

Title	Freshwater Algae from North Borneo
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Citation	Contributions from the Biological Laboratory, Kyoto University (1974), 24(3): 121
Issue Date	1974-03-31
URL	http://hdl.handle.net/2433/155998
Right	
Type	Departmental Bulletin Paper
Textversion	publisher

Freshwater Algae from North Borneo

Minoru HIRANO

The samples of freshwater algae from North Borneo entrusted to the author were collected by Dr. Mitsuru Hotta (now Yoshida College of Kyoto University) and Dr. Gentryo Imadaté (now Biological Laboratory of Konodai College, Tokyo Medical and Dental University), the former members of "The Osaka City University North Borneo Biological Expedition, 1968".

Most of the samples were collected from the stations in the vicinity of the Mt. Kinabalu area in North Borneo (Sabah). Mt. Kinabalu, the highest peak in Borneo, is about 4,100 meters above sea level. The foot of the mountain is covered with a tropical rainy forest. The side of the mountain (alt. 1,500–2,500 m) is characterized by a mossy-forest, while the upper or the alpine part chiefly consists of the granite rocks with no trees around. Although the Mt. Kinabalu area has been explored by many botanists for the past hundred years, full investigation has not yet been made on the algal flora of the area except one old report by West (1914), the material of which was collected by Lilian S. Gibbs. West's article includes description of 109 taxa of freshwater algae in the total number. Samples of his algal species were mainly collected from the areas of Tenom and Malalap (alt. 700–800 feet), of Maraiparai (alt. 7,000 feet), and around the summit of the mountain (alt. 12,500 feet). Among the species he described, only 29 taxa were reported from the localities of the standing waters in damp ground and the temporary pools of the alpine area. This indicates that the geological condition of Mt. Kinabalu is not favourable for a rich algal flora.

The freshwater algal samples examined and reported in the present paper were collected in the following places.

1. A small stream at the Keningan hill. Coll. Dr. G. IMADATÉ. 1 Sept., 1968.
2. A small stream at Sepulot. Two kinds of samples. Coll. Dr. G. IMADATÉ. 11 Aug., 1968.
3. A pool by the railroad at the Sungai Pin, Kinabatangan. Coll. Dr. M. Hotta. 25 Nov., 1968.
4. A hot spring in the south-east slope of Mt. Kinabalu (alt. 600 m). Water temp. 35° to 60°C. Samples were obtained from the four different places of temperature, 35°, 45°, 55° and 60°C respectively. Coll. Dr. M. Hotta.
5. A damp ground at Gnong Arab (alt. 800–900 m). Coll. Dr. M. Hotta. 12 Dec., 1968.
6. A damp ground at Tenom Pok, Mt. Kinabalu (alt. about 1,500 m). Coll. Dr. M. Hotta. 4 Jan., 1969.
7. A damp ground at the Mamut ridge, south-east slope of Mt. Kinabalu (alt.

about 1,700 m). Samples were obtained from the mosses in a mossy forest. Coll. Dr. M. HOTTA. 20 Feb., 1969.

8. A Paka cave of Mt. Kinabalu (alt. about 3,200 m). Samples were obtained from a flowing water over rocks in a sunny place. Coll. Dr. M. HOTTA. 8 Jan., 1969.

9. A mossy ground at Panal Laban of Mt. Kinabalu (alt. 3,200 m). Coll. Dr. M. HOTTA. 16 Jan., 1969.

10. A mossy ground at Panal Laban of Mt. Kinabalu (alt. 3,300 m). Samples were obtained from *Sphagnum* in a wet soil. Coll. Dr. M. HOTTA. 16 Jan., 1969.

11. A small pool near the summit of Mt. Kinabalu (alt. about 4,000 m). Coll. Dr. M. HOTTA. 9 Jan., 1969.

The number of freshwater algae taxa found in the present samples attains to 137, and an interesting fact is that there is much difference between the species of WEST's report and those of the present paper. This may be due to the different sites of collecting samples.

