	7.34	0.24	31	1.0	0.06	1.1	8.52	*0.01	25.7	0.584
			3		4.8								*0.02	39.9	
			4		4.8	7.57	0.24	29		0.06	0.0	8.48	*0.02	38.0	0.422
			5		4.8								*0.02	39.8	
			6		5.3	7.25	0.24	29	1.0	0.08	0.0	8.48	*0.02	40.2	0.452
			7		5.3									36.7	
Outlet of the Yukidori Ike	Jan. 15, 1975	⊖◎	0	5.0	5.8	8.02	0.14	29	1.1	0.00	0.3	8.48	*0.01	30.1	0.312
Middle part of Yukidori Zawa stream	Jan. 15, 1975	⊖◎	0	—	5.4	7.75	0.24	32	3.0	0.00	0.1	8.69	*0.01	30.1	0.550
Lower part of Yukidori Zawa stream	Jan. 15, 1975	⊖◎	0	5.5	9.9	8.09	0.14	47	0.7	0.00	0.3	8.57	*0.02	34.7	0.290
Mouth of the Yukidori Zawa stream	Jan. 17, 1975	⊖	0	5.5	11.5	8.41	0.68	57	0.6	0.05	1.0	8.34	0.61	—	0.738

* No correction was made by the water temperature.

** Calculated from the data of the electric conductivity (excluding the data at the mouth of the stream).

Table 3. A list of the freshwater algae from Yukidori Zawa in Antarctica (The Japanese Antarctic Research Expedition, 1974–1975).

Locality and the species identified	1 Yukidori Ike, bottom (Vial Nos. 40–41)	2 Littoral zone of the Yukidori Ike (Vial Nos. 18–29)	3 Uppermost part of Yukidori Zawa stream (Vial Nos. 30–34)	4 Upper part of Yukidori Zawa stream (Vial Nos. 1–4)	5 Middle part of Yukidori Zawa stream (Vial Nos. 5–11)	6 Lower part of Yukidori Zawa stream (Vial Nos. 12–17)	7 Mouth of Yukidori Zawa stream (Vial Nos. 35–39)
Microcystis pulverea					+		
Chroococcus dispersus		+	+			+	
C. minutus var. *minutus*					+		
C. minutus var. *obliteratus*		+	+	+	+		
C. pallidus		+					
C. cohaerens					+		
Synechococcus aeruginosus		+	+		+	+	
S. maior		+		+	+		
Gloeocapsa compacta			+				
G. dermochroa			+			+	
G. kuetzingiana						+	
G. magma					+		
G. ralfsiana		+	+		+		
Oscillatoria curviceps						+	
O. koetlitzi		+		+	+	+	
Phormidium antarcticum		+					+
P. bohneri		+	+		+		+
P. corium			+				
P. fragile		+					
P. frigidum						+	
P. incrustatum		+					+
P. laminosum		+	+	+	+	+	+
P. pristleyi			+		+		
P. retzii		+	+	+	+	+	
P. uncinatum		+				+	+
Lyngbya aerugineo-coerulea		+	+		+	+	
L. aestuarii		+				+	
L. borneti		+		+	+	+	+
L. lutea					+	+	
L. martensiana		+		+	+	+	+
L. murrayi			+				
L. purpurea		+	+		+		
Schizothrix coriacea		+		+		+	
Microcoleus sociatus			+				
Nostoc borneti					+	+	
N. minutum		+		+		+	
N. sphaericum		+					
Nodularia quadrata	+						+
Dichothrix orsiniana		+	+				
Petalonema velutinum		+		+	+		
Stigonema hormoides						+	
S. tomentosum				+			
Ulothrix subtilissima		+	+				

Table 3. (*Continued*)

Locality and the species identified	1 Yukidori Ike, bottom (Vial Nos. 40–41)	2 Littoral zone of the Yukidori Ike (Vial Nos. 18–29)	3 Uppermost part of Yikidori Zawa stream (Vial Nos. 30–34)	4 Upper part of Yukidori Zawa stream (Vial Nos. 1–4)	5 Middle part of Yukidori Zawa stream (Vial Nos. 5–11)	6 Lower part of Yukidori Zawa stream (Vial Nos. 12–17)	7 Mouth of Yukidori Zawa stream (Vial Nos. 35–39)
Ulothrix tenerrima			+	+			
U. variabilis			+	+			
Chlorhormidium mucosum		+		+	+		+
Microspora stagnorum					+	+	
Hormidiopsis crenulata	+						+
Pleurococcus antarcticus f. *robusta*		+					
Sphaerocystis schroeteri f. *nivalis*		+			+		
Palmodictyon viride		+	+			+	
Oedogonium sp.		+					
Cosmarium clepsydra var. *dissimile*		+	+	+			
C. clepsydra var. *granulatum*	+						
C. clepsydra var. *undulatum*		+					
C. clepsydra var. *depressum*		+					
C. subcrenatum		+		+			
C. cucurbita var. *cucurbita*		+		+			+
C. cucurbita var. *attenuatum*		+		+			
C. cucurbita var. *rotundatum*		+	+		+		+
C. bioculatum var. *depressum*		+					
C. yukidoriense		+					
C. phaseolus var. *minus*		+					

Enumeration of the Species Examined

Microcystis pulverea (WOOD) FORTI in GEITLER, Kryptogamen-Flora, **14**, 143, 1932.

The outline of the colony is distinct, spherical in shape and 46 μ in diameter, with non-stratified colorless mucous; cells arranged densely (2.6 μ in diameter in each cell). Very rare in vial No. 9.

Every known species of the genus *Microcystis* hitherto reported from Antarctica including the present species is given in the following key.

1. Cells less than 3 μ in diameter.
   2. Cells regularly arranged in longitudinal and horizontal series, cell 0.6 μ in diameter ..... *M. merismopedioides*
   2. Cells not regularly disposed.
      3. Outline of mucous envelope distinct; cells 2–3 μ in diameter .....

..... *M. pulverea*

3. Outline of mucous envelope indistinct; cells 1–2 μ in diameter.
   4. Colony long ..... *M. stagnalis*
   4. Colony spherical ..... *M. parasitica*
      5. Cells 2 μ in diameter; mucous envelope colorless ..... *M. p.* var. *parasitica*
      5. Cells 0.5 μ in diameter, mucous envelope reddish-brown ..... *M. p.* var. *glacialis*

1. Cells 3–7 μ in diameter.
   2. Cells 4–7 μ in diameter; colony consists of a small number of cells (6–24 individuals), brackish ..... *M. chroococcoidea*
   2. Cells 3–6 μ in diameter; colony consists of many cells, freshwater ..... *M. aeruginata*

Up to the present, 12 taxa of *Chroococcus* have been reported from Antarctica by WEST, FRITSCH, GAIN and CARLSON. The identification of each species is most difficult if the sample is not preserved in a good condition. Moreover, the species of the genera *Chroococcus* and *Gloeocapsa* are very similar in the shape of cells, the general appearance of the cell masses and of the mucous. They may occur in the similar habitats. In the samples examined from Yukidori Zawa, 5 taxa of *Chroococcus* were identified (see the next key).

1. Cell mass small, consisting of a small number of cells.
   2. Mucous envelope indistinct ..... *C. dispersus*
   2. Mucous envelope distinct.
      3. Mucous envelope thick ..... *C. minutus* var. *minutus*
      3. Mucous envelope thin ..... *C. m.* var. *obliteratus*
1. Cell mass large, consisting of numerous cells.
   2. Cells 5–8 μ in diameter ..... *C. pallidus*
   2. Cells 2–4 μ in diameter ..... *C. cohaerens*

Chroococcus dispersus (KEISSL.) LEMM. in GEITLER, *l.c.*, 233, f. 113d, 1932.

The colony consists of a small number of cells; with a diffluent mucous envelope and its outline is indistinct; each cell is 3–5.6 μ in diameter; usually 2 cells form a pair. The present species resembles *Microcystis chroococcoidea* in the size of the cell masses but is distinguished from the latter by the character of the paired cells. Rather common in vial Nos. 12, 23 and 26.

Chroococcus minutus (KÜTZ.) NÄG. var. ***minutus*** in GEITLER, *l.c.*, 232, f. 112a, 113c, 1932.

A single cell or paired 2 cells are enveloped in the mucous; each cell attains 6.5–8 μ in diameter; 12 μ in diameter with the mucous envelope. Rather common in vial Nos. 3 and 5.

C. m. var. ***obliteratus*** (RICHTER) HANSG. in GEITLER, *l.c.*, 232, f. 112b, 1932.

Cells 5.6–8 μ in diameter without the mucous envelope. The present variety of *C. minutus* is distinguished from the typical form in having a thinner mucous envelope. Rather rare in vial Nos. 6, 7, 24 and 26.

Chroococcus pallidus NÄG. in GEITLER, *l.c.*, 238, f. 116b, 1932.

A pair of cells are enveloped in the very thick mucous. Rare in vial No. 24. Pl. 3, f. 5.

Chroococcus cohaerens (BRÉB.) NÄG. in GEITLER, *l.c.*, 238, f. 116e, 1932.

Aggregated cells form a colony; each cell is 2.6 μ in diameter and is enveloped in a non-lamellated colorless mucous. Although the specimens examined resemble the cells of the *Gloeocapsa* species, they are distinguished from the latter by the above-mentioned characters. The present species and the *Gloecapsa* species may grow on the surface of wet rocks. The fragments and incomplete specimens of *C. cohaerens* may not be distinguished from those of *C. minor*. Rare in vial No. 10.

Three species of the genus *Gloeocapsa* have been reported from Antarctica by WEST, FRITSCH and GAIN. In Kerguelen the other 3 species of the genus have also been reported by WILLE. In Yukidori Zawa, 5 species which differ from the above-mentioned records were found; their characters are given in the following key.

1. Mucous envelope reddish.
   2. Mucous envelope thin and color homogeneous ..... *G. magma*
   2. Mucous envelope thick, inner part reddish and outer one light color or colorless ..... *G. ralfsiana*
1. Mucous envelope yellow to yellow-brown.
   2. Cells small, 2 μ in diameter, envelope thick ..... *G. dermochroa*
   2. Cells somewhat large, 3 μ in diameter, envelope thin .... *G. kuetzingiana*
1. Mucous envelope blackish-violet ..... *G. compacta*

Gloeocapsa magma (BRÉB.) HOLLERBACH in GEITLER, *l.c.*, 198, f. 93, 1932.

Non-stratified, thin mucous envelope is reddish in color; cells moderate in size, 5 μ in diameter. Common in vial Nos. 6 and 7.

Gloeocapsa ralfsiana (HARV.) KÜTZ. in GEITLER, *l.c.*, 204, f. 96, 97, 1932.

Cells 4–6 μ in diameter; with a stratified thick mucous envelope which consists of three layers, *i.e.*, the inner reddish-brown color one, the middle pale reddish one, and the outer colorless one; the form of the colony of the young specimens is spherical in shape, and of the fully grown specimens is spherical or ellipsoidal; cells are arranged in the center of the mucous envelope in the young specimens, but in the fully grown specimens they are located in a slightly excentric position; in a large colony each cell is surrounded by a ring of small granules (the ring measures 9 μ in diameter) having a common mucous envelope.

The present species resembles *G. itzigsohnii* but the cells of the former are smaller than those of the latter. Although SKUJA classified the present species as *G. sanguina*, GEITLER divided the species into two forms, *i.e.*, *G. ralfsiana* (having the lamellated mucous envelope) and *G. sanguina* (having the non-lamellated mucous envelope). The author agrees with GEITLER. Fairly common in vial Nos. 8, 9, 18, 20 and 23. Pl. 5, f. 1–9.

Gloeocapsa dermochroa NÄG. in GEITLER, *l.c.*, 194, f. 90, 1932; DESIKACHARY, Cyanophyta, 118, 1959.

Cells small, 2–2.5 μ in diameter, and enclosed in a thick, homogeneous, yellowish to golden yellowish colored mucous envelope; the aggregated ones form a large visible mass. When the colony is broken, the cells of the present species can hardly be distinguished from those of *Chroococcus varius* and its allied species. However, the fragmented cells with a yellowish colored mucous envelope belong clearly to the genus *Gloeocapsa*. Common in vial Nos. 10, 11, 14, 16 and 32. Pl. 5, f. 10–12.

Gloeocapsa kuetzingiana NÄG. in GEITLER, *l.c.*, 194, f. 91a, 1932.

Cells 5 μ in diameter; with a thin, yellowish brown colored mucous envelope; usually, the aggregated cells form a large mass. Fairly common in vial No. 16. Pl. 4, f. 21, 22.

Gloeocapsa compacta KÜTZ. in GEITLER, *l.c.*, 207, f. 101, 1932.

Cells 2 μ in diameter; with a thick, blackish violet colored mucous envelope having an irregular outline; the common envelope covering the cells is of a lighter hue or colorless. Rare in vial No. 34. Pl. 2, f. 5.

Synechococcus aeruginosus NÄG. in GEITLER, *l.c.*, 274, f. 133d–e, 1932.

Cells large, elliptical or cylindrical in shape, and measured 11.5–16 μ in width and 22 μ in length. Occurs commonly in Yukidori Zawa. Common in vial Nos. 5, 6, 9, 18, 19, 24 and 30. Pl. 2, f. 7–8.