The species reported by WEST consist largely of subaerial algae and are characteristically rich in blue-green algae. The present samples were chiefly obtained by the squeezing method from the *Sphagnum* mass and various kinds of other mosses growing in the stream sides and the damp grounds. According to the collectors, there are very few pools and standing waters in the alpine area surveyed, because the rain waters quickly flow down on the surface of the steep granite slopes.

My chief interest recently in the algology is the comparative study of the freshwater algal floras in the alpine regions between the Tropical and the Temperate Zones. The algal species from the small pond located near the top of Mt. Kinabalu (alt. 4,000 m), collected at the highest place in the present collection, are also well known in the lakes, ponds and marshes in the Temperate Zone. These species are: *Aphanocapsa pulchra*, *A. biformis*, *Chroococcus turgidus*, *Synechococcus aeruginosus*, *Stigonema ocellatum*, *Mesotaenium macrococcum* and *m. var. micrococcum*, *Cosmarium cucurbita* var. *rotundatum*, *C. minimum*, *C. globosum*, *C. pseudopyramidatum*, *Staurastrum zachariasii* var. *minor*.

In Borneo the areas over the contour line of about 3,000 meters seem to be a subalpine or an alpine district in its nature. The algal samples obtained by the squeezing method from the Panal Laban and Poka cave areas located in the altitude range from about 3,200–3,300 meters are characterized by the so-called moss-living or the sphagnophilous species. These species are also common in the temperate districts. These species are: *Aphanocapsa pulchra*, *Chroococcus turgidus*, *Ch. minutum*, *Gloeocapsa rupicola*, *Stigonema ocellatum*, *St. minutum*, *Scytonema subtile*, *Microcoleus vaginatus*, *Cyclotella stelligera*, *Tabellaria fenestrata*, *Cocconeis placentula* var. *euglypta* f. *pumila*, *Eunotia fallax* var. *dispersa*, *E. lunaris* var. *capitata*, *E. sudetica* var. *incisa*, *E. monodon*, *E. praerupta* var. *bidens*, *E. tenella*, *E. pectinalis* var. *minor*, *E. alpina*, *E. robusta* var. *diadema*, *E. robusta* var. *tetraodon*, *E. exigua*, *E. faba* var. *intermedia*, *Anomooneis serians* var. *brachysira*, *Neidium affine* var. *amphirhynchus*, *Frustulia rhomboides* var. *saxonica*, *Pinnularia gibba* var. *sancta*, *P. stauraptera* var. *parva*, *P. sudetica*, *P. subcapitata*, *Cymbella angustata* var. *inaequilatera*, *Nitzschia sublinearis*, *Surirella angustata* var. *constricta*, *Mesotaenium macrococcum* var. *micrococcum*, *Cylindrocystis crassa*,

Penium rufescens, *Cosmarium cucurbita*, *C. cucurbita* var. *rotundatum*, *C. minimum*, *C. crassiusculum*, *C. norimbergense*, *C. decedens* var. *sinuosum*, *C. tatricum* var. *novizelandicum*, *C. pseudoprotuberans* var. *pygmaeum*, *Euastrum subalpinum* var. *quadratum*.

C Y A N O P H Y T A

Chroococcaceae

Aphanocapsa elachista W. & G. S. WEST var. *conferta* W. & G. S. WEST in GEITLER, Rabenh. Krypt. Fl. 14, p. 157, f. 69 e, f, 1932.

Cell 1.5 μ in diameter. Hab. Tenom Pok.

Aphanocapsa pulchra (KÜTZ.) RABENH. in GEITLER, l.c. p. 159, f. 69 g, 1932.

Cell 4.5 μ in diameter. Hab. Small pond near the summit of Mt. Kinabalu, altitude about 4,000 meters sea level.

Aphanocapsa biformis A. BR. in GEITLER, l.c. p. 158, f. 70, 1932.

Cell 6.5 μ in diameter. Hab. Small pond near the summit of Mt. Kinabalu.