Synechococcus maior SCHRÖTER in GEITLER, *l.c.*, 274, 1932.

Cells elliptical in shape, 18–22 μ broad and 19–27 μ long. Usually, both the present species and *S. aeruginosus* occur in the same localities. Rather common in vial Nos. 3, 5, 20, 24, 25 and 26. Pl. 2, f. 6.

Many species of the genera belonging to the family Oscillatoriaceae —especially the members of the genus *Oscillatoria*— have been reported in the previous papers on the Antarctic algae. Thus, the *Oscillatoria* species seem to be the principal components of the Antarctic algal flora. In fact, many *Oscillatoria*-like specimens were found in the materials from Yukidori Zawa. After the close examination, the author has found only two species of the genus. The other *Oscillatoria*-like specimens in the materials examined were the members of the genus *Phormidium*. In the *Phormidium* species, the mucous sheath secreted from the trichomes is often invisible in the preserved specimens. When the mucous sheath without trichomes is

observed, the specimens can easily be classified as the members of *Phormidium*.

Oscillatoria curviceps AG. in GEITLER, *l.c.*, 947, f. 598e, 1932.

Trichomes straight or slightly curved near the apex (trichomes sometimes attenuated) and slightly thickened; without constriction at the connecting place of both adjacent cells; trichomes about 9 μ in width; cells long, the length attains about 1/4–1/6 times the width; granules may occur in some specimens, but sometimes they are arranged along the cross wall of the adjacent cell. Occurs in vial Nos. 12 and 26. Pl. 4, f. 1–3.

Oscillatoria koetlitzi FRITSCH, Natl. Antarct. Exped., Nat. Hist., **6**, 34, pl. 1, f. 55–59, 1912; GEITLER, *l.c.*, 958, f. 610a–d, 1932.

Trichomes straight, not attenuated or slightly attenuated toward the apex, 6.5–8 μ in width, and not constricted at the connecting place of adjacent cells; apex capitate in shape and forms a calyptra, having the flat end; the width of the calyptra is larger or sometimes smaller than that of the trichomes; cells long, the length attains about 1/3–1/2 times the width. Occurs in vial Nos. 5 and 24. Pl. 2, f. 9–10.

The species of the genus *Phormidium* are distributed commonly in many stations of Yukidori Zawa. Although numerous specimens have been found in the materials examined, the identification of each species is rather difficult because their morphological differences are minor. The mucous sheath of the trichomes is often thin and diffluent. This means that the mucous sheath cannot be observed except when the trichomes are lost. Under a microscope, the specimens with the trichomes that have a bright outline or appearance seem to be the members of *Phormidium*.

Fourteen taxa of the genus *Phormidium* from Antarctica were reported by WILLE, WEST, FRITSCH and some other researchers. The author has identified 10 taxa in the materials examined (see the following key). Among these species, 5 of them (*P. fragile, P. retzii, P. laminosum, P. pristleyi* and *P. antarcticum*) were included in the papers mentioned above. The other 2 species, *P. tenue* and *P. bohneri*, were reported in the papers based upon the materials from the vicinities of Syowa Station. Only *P. bohneri* occurs in Yukidori Zawa.

1. Trichome constricted at the cross wall between adjacent cells.
   2. Trichome less than 3 μ broad.
      3. Trichome less than 1 μ broad, average 0.6–0.8 μ broad; cells 1–2 times longer than broad ..... *Ph. frigidum*
      3. Trichome 1.5–2.8 μ broad; cells as long as broad.... .... *Ph. fragile*
   2. Trichome more than 3 μ broad, average 3–3.6 μ; cells short, about a half as long as broad ..... *Ph. pristleyi*
1. Trichome not constricted at the cross wall between adjacent cells.
   2. Trichome less than 3 μ broad.

3. Trichome curved; about 0.5 μ broad ..... *Ph. antarcticum*
3. Trichome not curved; more than 1 μ broad.
4. Trichome 1–1.6 μ broad; cells long, about 2–4 times longer than broad ..... *Ph. laminosum*
4. Trichome 1.5–2 μ broad; cells short, as long as or sometimes slightly longer or shorter than broad ..... *Ph. bohneri*

2. Trichome more than 3 μ broad.
3. Trichome not curved except at the apical part; about 6–12 μ broad; cell shorter in general than broad.
4. Cell about as long as broad, or sometimes slightly longer or shorter than broad; cell without a series of granules along the cross wall ..... *Ph. retzii*
4. Cell short, 1/2–1/3 times longer than broad, sometimes with a series of granules along the cross wall ..... *Ph. uncinatum*
3. Trichome curved in one direction or spirally curved near the apical part, 3–5 μ broad.
4. Cell 1–2 times longer than broad ..... *Ph. corium*
4. Cell shorter than broad ..... *Ph. incrustatum*

Phormidium frigidum FRITSCH, Natl. Antarct. Exped., Nat. Hist., **6**, 31, pl. 1, f. 52, 1912; GEITLER, *l.c.*, 997, f. 636a, 1932.

Trichome short, and not attenuated toward the end; 0.6–0.8 μ in width, and usually constricted at the junction or the cross walls; the length of the cells attains about 1.5–2 times the width; mucous sheath may envelope the trichomes along the full length (not clear). The present specimens examined by the author differ in the details from the FRITSCH's specimens collected on the surface of the ice in McMurdo Sound. According to his description and figure, the granules are arranged along the cross wall of the adjacent cells. This character is not observed in the specimens from Yukidori Zawa. The trichomes of the latter are shorter than those of the McMurdo Sound specimens. Occurs in vial No. 13. Pl. 3, f. 4.

Phormidium fragile GOM. in GEITLER, *l.c.*, 999, f. 636c–d, 1932.

Trichome almost straight but slightly curved in one direction near the apex; cells constricted at the junction, and the length is slightly shorter than the width: trichomes 2.8 μ in width; mucous sheath is not observed. This species was already reported from Antarctica by WEST and FRITSCH. Rather rare in vial No. 24. Pl. 2, f. 18.

Phormidium pristleyi FRITSCH, Terra Nova Exped., **1**, 10, pl. 1, f. 16, 1917; GEITLER, *l.c.*, 1001, f. 636e, 1932.

Trichomes form loose spirals, not attenuated toward the end, having a rounded margin; each cell constricted at both ends where the cells join; trichomes 3–3.5 μ in width; the length of the cells attains about 1/2–2/3 times the width; mucous sheath observed in some of the specimens examined. Rather rare in vial

Nos. 6 and 34. Pl. 2, f. 16.

Phormidium antarcticum W. & G. S. WEST, Rep. Sci. Invest. Br. Antarct. Exped., 1907–09, **1** (7), 292, pl. 25, f. 74, 75a–g, 1911; FRITSCH, Natl. Antarct. Exped., Nat. Hist., **6**, 32, pl. 1, f. 71–73, 1912; GEITLER, *l.c.*, 1006, f. 644a, 1932.

Trichomes narrow in width, twisted irregularly, not attenuated toward the end; cells not constricted at the junction; trichomes 0.4–0.5 μ in width; the length of the cells nearly the same as, or twice the width; mucous sheath is observed where the trichomes do not exist. The present species is often found among the other samples of the algae. Rare in vial Nos. 23 and 25. Pl. 1, f. 8, 9.

Phormidium laminosum GOM. in FRITSCH, Natl. Antarct. Exped., Nat. Hist., **6**, 30, 1912; GEITLER, *l.c.*, 1005, f. 642c, 1932.

Trichomes curved; cells not constricted at the junction, and 0.8–1.5 μ in width; the length of the cells is greater than the width; without granules in the cells; mucous sheath distinct. FRITSCH already reported the present species from the Gap Pond in the Victoria Land; it is widely distributed in Yukidori Zawa. Fairly common in vial Nos. 3, 6, 8, 16, 17, 18, 30 and 37. Pl. 2, f. 15.

Phormidium bohneri SCHMIDLE in GEITLER, *l.c.*, 1008, 1932.

Trichomes straight, not attenuated toward the apex; cells not constricted at the junction, and 1.6–2.4 μ in width; the length of the cells is the same as the width; without granules in the cells. Occurs in vial Nos. 5, 6, 7, 10, 26 and 39. Pl. 2, f. 11.

Phormidium retzii (AG.) GOM. in W. & G. S. WEST, Rep. Sci. Invest. Br. Antarct. Exped., 1907–09, **1** (7), 291, 1911; GEITLER, *l.c.*, 1012, f. 647, 1932.

Trichomes not constricted at the junction and not attenuated toward the end, and 6.5–9.5 μ in the width; the length of the cells is slightly shorter than the width (a high degree of irregularity may occur); granules are usually scattered in the cells, but sometimes they are arranged along the cross walls. The present species is distributed widely in Yukidodi Zawa. Fairly common in vial Nos. 3, 4, 6, 7, 8, 9, 14, 19, 24, 30 and 32. Pl. 2, f. 12–14; **pl. 4**, f. 4–7.

Phormidium uncinatum GOM. in GEITLER, *l.c.*, 1025, f. 652h–i, 1932.

Trichomes 6–8 μ in width, not constricted at the junction, gradually attenuated toward the apex, and form a conical shaped, rather rounded or semicircular shaped calyptra; the length of the cells is usually shorter than the width (1/2–1/3 of the width); with granules in the cells. The occurrence of this species described in the present paper is the first record in the Antarctic region. *P. uncinatum* resembles *P. autumnale* in general appearance. The width of the trichomes of the latter is narrower than that of the former. Moreover, the width of the trichomes of the specimens from Yukidori Zawa may attain about 8 μ, and the length of the cells is about 1/3 of the width. Thus, the author has identified the species examined as *P. uncinatum*. Occurs in vial Nos. 12, 18, 19, 24 and 25. Pl. 1, f. 5–7.

Phormidium corium GOM. in GEITLER, *l.c.*, 1018, f. 649b–c, 1932.

Trichomes not constricted at the junction, attenuated toward the apex, and slightly curved at the region near the end; cells 3 μ in width and the length of the cells attains about 1.5 times the width; without granules along the cross walls of the adjacent cells. Rare in vial No. 30. Pl. 2, f. 17.

Phormidium incrustatum (NÄG.) GOM. in GEITLER, *l.c.*, 1017, f. 649a, 1932.

Trichomes not constricted at the junction, not or slightly attenuated near the end; cells 4–5.5 μ in width and slightly shorter than the width. Occurs in vial Nos. 22 and 35. Pl. 1, f. 10–11.

Sixteen species of the genus *Lyngbya* have been reported from Antarctica. It is demonstrated that 4 species of them are also distributed widely in Yukidori Zawa. The author has found the other 4 species of the genus which hitherto have not been recorded from Antarctica. The characters of these 8 species found in the materials examined are given in the following key.

1. Trichome less than 3.5 μ broad.
   2. Trichome violet in color, less than 2 μ broad; cell as long as broad .. .. *L. purpurea*
   2. Trichome blue-green in color, 3–3.3 μ broad; cell slightly longer and 1.5–1$\frac{3}{4}$ times longer than broad ..... *L. murrayi*
1. Trichome more than 3 μ broad.
   2. Cell with a series of granules along the cross wall.
      3. Trichome 3–6 μ broad, cell 1–1$\frac{1}{3}$ times longer than broad .. *L. lutea*
      3. Trichome 6–10 μ broad; cell short, slightly shorter than broad.
         4. Trichome 8–10 μ broad; cells 1/2–1/4 times longer than broad .. .. *L. martensiana*
         4. Trichome 6–7 μ broad; cells 1/5–1/6 times longer than broad .... *L. semiplana*
      3. Trichome 12–16 μ broad and straight ..... *L. borneti*
   2. Cell without a series of granules along the cross wall.
      3. Trichome 4–6 μ broad without gas-vacuole, and slightly curved .... *L. aerugineo-coerulea*
      3. Trichome 10–12 μ broad with gas-vacuole ..... *L. aestuarii*

Lyngbya purpurea (HOOKER & HARVEY) GOM. in GEITLER, *l.c.*, 1056, 1932.

Thallus forms a small, blackish violet colored mat on the under surface of the wet stones; trichomes violet in color and entwined densely each other, without constriction at the junction, and 1.5–1.8 μ in width; trichomes indistinct at the region of the cross walls; cells nearly quadrate in shape and of homogeneous substance. Rather common in vial Nos. 19, 20 and 23.

Lyngbya murrayi W. & G. S. WEST in Rep. Sci. Invest. Br. Antarct. Exped., 1907–09, **1** (7), 289, pl. 25, f. 70–71, 1911; GEITLER, *l.c.*, 1046, f. 660b, 1932.

Trichome straight, 4 μ in width, without constriction at the junction and not

attenuated toward the apex that has a rounded end; each cell having a distinct granule on both sides of the cross wall is rather long and attains about twice the width; mucous sheath thin but tough. The size of the trichomes of the specimens from Yukidori Zawa is slightly broader than that of the specimens described by WEST. Occurs in vial No. 34. Pl. 2, f. 22.

Lyngbya lutea (AG.) GOM. in GEITLER, *l.c.*, 1057, f. 670a–b, 1932.

Trichome straight, 2.8–3.6 μ in width, and without constriction at the junction; without granules along the cross walls; usually, the length of the cells is shorter than the width. Occurs in vial Nos. 8, 10 and 11. Pl. 2, f. 19.

Lyngbya martensiana MENEGH. in W. & G. S. WEST, Rep. Sci. Invest. Br. Antarct. Exped., 1907–09, **1** (7), 289, 1911; GEITLER, *l.c.*, 1064, f. 676, 1932.

Trichome straight, 7–10 μ in width, without constriction at the junction, and not attenuated toward the apex; the cell wall of the frontal end of the terminal cell is thickened; with or without granules along the cross wall of the cells; cells short in length attaining about 1/3–1/4 of the width. The present species is already reported from Blue Lake in Antarctica. Occurs in vial Nos. 17, 25 and 27. Pl. 2, f. 20–21.

Lyngbya semiplana AG. in GEITLER, *l.c.*, 1061, f. 672a, 1932.

Trichome straight, 6.5–7 μ in width, without constriction at the junction, and not attenuated toward the apex that has a rounded end; the cell wall of the frontal end of the terminal cell is sometimes thickened; cells very short attaining only about 1/6 the width. Rare in vial No. 24. Pl. 4, f. 19–20.

Lyngbya borneti ZUKAL, Ber. Dtsch. Bot. Ges., **12**, 260, pl. 19, f. 1–5, 1894—*Oscillatoria borneti* (ZUKAL) GEITLER, *l.c.*, 956, f. 609, 1932.

Trichome straight or slightly curved, 11–12 μ in width (13 μ in width when the mucous sheath is included), not or slightly attenuated near the end; the terminal cell forms a small, semicircular shaped calyptra; with or without granules along the cross walls; cells short attaining 1/2 to the same length of the width; cell contents pale blue-green in color. The general appearance of the trichomes in the present species shows a high degree of variations even in the same specimens. The present species resembles *Oscillatoria borneti*. However, GEITLER reported that the trichomes of *O. borneti* show a keritomish structure. No such structure is found in the specimens examined by the author. Moreover, the author's specimens have a mucous sheath. Thus, he has classified the present species as a member of the genus *Lyngbya* according to ZUKAL. The species is widely distributed in Yukidori Zawa. Common in vial Nos. 5, 6, 8, 11, 12, 15, 17 and 37. Pl. 1, f. 1–3; pl. 4, f. 8–12.

Lyngbya aerugineo-coerulea (KÜTZ.) GOM. in GEITLER, *l.c.*, 1062, f. 670f–g, 1932.

Trichome straight, 4–6 μ in width, without constriction at the junction, and not attenuated toward the apex that has a rounded end; cells short attaining about

1/2 the width; cell contents are granular, but without granules along the cross walls; mucous sheath colorless and common in vial Nos. 6, 11, 17, 19, and 30. Pl. 1, f. 4.

Lyngbya aestuarii LIEBM. in GEITLER, *l.c.*, 1052, f. 666, 1932.

Trichome about 12 μ in width, without constriction at the junction, and attenuated slightly or sometimes thicken near the apex that has a rounded end; cells short attaining 1/4–1/6 the width; numerous gas-vacuoles occur in the cells. Rare in vial No. 40. Pl. 4, f. 17–18.

Schizothrix coriacea (KÜTZ.) GOM. in GEITLER, *l.c.*, 1081, f. 690, 1932.

Mucous sheath distinct and colorless, non-stratified, often branched, and contains 2 trichomes; trichomes narrow in width (1.4 μ), constricted at the region of the cross walls, and twisted each other; cells long attaining 1.5 times the width; apical cells is of a long conical shape. Rare in vial Nos. 15 and 18. Pl. 2, f. 4.

Microcoleus sociatus W. & G. S. WEST, J. Bot., **35**, 272, 1897; GEITLER, *l.c.*, 1141, f. 746, 1932.

Filament long cylindrical in shape; mucous sheath colorless and containing many trichomes densely twisted like a tangled rope; trichomes 2.5–3 μ in width, without constrictions at the junction; cells rather long attaining 1.5–2 times the width; each cell contains one small but conspicuous granule; apical cell has a long conical shape with a rounded end. Although GEITLER states that the trichome of the present species has a constriction at the region of the cross walls, this character is not found in his figure that is taken from STRÖM's paper. Rather rare in vial No. 34. Pl. 7, f. 1–5.

Up to the present, 12 species of the genus *Nostoc* have been reported from Antarctica. The identification of the species in the present materials from Yukidori Zawa is most difficult because the resting spore is absent. No conspicuous taxonomic differences are found in the vegetative cells of the *Nostoc* species. Two species of the genus *Nostoc, N. verrucosum* and *N. punctiforme*, have been recorded in the previous reports based upon the materials obtained by the Japanese Antarctic Research Expeditions. The three species which the author identified in the present paper are different from the above-mentioned two species. They are given in the following key.

1. Trichome 4 μ broad, heterocyst 5–6 μ broad ..... *N. sphaericum*
1. Trichome 2.5–3 μ broad, heterocyst 4 μ broad.
   2. Heterocyst globose ..... *N. minutum*
   2. Heterocyst elliptical ..... *N. borneti*

Nostoc sphaericum VAUCH in FRITSCH, Natl. Antarct. Exped., Nat. Hist., **6**, 43, 1912; GEITLER, *l.c.*, 850, f. 539b, 1932; BAKER, N. Z. J. Bot., **5**, 461, f. 2g, 1967.

Colony spherical in shape and yellowish brown in color; trichomes without the mucous sheath show a loose entanglement in the sheath and 4 μ in width; without

an individual sheath in the colony of the mature state; heterocysts globose in shape and 6 μ in diameter; the resting spore is not found. The present species is already reported from the South Victoria Land. Occurs in vial Nos. 8, 18, 20 and 22.

Nostoc minutum DESM. in GEITLER, *l.c.*, 850, f. 540, 1932.

Trichome highly entangled; cells barrel-shaped and 2.5–3 μ in width; heterocysts globose in shape and 4 μ in diameter (greater than the width of the vegetative cells). Fairly common in vial Nos. 2, 3, 5, 11, 12, 17 and 26. Pl. 3, f. 8; pl. 9, f. 16.

Nostoc borneti GAIN, C. R. Acad. Sci., 1691, 1911; GEITLER, *l.c.*, 850, 1932.

Trichomes of the vegetative cells 2.5 μ in width and entangled in the common mucous envelope of a yellowish color; heterocysts ellipsoidal in shape and 5 μ in length and 4 μ in width; without an individual sheath. The present species resembles *Nostoc minutum*. FUKUSHIMA and WATANABE reported this species separated from the soil-culture of Antarctica. Pl. 3, f. 9; pl. 9, f. 15.

Nodularia quadrata FRITSCH, Natl. Antarct. Exped., Nat. Hist., 45, pl. 2, f. 109–115, 1912; GEITLER, *l.c.*, 865, f. 553, 1932.

Trichomes straight, 4 μ in width, and constricted at the junction; mucous sheath lost in almost all parts of the cells of a short barrel-shape; heterocysts quadrate in shape, 4 μ in width (same as the width of the vegetative cells). The present species is reported from the Kasumi Iwa located in the ice-free area of the Prince Olav Coast. Occurs in vial Nos. 35, 37 and 40. Pl. 7, f. 15.

Calothrix parietina THURET in GEITLER, *l.c.*, 604, f. 380, 1932.

Mucous sheath fairly thick, stratified and yellowish brown in color; the base of the filaments smooth and about 14 μ in width; the apical part of the filaments divided into fibrillae and diverging toward the outside; trichomes not inflated at the basal part, but slightly constricted at the junction, and gradually attenuated toward the end; cells gradually elongated in length toward the end which forms a hair-like structure or a whipcord; cells not constricted at the hairy part and without sheath; cells are of a short barrel-shape at the basal part of the trichomes and 5 μ in width, 1–1.5 times the width at the middle part, and 2–3 times the width at the hairy part. Occurs in vial No. 34.

Dichothrix orsiniana BORNET et FLAH. in GEITLER, *l.c.*, 588, f. 370, 1932.

Filaments form a subdichotomous false branch and frequently bend; mucous sheath thick, lamellated, and the coloration is yellowish brown at the basal part, yellowish at the middle part, and colorless and smooth at the apical part; trichomes slightly inflated, 4–6 μ in width, not constricted at the basal part, and then gradually attenuated toward the apex and show a hair-like appearance (3–4 μ in width); cells rather short or nearly the same as the width at the basal part; heterocysts located only at the basal part of the filaments are spherical or ellipsoidal in shape and 3.6 μ in width. Although the present species is common in the materials from Yukidori Zawa, the identification is rather difficult due to the high degree of variation of the shape of the filaments and trichomes. Thus, fragmental pieces of the present

species may not be separable from the species of the genus *Calothrix*. Occurs in vial No. 20. Pl. 3, f. 10.

Petalonema velutinum (RABENH.) MIGULA, Kryptogamen-Flora, **2**, 131, 1907; GEITLER, *l.c.*, 792, f. 507, 1932.

Mucous sheath thick, stratified, and usually yellowish in color (yellowish-brown in the old sheath and pale yellowish or colorless in the sheath of the young specimens); sheath usually shows simple stratification but sometimes a furrow or furrow-like stratification is observed on its surface (this is due to the nature of the surface of the trichomes); cells of the trichomes short and a barrel-shape in appearance; sheath without trichomes shows a ring-form; the end of the sheath frequently shows a diverging stratification direct to the outside or has a so-called funnel form (this character is found in the species of the genus *Petalonema*, not in those of the genus *Tolypothrix*); trichomes 7–9 μ in width, and 15–19 μ in width with a mucous sheath; cells short and barrel-shaped, attain about 1–1/2 times longer than the width; filaments have irregular false branches (the starting places of the branches are slightly apart from the main filament); cells contain granules; heterocysts spherical or hemispherical in shape and located at the base of the filaments. Although the present species resembles *Tolypothrix byssoidea*, the funnel-shaped structure of the sheath indicates that it belongs to the genus *Petalonema*. Occurs in vial Nos. 2, 5, 9, 18 and 27. Pl. 6, f. 1–5.

Stigonema hormoides (KÜTZ.) BORNET et FLAH. in GEITLER, *l.c.*, 499, f. 302, 1932; DESIKACHARY, Cyanophyta, 604, pl. 134, f. 1–4, 1959.

Filaments 10 μ in width; cells arranged in one row or rarely in 2 rows in the mucous sheath; cells small, spherical in shape, 3–4 μ in diameter, each having an individual sheath within the common mucous sheath. Only the incomplete specimens were available for this study, and the samples seem to be the fragments of some species of the genus *Fritschiella*. Since the elevated branching filaments are absent in the specimens, the author has identified the species as *S. hormoides*. Occurs in vial No. 17. Pl. 3, f. 7.

Stigonema tomentosum (KÜTZ.) HIERON. in GEITLER, *l.c.*, 502, 1932; DESIKACHARY, Cyanophyta, 606, 1959.

Filaments about 18 μ in width; cells arranged in one or rarely in 2 rows (this may be the state of the cell immediately after its division) in the mocous sheath of a yellowish brown color; cells spherical or short ellipsoidal in shape, 8–9 μ in width, each having an individual sheath within the common mucous sheath; the width of the filaments at the basal part is narrower than that of the filaments located at the middle part. Occurs in vial No. 3. Pl. 3, f. 6.

Pleurococcus antarcticus W. & G. S. WEST, Rep. Sci. Invest. Br. Antarct. Exped., 1907–09, **1** (7), 276, pl. 24, f. 49–51, 1911.

Cells large in size, 22 μ in diameter without the mucous envelope (with the envelope, its diameter attains about 30 μ); each cell contains one pyrenoid and

distinct oil-drops; mucous envelope thick and stratified; cells located at the excentric position in the envelope are found in some specimens examined. Common in vial Nos. 24 and 26. Pl. 3, f. 11–12; pl. 6, f. 7–10.

Sphaerocystis schroeteri CHODAT var. ***nivalis*** FRITSCH, J. Linn. Soc. London, Bot., **11**, 123, textf. 1, f. F, 1910.

Colony spherical in shape in the young specimens, but shows an irregular outline in the mature specimens; cells somewhat elliptical in shape, 7–8.5 μ in length and 5–8 μ in width, having a distinct pyrenoid. The samples examined include specimens of various stages of development. The character of the present species is coincident with that of FRITSCH's description and figure of the species from Antarctica. Occurs in vial Nos. 7, 9, 11, 19, 20 and 30. Pl. 6, f. 6.

Palmodictyon viride KÜTZ. in PRESCOTT, Cranbrook Inst. Sci. Bull., **30**, 85, pl. 4, f. 5–6, 1951.

Filaments gelatinous in nature, long cylindrical in shape, and not branched; numerous cells embedded in a common gelatinous substance arranged in 1 to 3 longitudinal rows; each cell with an individual gelatinous envelope is spherical in shape and enveloped in a common gelatinous substance, of which the surface is smooth, slightly undulated, or sometimes crenulated in appearance. The cells may diverge into three directions, so that the cells are sometimes arranged in 3 to 4 rows along the longitudinal axis of the filaments. The specimens from Yukidori Zawa examined by the author slightly resemble *Heimiochrysis borealis* in some details, but the specific characters that distinguish both species (flagella and the nature of the chromatophores) are uncertain in the preserved materials. Occurs in vial Nos. 17, 20 and 30. Pl. 9, f. 1.