Microcystis flos-aquae (WITTR.) KIRCHN. in GEITLER, l.c. p. 138, f. 59e, f, 1932.

Cell 5.3 μ in diameter, aggregated in irregular, amorphous, gelatinous envelope. Hab. Growing at the hot spring of Poring. (about 55°C)

Chroococcus minor (KÜTZ.) NÄG. in GEITLER, l.c. p. 240, f. 116 g, 1932.

Cell 3-4.5 μ in diameter and the breadth is relatively thin and scarcely visible. Hab. Among the mosses and growing in the sunny place of the rocks at the Paka cave, altitude 3,200 meters sea level. Also growing at the hot spring of Poring.

Chroococcus turgidus (KÜTZ.) NÄG. in GEITLER, l.c. p. 228, f. 109-110, 1932.

Cell 13 μ in diameter. Hab. Small pond near the summit of Mt. Kinabalu, about 4,000 meters sea level. Panal Laban, alt. 3,200 meters sea level, growing among *Sphagnum* carpet; Paka cave, in the sunny place of the rocks.

Synechococcus aeruginosus NÄG. in Gatt. einz. Alg. p. 56, pl. 1, f. E1, 1849; GEITLER, l.c. p. 274, f. 133 d, e, 1932.

Cell elliptic, 22 μ long, 17.5 μ broad. Hab. Panal Laban; Paka cave, and small pond near the summit of Mt. Kinabalu.

Gloeocapsa sanguina (AG.) KÜTZ. in GEITLER, l.c. p. 202, f. 94 a, 1932.

Sheath stratified, reddish-brown in colour, containing 4-cells; cell 5.7 μ in diameter. Hab. Tenom Pok, alt. 1,500 meters above the sea, southern slope of Mt. Kinabalu.

Oscillatoriaceae

Spirulina subsalsa OESTR. in GEITLER, l.c. p. 927, f. 593a, 1932.

Trichome 1.7 μ in broad, regularly coiled and closed. Hab. Growing in the thermal water of Poring (55°C)

Oscillatoria animalis AG. in GEITLER, l.c. p. 978, f. 603 e, 1932.

Trichome straight but gradually attenuated and curved to the apices, not constricted at the cross wall, 3 μ broad, apex conical and rounded at the extremity. Hab. In the Poring hot spring of 45°C, about 600 metres above the sea, southeast slope of Mt. Kinabalu and also growing on the rock face of the sunny place at the Paka cave, 3,200 metres above the sea. Previously reported from Mt. Kinabalu in various places.

Oscillatoria irrigua KÜTZ. in GEITLER, l.c. p. 961, f. 611 a, b, 1932.

Trichome straight, not constricted at the cross wall, 5.6–6 μ in broad, not attenuated to the apex; cell short, about one-third of the broad. Hab. In the Poring hot spring of 55–60°C.

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

Trichome not constricted at the cross wall, 4.5 μ broad. Hab. In the Poring hot spring (45°C)

Phormidium foveolarum GOM. in GEITLER, l.c. p. 999, f. 636 b, 1932.

Trichome tortuose, constricted at the cross wall; cell shorter than the broad, about 2.2 μ in broad. Hab. In the Poring hot spring (35°C).

Phormidium tenue (MENEH.) GOM. in GEITLER, l.c. p. 1004, f. 642d, e, 1932.

Trichome slender, slightly tortuose and slightly constricted at the cross wall, 2.2 μ broad; cell 2–3 times longer than broad. Hab. In the Poring hot spring (60°C).

Lyngbya martensiana MENEH. in GEITLER, l.c. p. 1064, f. 676, 1932.

Trichome 8.8 μ in diameter without sheath, not constricted at the cross wall. Sheath fairly thick but not stratified. Hab. Stagnant water along the railroad at Sungai Pin, Kinabatangan.

Lyngbya sordida (ZANARD) GOM. in GEITLER, l.c. p. 1039, f. 657 b, 1932.