Ulothrix subtilissima RABENH. in HEERING, Süssw.-fl., **6**, 31, f. 26, 1914; STARMACH, Flora Slod. Polsk., **10**, 36, f. 6–7, 1972.

Cells cylindrical in shape, 4 μ in width, and the length attains about twice the width; cell wall fairly thick and 0.5 μ in width. The present species is distinguished from *U. variabilis* in having a narrow width of the cells. Occurs in vial No. 30. Pl. 1, f. 15–16.

Ulothrix variabilis KÜTZ. in PRESCOTT, Cranbrook Inst. Sci. Bull., **30**, 97, pl. 6, f. 13, 1951; RAMANATHAN, Ulotrichales, 39, pl. 10, f. D–F, 1964.

Cells cylindrical in shape, 4–4.5 μ in width and 15 μ in length (attaining about 3 times the width); each cell has one pyrenoid; threads not constricted at the region of the junction. Occurs in vial Nos. 14, 16 and 17. Pl. 1, f. 17–18.

Ulothrix tenerrima KÜTZ. in STARMACH, Flora Slod. Polsk., **10**, 39, 1972.

Cells quadrate, about 8–9 μ in width, the length attains about 1–1.5 times the width and in some specimens the palmella-like stage is recognized. Occurs in vial Nos. 1, 5 and 24. Pl. 8, f. 14–16.

Chlorhormidium mucosum BOYE-PETERSEN in STARMACH, Flora Slod. Polsk., **10**, 37, f. 11, 1972—*Ulothrix mucosa* THURET in HEERING, Süssw.-fl., **6**, 31, 1914.

Cells with the thick mucous sheath, 3.6–5 μ in width, and the length attains nearly the same as the width or 1.5–2 times longer; threads 8 μ in width; cells cylindrical in shape but shorter ones have a long elliptical form perpendicular to the long axis of the threads. Some of the specimens examined resemble *Radiophilum flavescens*. Occurs in vial No. 6. Pl. 2, f. 25–30; pl. 7, f. 7–14.

Radiophilum flavescens G. S. WEST in STARMACH, Flora Slod. Polsk., **10**, 81, f. 83, 1972.

Threads slightly curved and 10–11 μ in width; cells variable in shape (usually from a short, broad elliptical to a long elliptical form) and 6 μ in width. There is a possibility that *Radiophilum flavescens* and the preceding species, *Chlorhormidium mucosum*, are the same species. Because of the difference of the width of these two forms, the author classified them into two different species. Occurs in vial Nos. 6 and 13.

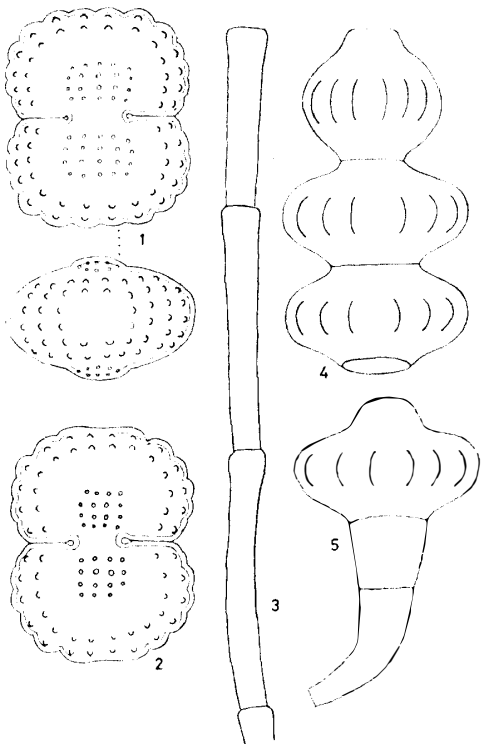
Microspora stagnorum (KÜTZ.) LAGERH. in HEERING, Süssw.-fl., **6**, 151, f. 212, 1914; STARMACH, Flora Slod. Polsk., **10**, 123, f. 154, 1972.

Threads not constricted at the region of the junction; cells cylindrical in shape, and the length may attain about 1.5 times the width; chloroplasts not scattered homogeneously in the cells. Occurs in vial Nos. 16 and 17. Pl. 1, f. 12–14; pl. 7, f. 6.

Oedogonium sp. The vegetative cells of *Oedogonium* are found commonly in the floating masses of the *Nostoc* species. The threads of these vegetative cells are usually straight but sometimes slightly curved or winding. No fruit bodies were found in the threads examined. The vegetative cells without the male cells measured 38–54 μ in length and 3.6–4.6 μ in width. On the other hand, the oogonia were found in the samples taken from vial Nos. 22 and 23. The specimen with an oogonium under which are 2 vegetative cells is very short. Unfortunately, the author could not find any specimens having both oogonium and the thread in one body. It was observed that the width of the vegetative cells and of the holdfast cells with the oogonium is coincident with each other. Judging from the above-mentioned data, the separated oogonium and the vegetative cells may belong to the same species. But the author reserves the identification of the present specimens from Yukidori Zawa; only a brief description of the samples examined is given below:

A single oogonium or a set of 3 cells of the oogonium occurs; oogonia, 21–32 μ in width and 15–16 μ in length, are a depressed elliptical form with 8 short projections and like a pumpkin in general appearance (the projections can easily be seen in the vertical view of the oogonium); the shape of the oospore is not known; the first holdfast cell which connects the oogonium is 4 μ in width at the frontal end, and 3 μ in width at the posterior end; the next holdfast cell is usually curved almost in a right-angled direction at its lower part.

Judging from the shape of the oogonia, the present specimens examined



Textfig. 1. Figs. 1–2: Cosmarium subcrenatum HANTZSCH. ×900.
Figs. 3–5. Oedogonium sp. (Fig. 3. Vegetative cell; Figs. 4–5, Oogonium). ×900.

rather resemble *Oedogonium platygynum* and its allied species. But the present species may be separable from these species by the characters of the vegetative cells and of the holdfast cells. Occurs in vial Nos. 22 and 23. Pl. 9, f. 11–12; textf. 1, f. 3–5.

Hormidiopsis crenulata (KÜTZ.) HEERING, Süssw.-fl., **6**, 51, f. 62, 1914; STARMACH, Flora Slod. Polsk., **10**, 67, f. 63, 1972.

Filaments with the mucous sheath 12–20 μ in width; cells 8–12 μ in width, each having an individual sheath; common mucous sheath can easily be seen in the old parts of the filaments; usually, the cells are quadrate in shape except for the apical cell of an oval shape; the distinct large cells with the thick, stratified mucous sheath (elliptical in shape and 15 μ in width) sometimes found in the thread are undoubtedly an akinete or a resting cell. Occurs in vial Nos. 37, 39 and 40. Pl. 1, f. 19–21; Pl. 8, f. 1–5.

Cosmarium cucurbita BRÉB. in W. & G. S. WEST, Monogr. Br. Desm., **3**, 106, pl. 73, f. 31–33, 1908.

The present species was already reported from Antarctica by FRITSCH under the name of *Penium* sp. The specimens from Yukidori Zawa are coincident with his description in general, but are a highly variable in the shape of cells. The

median constriction of the cells is usually shallow, but sometimes fairly deep. In some cells the side walls are tapering gradually toward the both apical ends; the side walls show a convexo-convex outline in some other cells. The shape of the semicells is also variable. Some cells have a long truncate pyramidal shape; some have a rounded apex. Thus, the author comes to the conclusion that the specimens of *Cosmarium cucurbita* from Yukidori Zawa should be classified into three varieties (*C. cucurbita* var. *cucurbita, C. c.* var. *attenuatum* and *C. c.* var. *rotundatum*).

C. c. var. ***cucurbita.*** Cells subcylindrical with shallow median constriction, 34–40 μ in length and 17–20.5 μ in width; isthmus 16–18 μ in width. Occurs in vial Nos. 3, 4, 16, 24 and 37.

C. c. var. ***attenuatum*** G. S. WEST. Semicells distinctly attenuated toward the apex of a somewhat truncated shape, 32–34 μ in length and 16–18 μ in width; isthmus 15.5–17 μ in width. Occurs in vial Nos. 1, 24 and 26. Pl. 3, f. 13; pl. 8, f. 17–19.

C. c. var. ***rotundatum*** KRIEGER. Apex of the semicells broad and rounded and without an accurate angle, 34–38 μ in length and 18–20 μ in width; isthmus 17–19 μ in width. Occurs in vial Nos. 5, 8, 26, 27, 30, 35 and 37. Pl. 2, f. 23–24; pl. 8, f. 20–23.

Cosmarium clepsydra NORDST. var. ***dissimile*** (RACIB.) KRIEGER & GERLOFF, Die Gattung *Cosmarium*, 145, pl. 30, f. 9, 1965.

Semicells semicircular in shape and the lowermost part of both lateral margins slightly divergent; apex flattened or slightly retused, 21 μ in length and 18 μ in width; isthmus 4 μ in width. The vertical view of the semicell shows a rhomboid-elliptical shape with a protuberance on each side. Occurs in vial Nos. 1, 18, 22 and 26. Pl. 9, f. 2–4.

C. c. var. ***undulatum*** HIRANO, var. nov.

Semicellulae leviter triangulares, marginibus lateralibus inferioribus divergentibus, marginibus lateralibus superioribus convergentibus et triundulatis, apicibus semicellularum leviter retusis; semicellulae a latere visae circulares cum protuberantibus ad medium utrobique; a vertice visae angusto-rhomboido-ellipticae cum protuberantibus ad medium utrobique. Cellulae 17 μ longae, 16 μ latae et isthmo 3.6 μ latae. Pl. 3, f. 14–15.
Occurs in vial No. 22.

C. c. var. ***granulatum*** HIRANO, var. nov.

Semicellulae subtriangulares, marginibus undulatis, marginibus lateralibus superioribus valde quadriundulatis cum angulis basalibus et apicalibus, marginibus lateralibus inferioribus convexis vel paene rectis et divergentibus; membrana punctata et granulato-protuberantibus ad medium et supra isthmum semicellularum. Granulis tribus ornatis. Cellulae 16 μ longae, 18 μ latae et isthmo 4 μ latae. Pl. 3, f. 17.

Occurs in vial No. 41.

C. c. var. ***depressum*** HIRANO, var. nov.

Semicellulae subtriangulares, marginibus lateralibus inferioribus divergentibus, marginibus lateralibus superioribus convexo-biundulatis et convergentibus, apice retuso. Cellulae 17 μ longae, 16 μ latae et isthmo 3.5 μ latae. Pl. 3, f. 18–19.

Occurs in vial No. 22.

Cosmarium yukidoriense HIRANO, sp. nov.

Cellulae parvae, profunde constrictae ad medium, sinu aperto et acuminato ad verticem; semicellulae late ellipticae vel elliptico-obovatae cum apice leviter retuso; latere visae ovatae sine inflatione mediana ad medium utrobique, membrana delicatissime punctata. Cellulae 28 μ longae, 17 μ latae et isthmo 8 μ latae. Pl. 9, f. 9–10.

Occurs in vial No. 22. The present specimens resemble *Cosmarium contractum* var. *minutum* but differ from the latter by having a retuse apex.

Cosmarium subcrenatum HANTZSCH in W. & G. S. WEST, Monogr. Br. Desm., **3**, 223, pl. 86, f. 10–14, 1908.

Semicells truncated-pyramidal in shape, with 4 crenations at the apex, and with 6 crenations on both sides (2 of 6 located at the upper position are larger than the remaining 4); central tumor of the semicell is accompanied with 4 to 5 longitudinal rows of granules (each row consists of 3 to 4 small granules); every crenation includes 2 to 3 rows of granules; cells 26–30 μ in length and 22–23 μ in width; isthmus 6 μ in width. Occurs in vial Nos. 1, 4 and 22. Pl. 9, f. 8, textf. 1, f. 1–2.

Cosmarium bioculatum BRÉB. var. ***depressum*** (SCHAARSCHM.) SCHMIDLE in KRIEGER & GERLOFF, Die Gattung *Cosmarium*, 61, pl. 15, f. 6, 1962.

Cells minute, 12 μ long, 10 μ broad and isthmus 3.5 μ broad. Occurs in vial No. 22. Pl. 9, f. 13.

Cosmarium phaseolus BRÉB. var. ***minus*** (BOLDT) KRIEGER & GERLOFF, Die Gattung *Cosmarium*, 55, pl. 14, f. 5, 1962.

Cells 15 μ long, 11 μ broad and isthmus 2 μ broad. The present specimens are distinguished from *C. clepsydra* by the small size of cell and having a median inflation instead of mamillate protuberance. Occurs in vial No. 26. Pl. 9, f. 17.

Acknowledgments

The author wishes here to express his sincere gratitude to Dr. Masao OHNO of Kochi University for providing the rare opportunity to study the Antarctic material of algae collected by himself. Also he expresses his thanks to Mr. Masashi SUE of Hydrographical Department, Maritime Safety Agency, for the permission to refer to the data of the physico-chemical analysis of the water of Yukidori Zawa.

References

AKIYAMA, M. (1967): On some Antarctic terrestrial and subterranean algae. Mem. Fac. Educ., Shimane Univ., **1**, 36–56.

AKIYAMA, M. (1974): A preliminary note on some algae found in the ice-free area of the coastal region of Lützow-Holm Bay, Antarctica. Mem. Fac. Educ., Shimane Univ., **8**, 37–50.

BAKER, A. N. (1967): Algae from Lake Miers, a solar-heated Antarctic lake. N. Z. J. Bot., **5**, 453–468.

DESIKACHARY, T. V. (1959): Cyanophyta. New Delhi, Ind. Counc. Agr. Res., 686p.

FRITSCH, F. E. (1912): Freshwater algae. Natl. Antarct. Exped., Nat. Hist., **6**, 1–60.

FRITSCH, F. E. (1912): Freshwater algae of the South Orkney. Rep. Sci. Res. Voy. S.Y. "Scotia", **III**, 95–134.

FRITSCH, F. E. (1917): Freshwater algae. Br. Antarct. ("Terra Nova") Exped., 1910. Nat. Hist. Rep., Bot., **1**, 1–16.

FUKUSHIMA, H. (1959): General report on fauna and flora of the Ongul Island, Antarctica, especially on freshwater algae. J. Yokohama Munic. Univ., Ser. **C-31** (112), 1–10.

FUKUSHIMA, H. (1968): Nankyoku tairiku Kasumi Iwa rogan chitai no sô-rui shokusei (Algal vegetation of the Kasumi Rock ice-free area, Prince Olav Coast, Antarctica). Nankyoku Shiryo (Antarct. Rec.) **31**, 73–86.

GAIN, L. (1912): La Flore Algologique des Région Antarctique et Subantarctiques. Paris, Masson, 218p.

GEITLER, L. (1932): Cyanophyceae. Kryptogamen-Flora, **14**, 1196p.

HIRANO, M. (1959): Notes on some algae from the Antarctic collected by the Japanese Antarctic Research Expedition. Biol. Results Jap. Antarct. Res. Exped., **3**, 1–13.

HIRANO, M. (1965): Freshwater algae in the Antarctic regions. Biogeography and Ecology in Antarctica, ed. by J. VAN MIEGHEM and P. VAN OYE. The Hague, Dr. W. Junk, 127–193 (Monogr. Biol., Vol. 15).

KOL, E. and FLINT, E. A. (1968): Algae in green ice from the Balleny Islands, Antarctica. N.Z.J. Bot., **6**, 249–261.

KREIGER, W. and GERLOFF, J. (1962–69): Die Gattung *Cosmarium*. Lief. **1–4**, 1–410.

LAVRENKO, G. Y. (1960): Algae of a lake near Novolazarevskaya Station. Sov. Antarct. Exped. Inf. Bull., **6** (1), 63–65.

MIGULA, W. (1907): Kryptogamen-Flora von Deutschland, Deutsch-Oesterreich und der Schweiz. Bd. II. Algen.

PRESCOTT, G. W. (1951): Algae of the Western Great Lakes area. Cranbrook Inst. Sci. Bull., **30**, 946 p.

RAMANATHAN, K. R. (1964): Ulotrichales. New Delhi, Ind. Counc. Agr. Res., 188 p.

REINSCH, P. F. (1890): Die Süsswasseralgenflora von Süd-Georgien. Intern. Polarforschung 1882–1883. Dtsch. Exped. Ergebn., **II**, 329–365.

SKUJA, H. (1956): Taxonomische und Biologische Studien über das Phytoplankton schwedischer Binnengewässer. Nova Acta Regiae Soc. Sci. Ups., **16** (3), 1–404.

SKUJA, H. (1964): Grundzüge der Algenflora und Algenvegetation der Fjeld-Gegenden um Abisko in Schwedisch-Lappland. Nova Acta Regiae Soc. Sci. Ups., **18** (3), 1–462.

STARMACH, K. (1972): Flora Slodkowodna Polski., **10**, Warsaw, Polish Academy of Sciences, 1–745.

TIFFANY, L. H. (1934): The Oedogoniaceae, a monograph. Columbus, Ohio, 1–188.

WATANABE, A., FUKUSHIMA, H., FUJITA, Y., KIYOHARA, T. and ISHIKAWA, M. (1961): Some remarks on the cultivation of microalgae collected in the Ongul Islands and adjacent areas. Nankyoku Shiryo (Antarct. Rec.), **11**, 154–155.

WEST, W. and WEST, G. S. (1911): Freshwater Algae. Rep. Sci. Invest. Br. Antarct. Exped., 1907–09, **1** (7), 263–298.

WILLE, N. (1924): Süsswasseralgen von der Deutschen Südpolar-expedition auf dem Schiff "Gauss". Dtsch. Südpolar-Exped., 1901–03, **8** (4), Bot., 377–445.

(*Received December 12, 1977*)

Plate 1

Figs. 1–3. *Lyngbya borneti* ZUKAL
Fig. 4. *L. aerugineo-coerulea* (KÜTZ.) GOM.
Figs. 5–7. *Phormidium uncinatum* GOM.
Figs. 8–9. *Ph. antarcticum* W. & G. S. WEST
Figs. 10–11. *Ph. incrustatum* (NÄG.) GOM.
Figs. 12–14. *Microspora stagnorum* (KÜTZ.) LAGERH.
Figs. 15–16. *Ulothrix subtilissima* RABENH.
Figs. 17–18. *U. variabilis* KÜTZ.
Figs. 19–21. *Hormidiopsis crenulata* (KÜTZ.) HEERING
Scale: All ×900

Plate 1

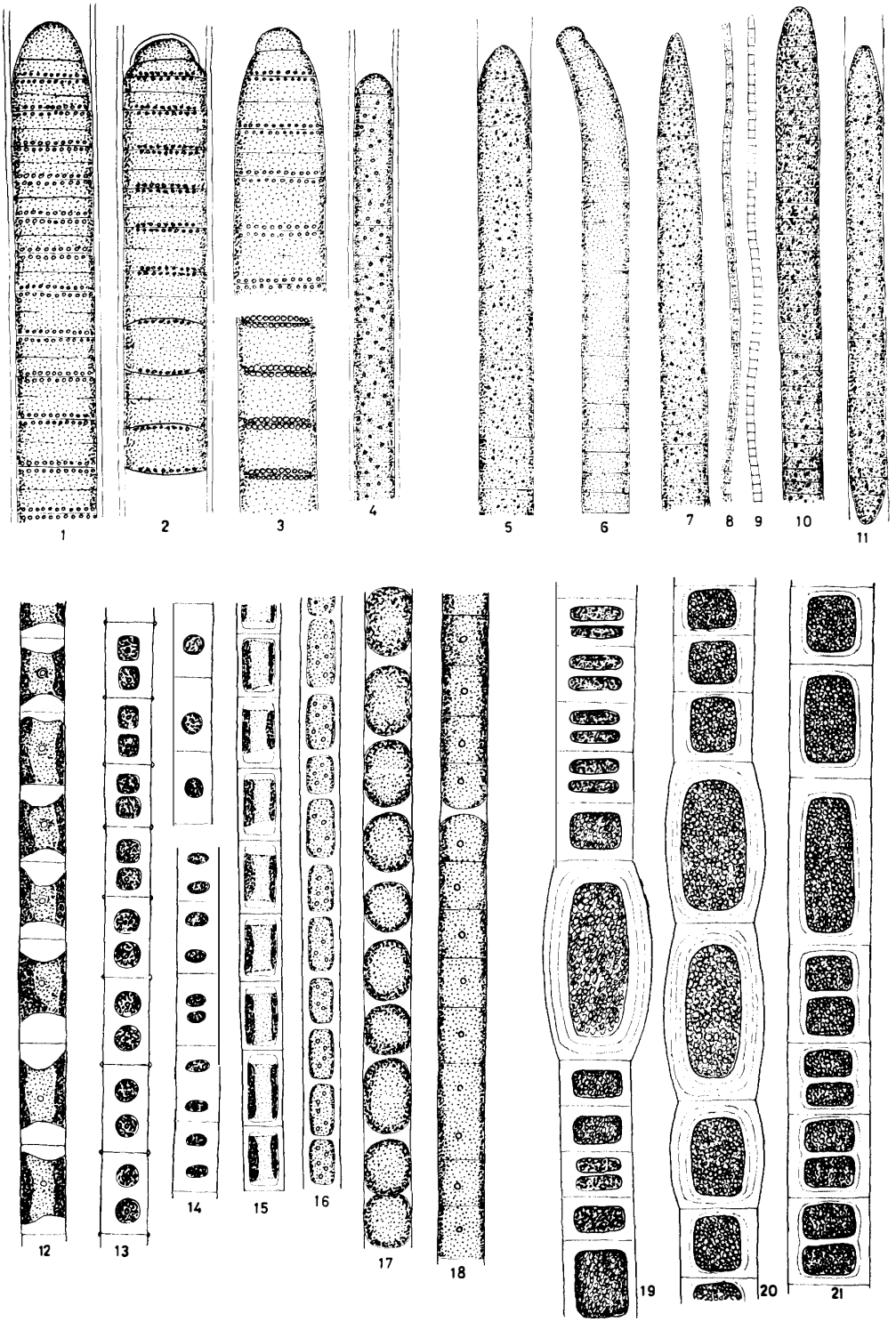
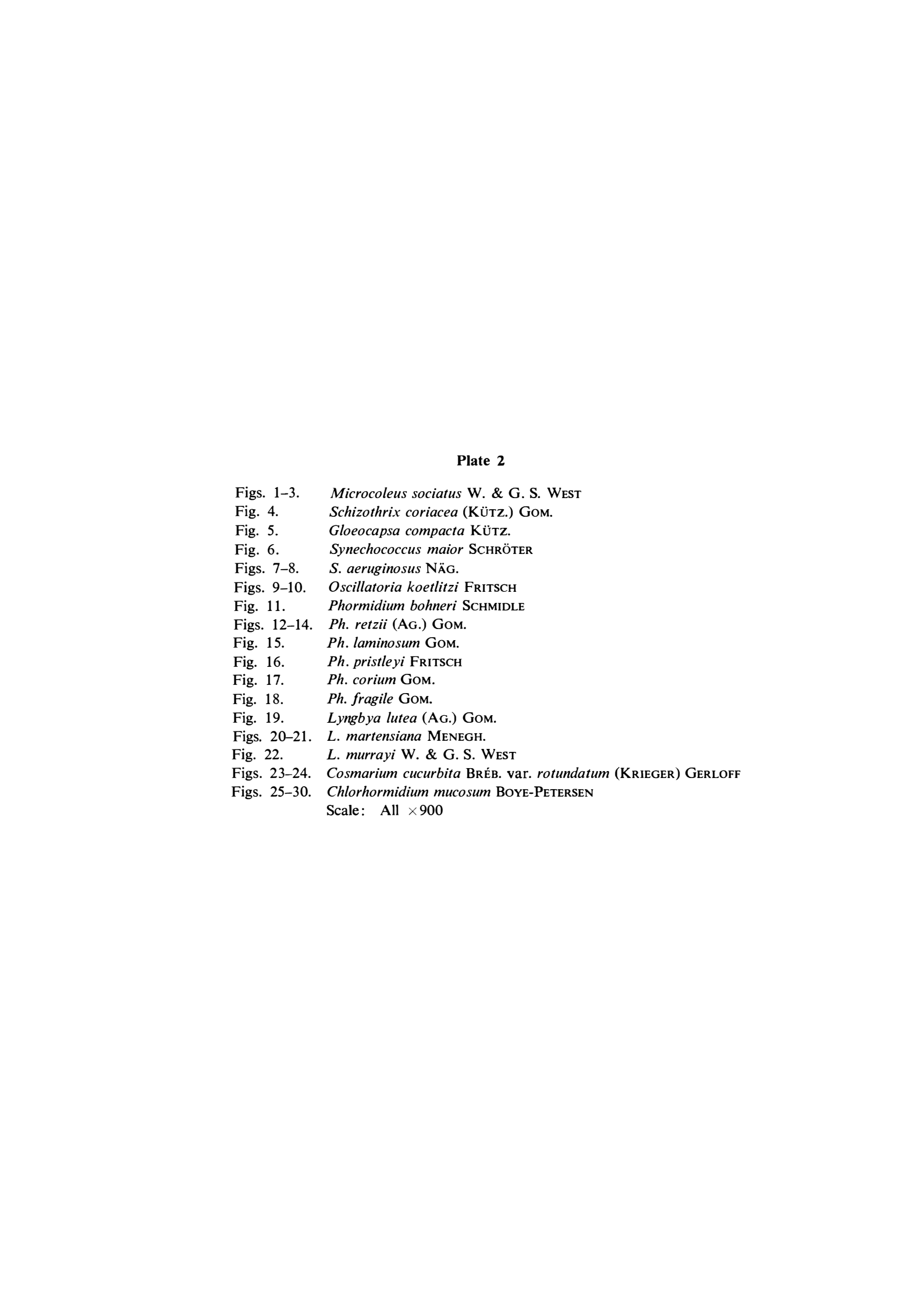