Trichome 16.3 μ in diameter without sheath, and 17.6 μ with sheath, distinctly constricted at the cross wall; cell content homogeneous, possessing no remarkable granules. Sheath not lamellated. The present specimens resemble *L. aestuarii* var. *constricta* GHOSE but differ from it by the narrower breadth of trichome and the different nature of sheath. Hab. Stagnant water along the railroad at Sungai Pin, Kinabatangan.

Microcoleus sociatus W. & G. S. WEST in GEITLER, l.c. p. 1141, f. 746, 1932.

Trichome somewhat tortuose, densely disposed in a sheath, 2.2 μ in diameter; cell long cylindrical, 2–3 times as long as broad, end long conical and rounded at the extremity. Hab. In the Poring hot spring of 45–60°C.

Microcoleus vaginatus (VAUCH) GOM. in GEITLER, l.c. p. 1136, f. 741, 1932.

Trichome 5.7μ in diameter; sheath thick and smooth, yellow-green in colour; cell slightly shorter or quadrate, not constricted at the cross wall. Hab. Paka cave at 3,200 meters above sea level.

Schizothrix tenuis WORONICHIN in GEITLER, l.c. p. 1078, 1932.

Trichome slender, 1.5μ in diameter, not constricted at the cross wall; cell cylindrical, 2–3 times as long as broad. Hab. In the Poring hot spring of 45°C .

Scytonemataceae

Hydrocoryne cf. ***wardii*** WELSH in Revista Biologia 2, p. 257, f. 1, 1961.

Trichome 10μ in diameter, distinctly constricted at the cross wall; cell short, half a time as long as broad, cell content granulate, end cell half-circular. Hab. Tenom Pok, about 1,500 meters above the sea.

Scytonema cf. ***subtile*** MÖBIUS in DESIKACHARY, Cyanophyta p. 495, pl. 88, f. 1, 2, 1959.

Trichome $1.8\text{--}3 \mu$ broad; cell cylindrical, about 5 times longer than broad; heterocyst cylindrical, 3μ broad and 8μ long. Hab. Panal Laban of Kinabalu, about 3,200 meters above the sea.

Stigonemataceae

Stigonema minutum (AG.) HASS. in GEITLER, l.c. p. 513, f. 313–317. 1932; DESIKACHARY, l.c. p. 611, pl. 137, f. 1, 1959.

Sheath thick and yellowish-brown in colour, 25μ in diameter; cell small, 6.5μ in diameter, disposed in a row, but two rows at places even in a younger or an apical part of the filament. Hab. Panal Laban, at about 3,300 meters above the sea and among the *Sphagnum* growing at the wet soil.

Stigonema ocellatum THURET in GEITLER, l.c. p. 504, f. 305–307, 1932.

Sheath broad, $30\text{--}35 \mu$ in breadth, yellowish- but colourless in an apical part of the filament; cell quadrate or globose, disposed in a single row but 2 or 3 at places; hormogone formed at a terminal or at a short branch of the filament. Hab. Gnong Arab, at 800–900 meters above the sea; Panal Laban, at 3,300 meters above the sea; small pond near the summit of Mt. Kinabalu.

D I A T O M E A E

Coccosinodiscaceae

Melosira italica (EHRENB.) KÜTZ. in HUSTEDT, Süsw.-fl. 10, p. 91, f. 50, 1930. Valve 5μ in diameter. Hab. Keningan Hill; Panal Laban.

Melosira Roeseana RABENH. in HUSTEDT, l.c. p. 93, f. 59, 1930.

Valve 27–30 μ in diameter. Hab. Tenom Pok.

Cyclotella glomerata BACHMANN in HUSTEDT, l.c. p. 105, f. 81, 1930.

Valve 5 μ in diameter. Hab. Sepulot.

Cyclotella stelligera CLEVE & GRUN. in HUSTEDT, l.c. p. 100, f. 65, 1930.

Valve 7–10 μ in diameter. Hab. Among *Sphagnum*-polster at the Panal Laban, altitude 3,300 meters above the sea level; Keningan Hill.