Plate 2



Figs. 1–3. *Microcoleus sociatus* W. & G. S. West
Fig. 4. *Schizothrix coriacea* (Kütz.) Gom.
Fig. 5. *Gloeocapsa compacta* Kütz.
Fig. 6. *Synechococcus maior* Schröter
Figs. 7–8. *S. aeruginosus* Näg.
Figs. 9–10. *Oscillatoria koetlitzi* Fritsch
Fig. 11. *Phormidium bohneri* Schmidle
Figs. 12–14. *Ph. retzii* (Ag.) Gom.
Fig. 15. *Ph. laminosum* Gom.
Fig. 16. *Ph. pristleyi* Fritsch
Fig. 17. *Ph. corium* Gom.
Fig. 18. *Ph. fragile* Gom.
Fig. 19. *Lyngbya lutea* (Ag.) Gom.
Figs. 20–21. *L. martensiana* Menegh.
Fig. 22. *L. murrayi* W. & G. S. West
Figs. 23–24. *Cosmarium cucurbita* Bréb. var. *rotundatum* (Krieger) Gerloff
Figs. 25–30. *Chlorhormidium mucosum* Boye-Petersen
Scale: All ×900

Plate 2

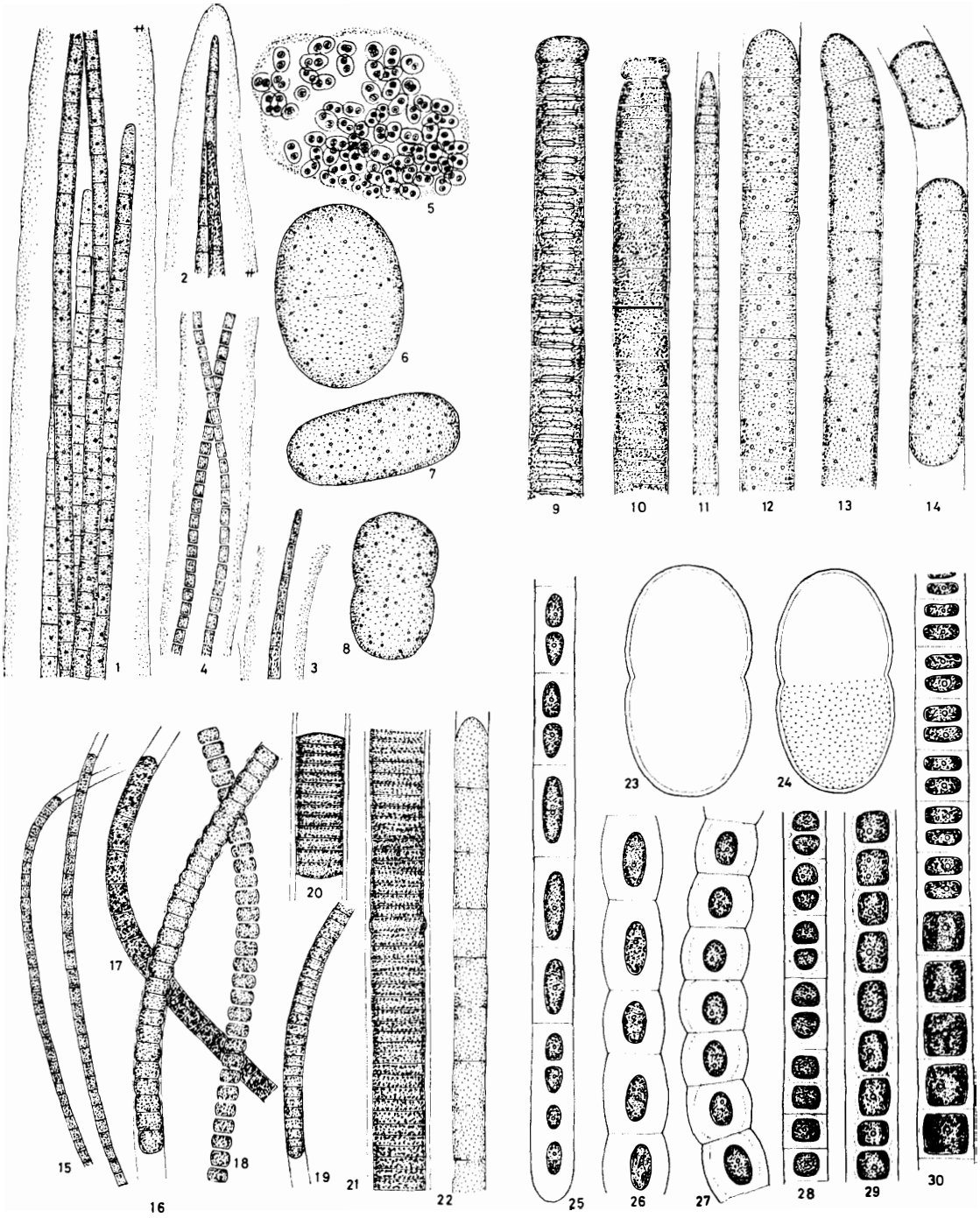

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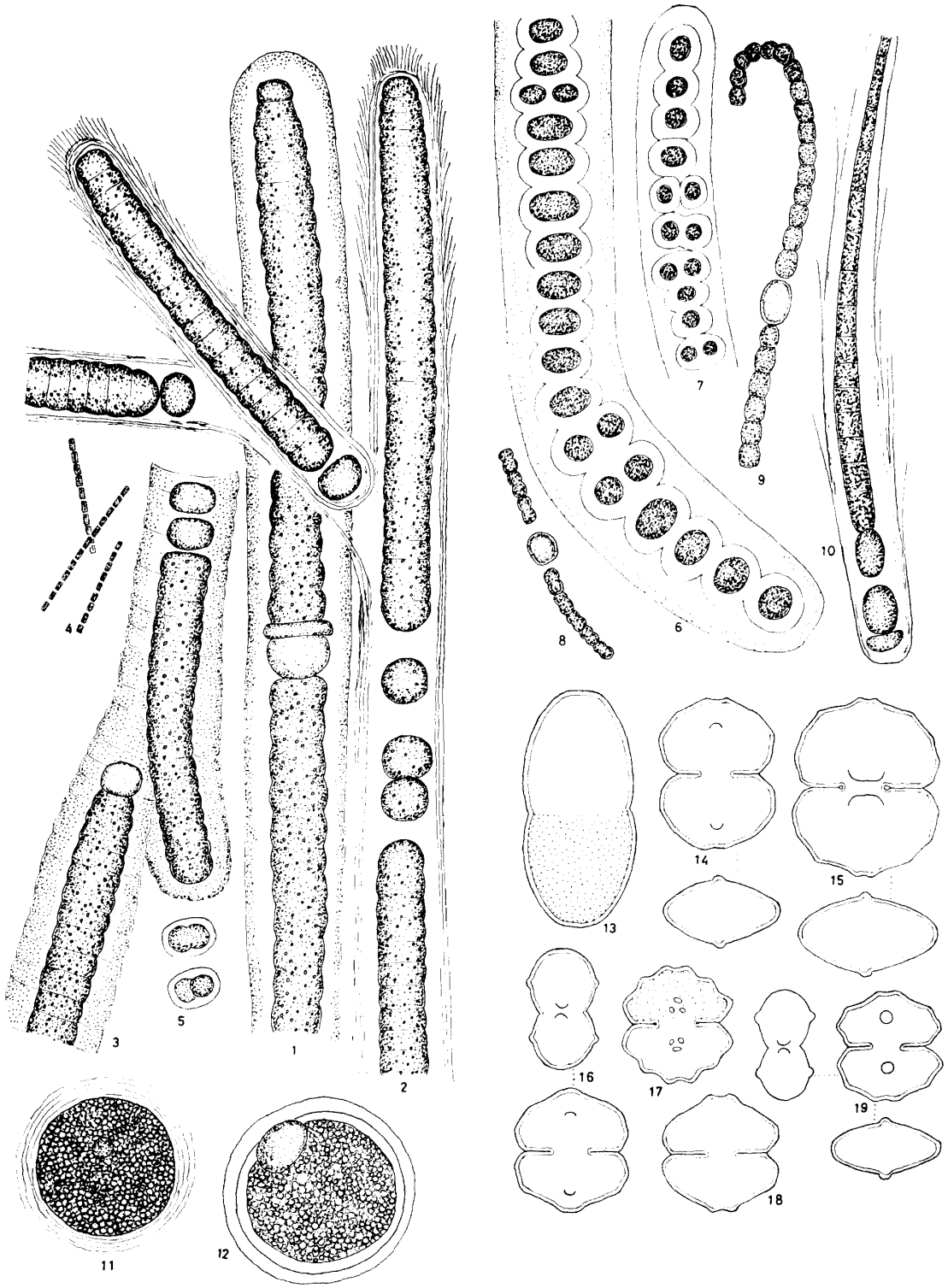
Plate 3

Figs. 1–3. *Petalonema velutinum* (RABENH.) MIGULA
Fig. 4. *Phormidium frigidum* FRITSCH
Fig. 5. *Chroococcus pallidus* NÄG.
Fig. 6. *Stigonema tomentosum* (KÜTZ.) HIERON.
Fig. 7. *S. hormoides* (KÜTZ.) BORNET et FLAH.
Fig. 8. *Nostoc minutum* DESM.
Fig. 9. *N. borneti* GAIN
Fig. 10. *Dichothrix orsiniana* BORNET et FLAH.
Figs. 11–12. *Pleurococcus antarcticus* W. & G. S. WEST f. *robusta* W. & G. S. WEST
Fig. 13. *Cosmarium cucurbita* BRÉB. var. *attenuatum* G. S. WEST
Figs. 14–15. *C. clepsydra* NORDST. var. *undulatum* HIRANO, var. nov.
Fig. 16. *C. clepsydra* NORDST. var. *dissimile* (RACIB.) KRIEGER & GERLOFF
Fig. 17. *C. clepsydra* NORDST. var. *granulatum* HIRANO, var. nov.
Figs. 18–19. *C. clepsydra* NORDST. var. *depressum* HIRANO, var. nov.
Scale: All ×900

Plate 3



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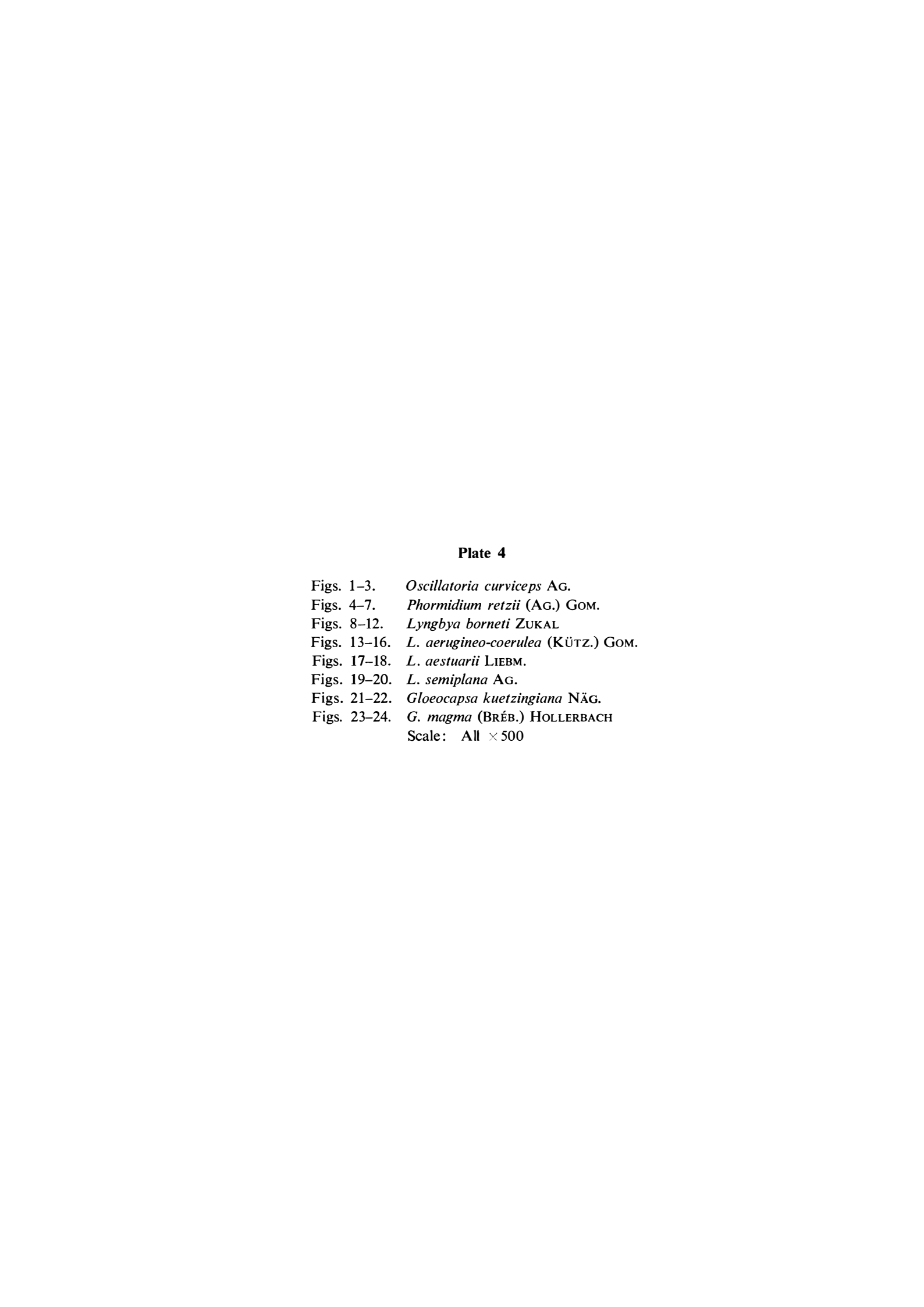


Figs. 1–3. *Oscillatoria curviceps* AG.
Figs. 4–7. *Phormidium retzii* (AG.) GOM.
Figs. 8–12. *Lyngbya borneti* ZUKAL
Figs. 13–16. *L. aerugineo-coerulea* (KÜTZ.) GOM.
Figs. 17–18. *L. aestuarii* LIEBM.
Figs. 19–20. *L. semiplana* AG.
Figs. 21–22. *Gloeocapsa kuetzingiana* NÄG.
Figs. 23–24. *G. magma* (BRÉB.) HOLLERBACH
Scale: All ×500

Plate 4

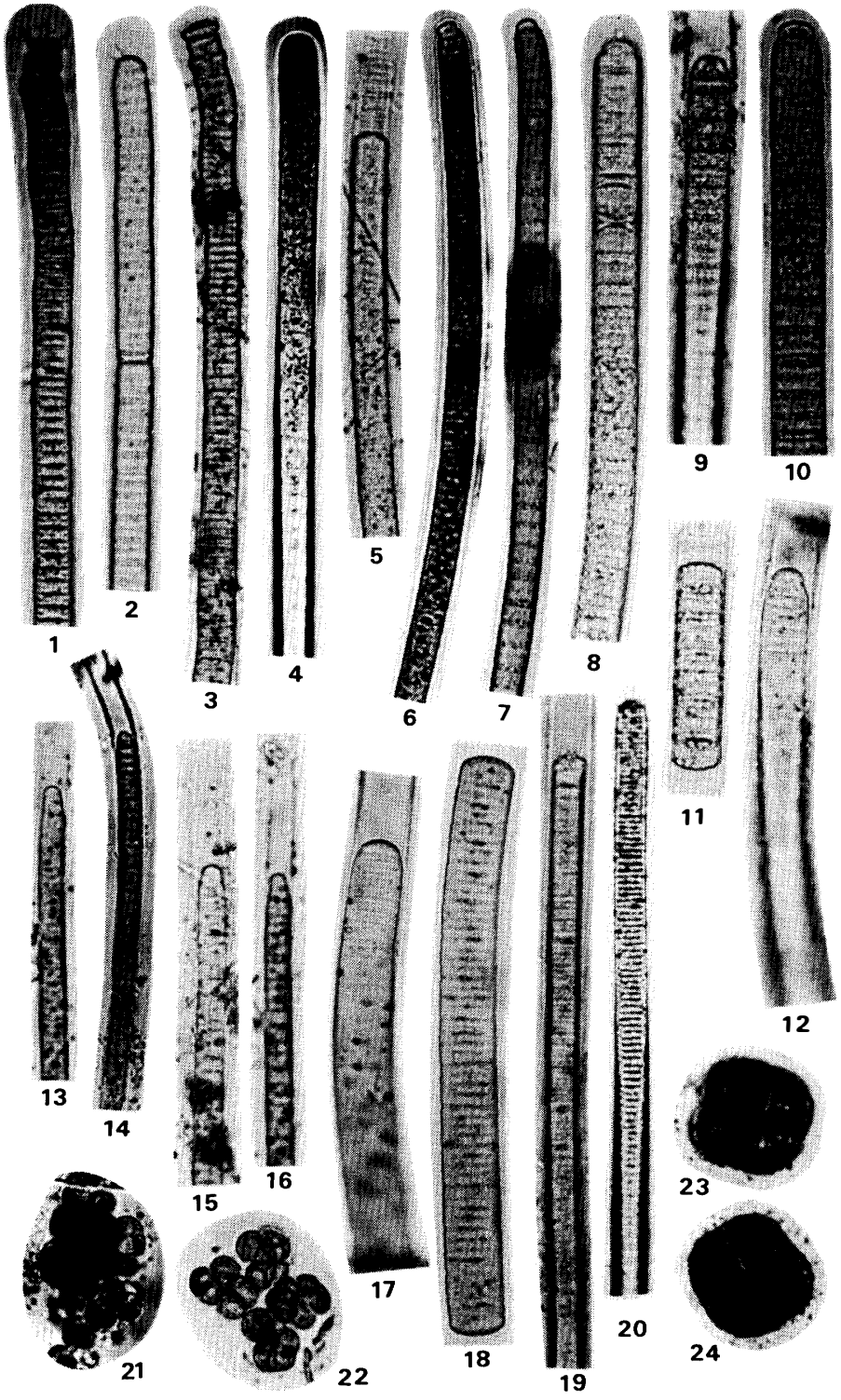


Plate 5

Figs. 1–9. *Gloeocapsa ralfsiana* (HARV.) KÜTZ.
Figs. 10–12. *G. dermochroa* NÄG.
Scale: All × 500

Plate 5

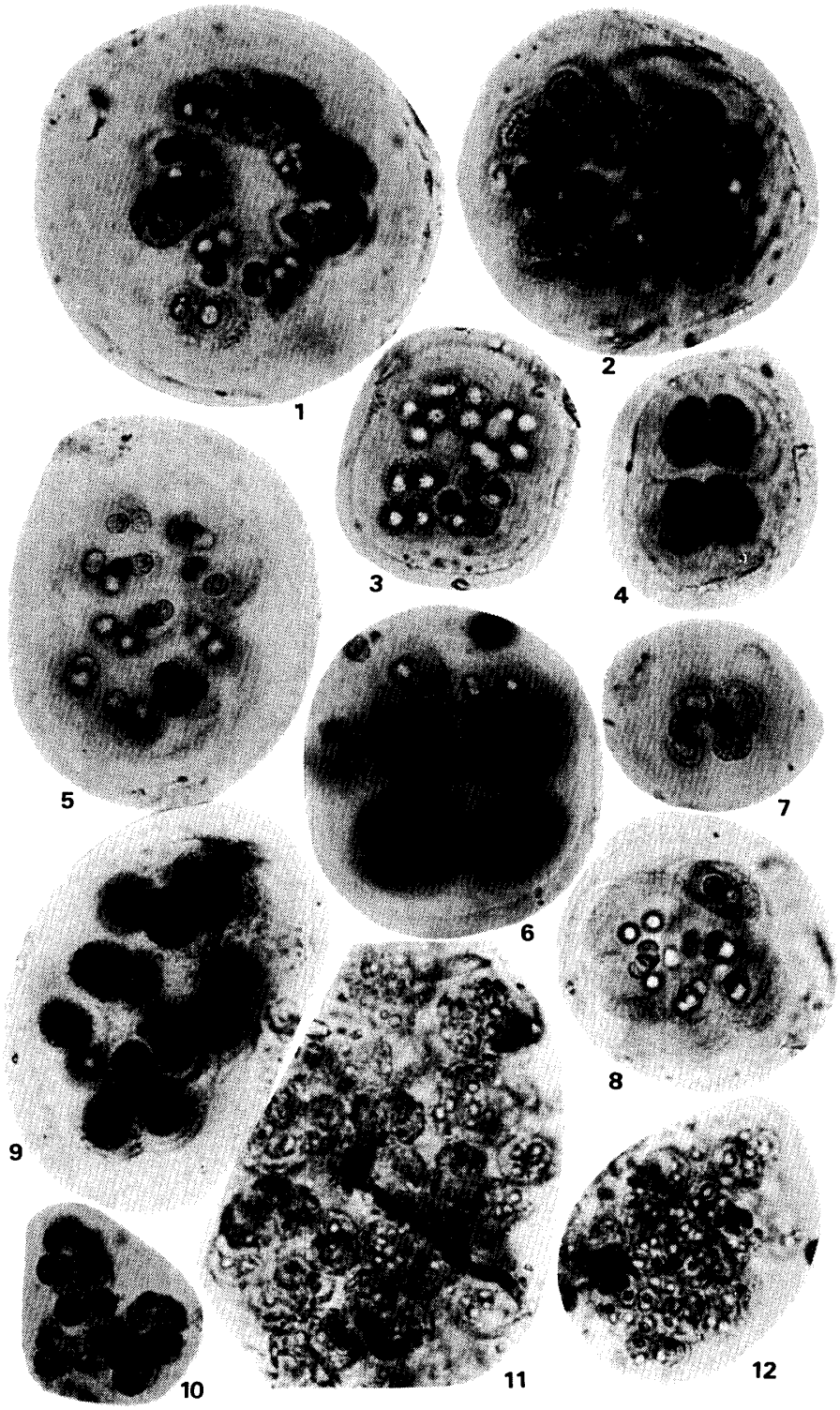
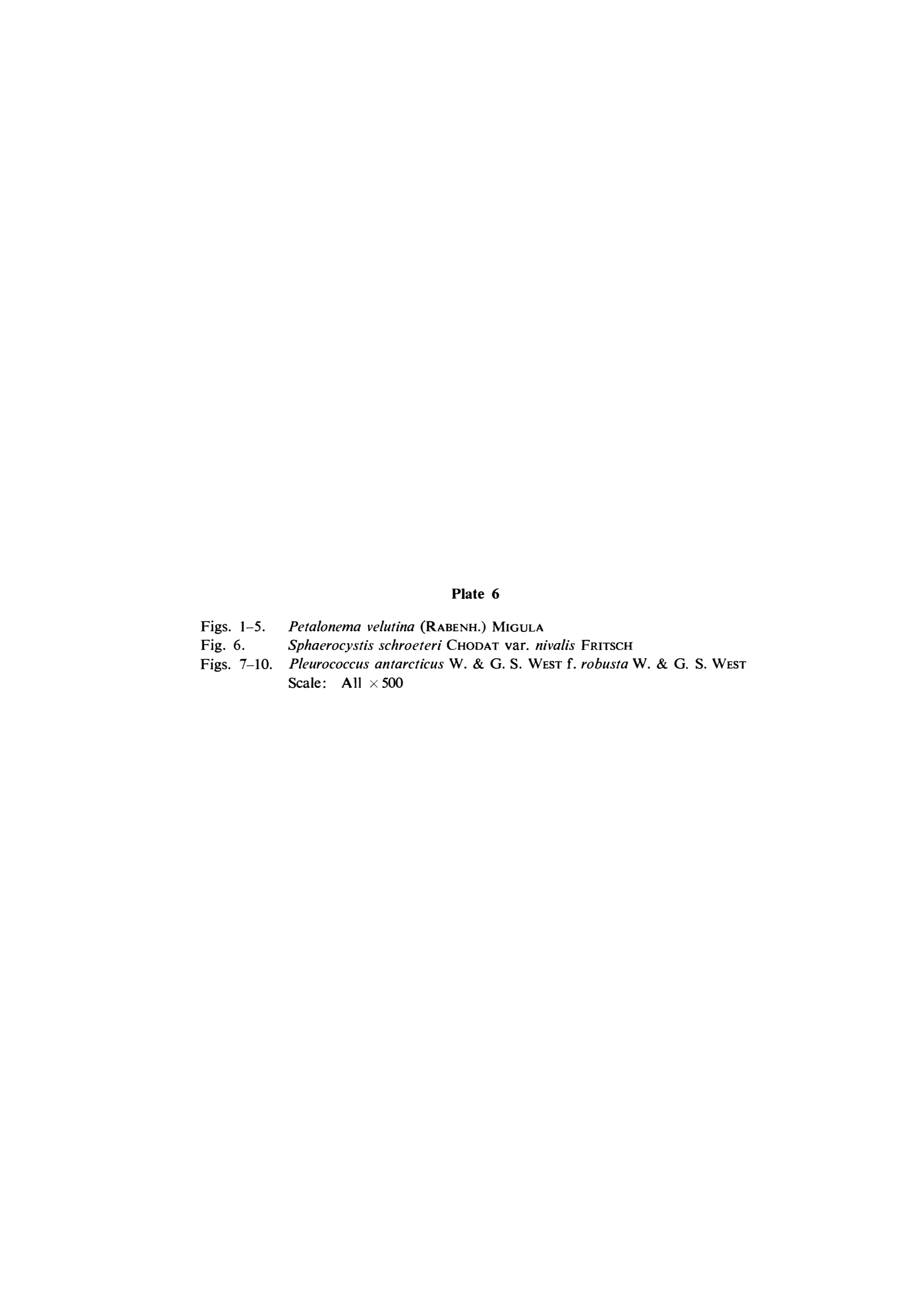


Plate 6



Figs. 1–5. *Petalonema velutina* (RABENH.) MIGULA
Fig. 6. *Sphaerocystis schroeteri* CHODAT var. *nivalis* FRITSCH
Figs. 7–10. *Pleurococcus antarcticus* W. & G. S. WEST f. *robusta* W. & G. S. WEST
Scale: All × 500