Fragilariaceae

Tabellaria fenestrata (LYNGB.) KÜTZ. in HUSTEDT, l.c. p. 122, f. 99, 1930.

Valve 44–59 μ long and 6.7–8 μ broad. Hab. Among mosses at the wet soil of the Panal Laban, altitude 3,300 meters of Kinabalu.

Ceratoneis arcus KÜTZ. var. *recta* CLEVE in A. CLEVE, K. V. Akad. Handl. 4: 1, p. 54, f. 373 h-k, 1953; KOBAYASHI, Journ. Jap. Bot. 40, p. 126, f. 1–5, 1965.

Valve 51 μ long, 6 μ broad and striae 12 in 10 μ . Hab. Gnung Arab.

Fragilaria construens (EHRENB.) GRUN. in HUSTEDT, l.c. p. 140, f. 135, 1930.

Valve 17 μ long, 6 μ broad. Hab. Sungai Pin, Kinabatangan.

var. *venter* (EHRENB.) GRUN. in HUSTEDT, l.c. p. 141, f. 138, 1930.

Valve 12 μ long, 6 μ broad and striae 12–13 in 10 μ . Hab. Poring hot spring.

Synedra vaucheriae KÜTZ. var. *capitellata* GRUN. in HUSTEDT, l.c. p. 161, f. 194, 1930.

Valve 35–40 μ long, 5–6 μ broad. Hab. Sepulot.

Eunotiaceae

Eunotia alpina (NÄG.) HUSTEDT, l.c. p. 185, f. 252, 1930.

Valve slender and arcuate, 68 μ long, 2.8 μ broad, and striae dense and not counted exactly. Hab. Among mosses at the wet soil of Panal Laban.

Eunotia angusta (GRUN.) A. BERG var. *tenuis* A. BERG in A. CLEVE, l.c. p. 82, f. 407 : 1, 1953.

Valve 66 μ long, 4.3 μ broad, and striae 9–10 in 10 μ . Hab. Sungai Pin, Kinabatangan. The present specimens resemble the figure given by A. CLEVE on the specimens of Finish Lapland.

Eunotia damasi HUSTEDT in Explor. Parc. National Albert 8, p. 67, pl. 3, f. 1–12, 1949.

Valve 36–51 μ long, 9.5–10 μ broad, and striae 11–12 in 10 μ . The present specimens coincide well with the description and figures given by HUSTEDT of the African diatom. The specimens also resemble *E. arcus* in outline and the character

of an apical part of the valve, but they coincide rather with the African diatoms collected by DAMAS in the following respects: the ventral margin is strong convex and the breadth of the valve slightly broader than that of the *E. arcus*. Hab. Panal Laban, in the wet soil, 3,300 meters above the sea of Mt. Kinabalu.

Eunotia diodon EHRENB. in A. CLEVE, K. V. A. Handl. 4: 1, p. 128, f. 468a-d, 1953 (as var. *minor* GRUN.).

Valve 42–50 μ long, 17–18 μ broad and striae 12 in 10 μ . Hab. Panal Laban.

Eunotia exigua (BRÉB.) GRUN. in A. CLEVE, l.c. p. 106, f. 439, 1953.

Valve small, 13 μ long, 3 μ broad, and striae fine and delicate and scarcely visible. Hab. Among mosses in the wet soil of the Panal Laban.

Eunotia faba (EHRENB.) GRUN. var. ***nipponica*** SKVORTZOW in Philip. Journ. Sci. 61, p. 21, pl. 14, f. 4, 1936; HIRANO & IWAKI, Bull. Fuji Women's Coll. Ser. II, 8, p. 68, pl. 10, f. 19–22, 1970.

Valve 14–17 μ long, 2–2.5 μ broad, and striae 14–15 in 10 μ . Hab. Gnong Arab. Small stream of the Keningan Hill and Sepulot.

var. ***intermedia*** (KRASSKE) A. CLEVE in l.c. p. 112, f. 449, i-k, 1953.