Plate 6

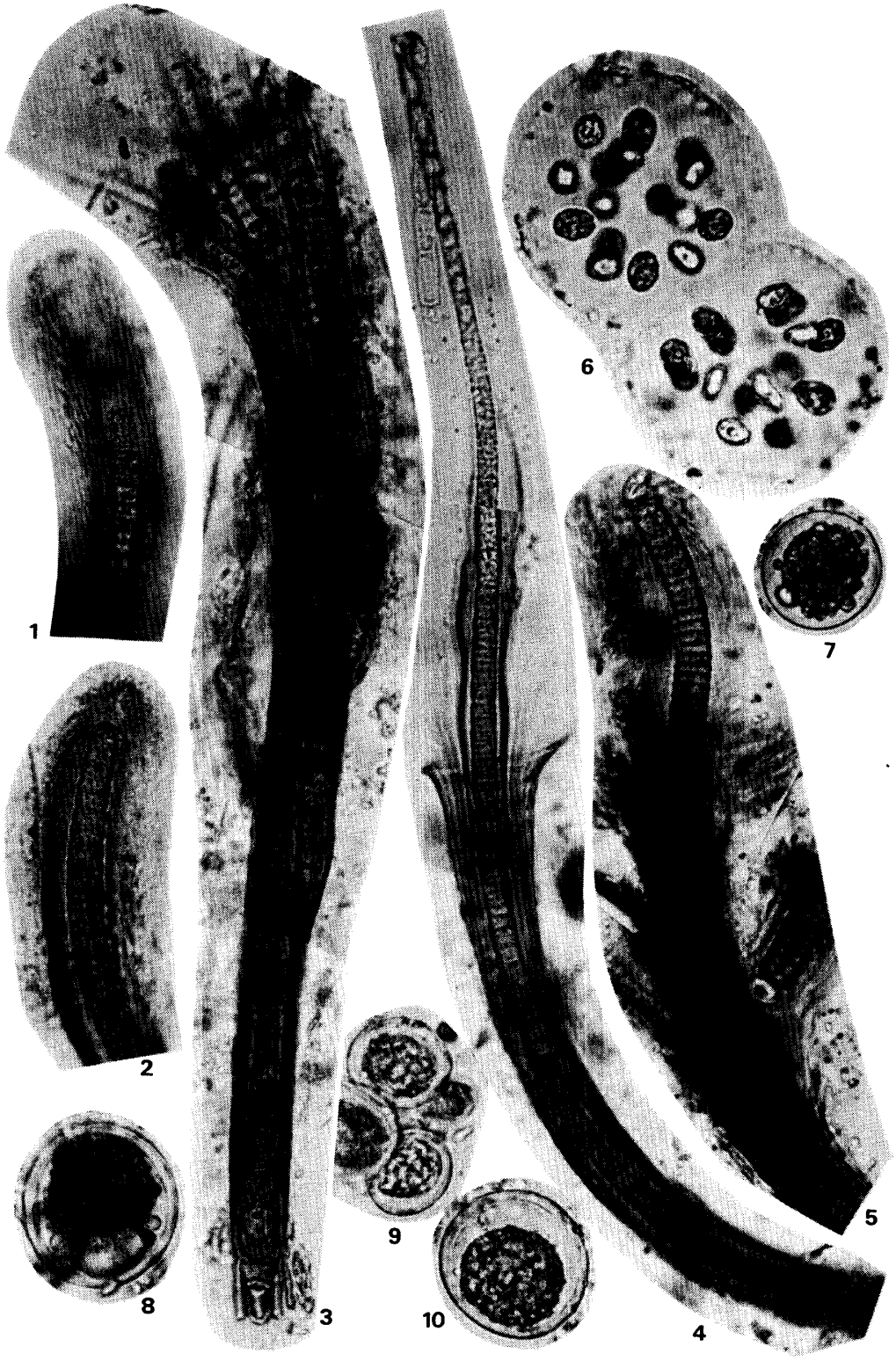


Plate 7

Figs. 1–5. *Microcoleus sociatus* W. & G. S. WEST
Fig. 6. *Microspora stagnorum* (KÜTZ.) LAGERH.
Figs. 7–14. *Chlorhormidium mucosum* BOYE-PETERSEN
Fig. 15. *Nodularia quadrata* FRITSCH
Scale: 1–4, 6–15, × 500; 5, × 125

Plate 7

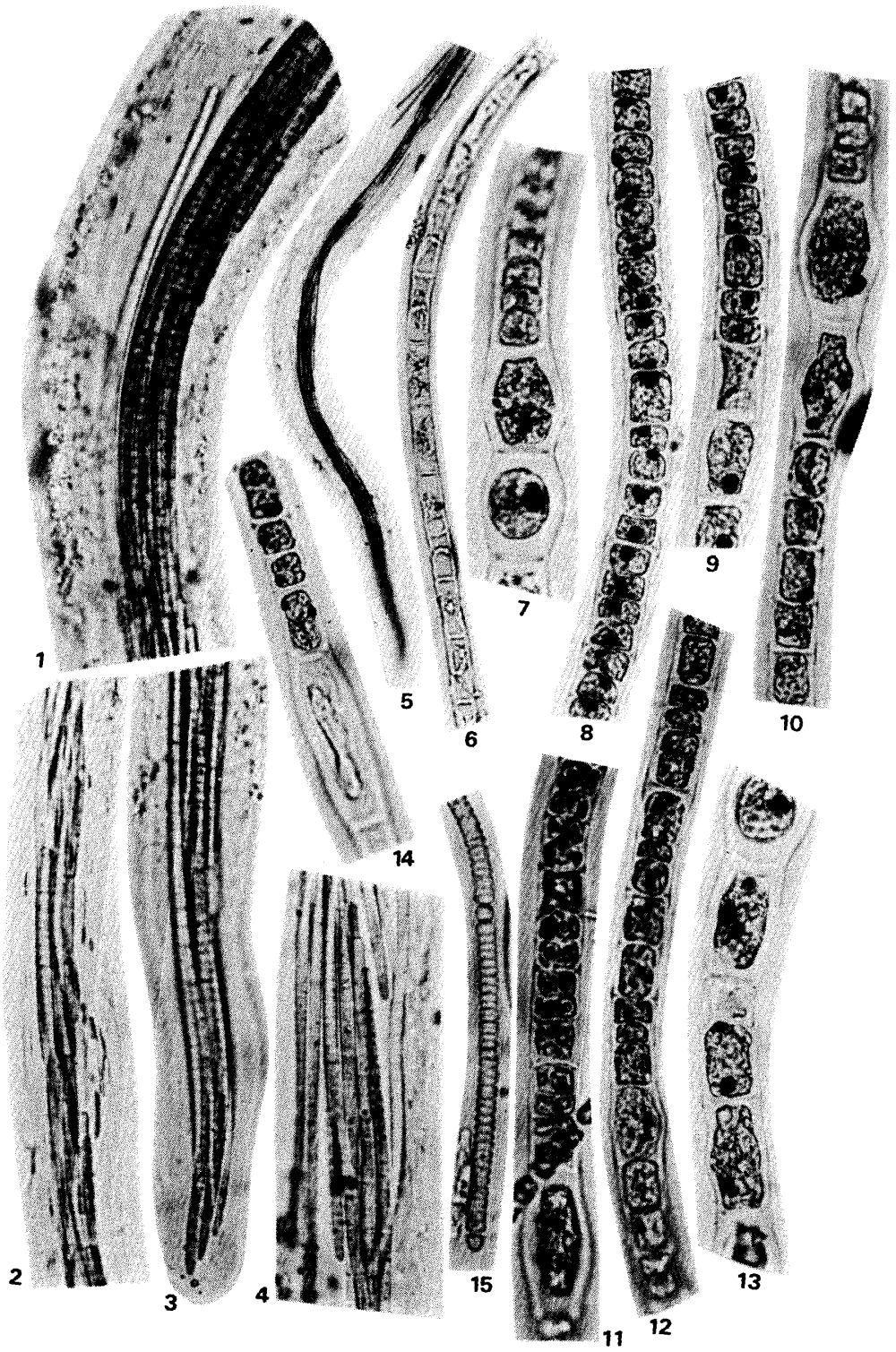


Plate 8

Figs. 1–5. *Hormidiopsis crenulatus* (KÜTZ.) HEERING
Figs. 6–11. *Ulothrix variabilis* KÜTZ.
Figs. 12–13. *U. subtilissima* RABENH.
Figs. 14–16. *U. tenerrima* KÜTZ.
Figs. 17–19. *Cosmarium cucurbita* BRÉB. var. *attenuatum* G. S. WEST
Figs. 20–23. *C. cucurbita* BRÉB. var. *rotundatum* (KRIEGER) GERLOFF
Scale: All $\times 500$

Plate 8

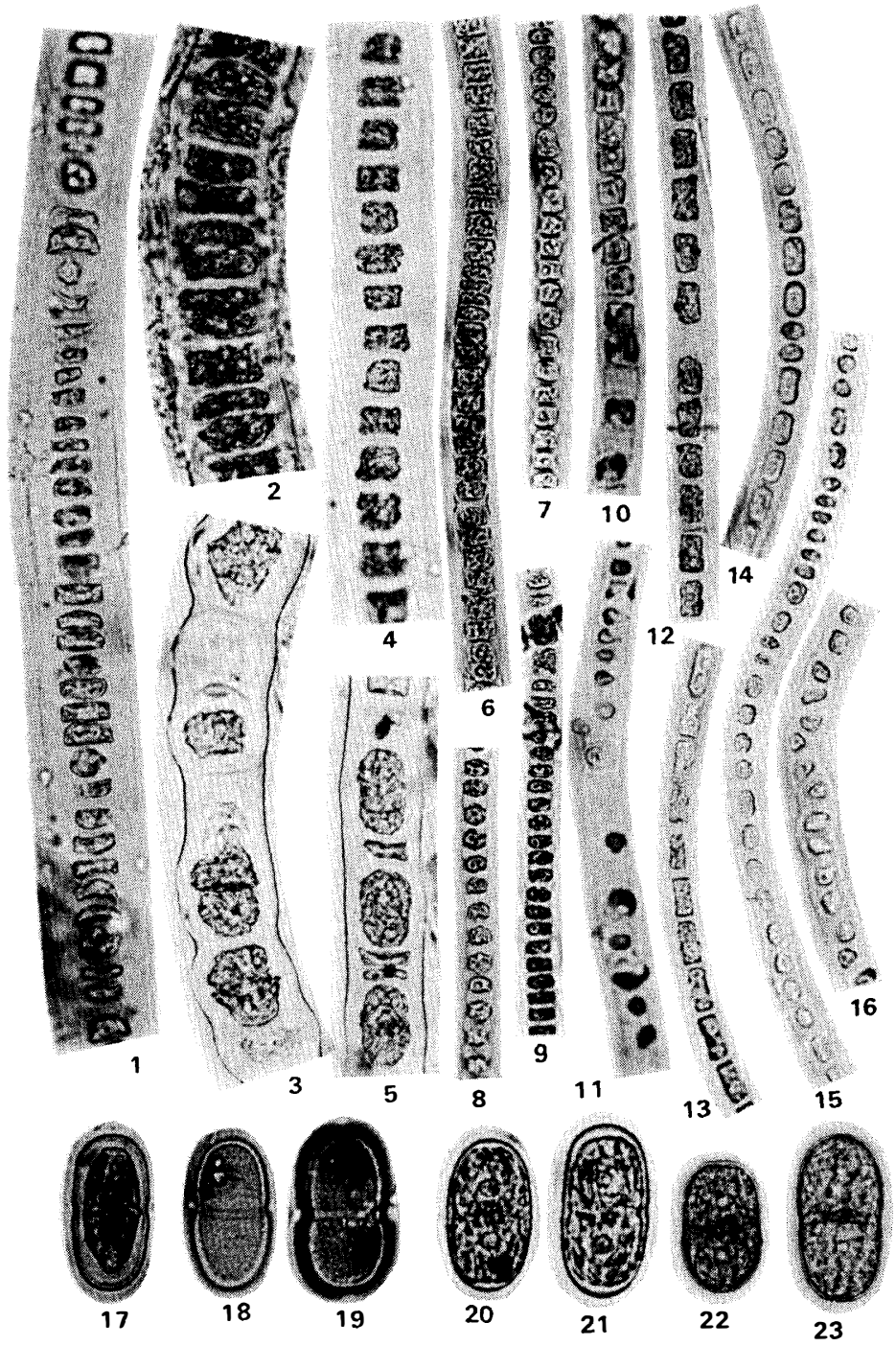


Plate 9

Fig. 1. *Palmodictyon viride* KÜTZ.
Figs. 2–4. *Cosmarium clepsydra* NORDST. var. *dissimile* (RACIB.) KRIEGER & GERLOFF
Fig. 5. *C. clepsydra* NORDST. var. *clepsydra*
Fig. 6. *C. clepsydra* var. *granulatum* HIRANO, var. nov.
Fig. 7. *C. clepsydra* var. *depressum* HIRANO, var. nov.
Fig. 8. *C. subcrenatum* HANTZSCH
Figs. 9–10. *C. yukidoriense* HIRANO, sp. nov.
Figs. 11–12. *Oedogonium* sp. 11, Oogonium
Fig. 13. *C. bioculatum* BRÉB. var. *depressum* (SCHAARSCHM.) SCHMIDLE
Fig. 14. *Phormidium frigidum* FRITSCH
Fig. 15. *Nostoc borneti* GAIN
Fig. 16. *N. minutum* DESM.
Fig. 17. *Cosmarium phaseolus* BRÉB. var. *minus* (BOLDT) KRIEGER & GERLOFF
Scale: All $\times 500$

Plate 9