Valve slightly curved and attenuated toward the apex, 20 μ long, 4 μ broad and striae 20 in 10 μ . The present specimens are somewhat different from the figures given by A. CLEVE of the Swedish specimens. Also the present specimens resemble *E. lunaris* var. *falcata*.

var. ***inflata*** HIRANO, var. nov.

Valvae mediocriter longae, leviter curvatae et leviter tumidae ad medium, gradatim attenuatae ad apicem, apice oblique truncato et rotundo. Valvae 41–42 μ longae, 7.5–8 μ latae et striae 9–10 in 10 μ . Hab. Poring hot spring.

Eunotia fallax A. CLEVE var. ***dispersa*** A. CLEVE, l.c. p. 99, f. 426d, 1953.

Valve slightly curved, dorsal margin slightly convex, ventral margin slightly concave or almost straight, gradually and distinctly attenuated toward the apex, apical part slightly elongate and capitate on the dorsal side, 39.5–42.5 μ long, 4.5–5 μ broad and striae 14–15 in 10 μ . Hab. Paka cave, Panal Laban and Gnong Arab.

Eunotia Grunowii A. BERG var. ***uplandica*** A. CLEVE forma ***subundulata*** A. CLEVE, l.c. p. 97, f. 421p, r, 1953.

Valve 31–41 μ long, 9–9.5 μ broad, and striae 11–12 in 10 μ . Hab. Tenom Pok, 1,500 meters altitude and Panal Laban, 3,300 meters altitude of Kinabalu.

Eunotia lineolata HUSTEDT, Explor. Parc. National Albert 8, p. 73, 1949.—*Desmogonium guyanense* EHRENB. in HUSTEDT, Atlas Diat. pl. 293, f. 13, 1913.

Valve slightly curved and the margin parallel, apical part gradually and distinctly attenuated to the apex which is rounded, margin without a series of marginal denticulations. Valve 59.5–105 μ long, 7–7.5 μ broad, and striae 9–10 in 10 μ . Hab. Gnong Arab.

Eunotia lunaris (EHRENB.) GRUN. in HUSTEDT, l.c. p. 249, 1930.

Valve 33 μ long, 3.5 μ broad, and striae 15 in 10 μ . Hab. Gngong Arab and Poring hot spring.

var. ***capitata*** GRUN. in HUSTEDT, l.c. p. 185, f. 250, 1930; A. CLEVE, l.c. p. 88, f. 421h, 1953.

Valve 35–90 μ long, 3.4 μ broad, and striae 17–18 in 10 μ . Hab. Gngong Arab; Panal Laban, mossy soil at the 3,300 meters above the sea.

Eunotia monodon EHRENB. in A. CLEVE, l.c. p. 118, f. 455 a, b, 1953.

Valve 37.5–78 μ long, 10–11 μ broad, and striae 10–11 in 10 μ . Hab. Gngong Arab.

Eunotia paludosa GRUN. var. ***pumila*** A. CLEVE, l.c. p. 107, f. 441 e,f, 1953.

Valve minute, slightly curved, ends slightly recurved and capitate, 15 μ long, 2 μ broad, and striae fine and delicate. Hab. Gngong Arab.

Eunotia parallela EHRENB. in HUSTEDT, l.c. p. 183, f. 247, 1930; A. CLEVE, l.c. p. 83, f. 408, a-c, 1953.

Valve slightly curved, not attenuated toward the apices, both margins parallel, 63–75 μ long, 5 μ broad, and striae 12 in 10 μ . The present specimens differ from the European forms by the not curved valve. Hab. Sepulot, a small stream.

Eunotia pectinalis (KÜTZ.) RABENH. var. ***curta*** V. H. in A. CLEVE, l.c. p. 84, f. 409d, 1953.

Valve 15 μ long, 4.3 μ broad, and striae 15 in 10 μ . Hab. Gngong Arab.

var. ***minor*** (KÜTZ.) RABENH. in A. CLEVE, l.c. p. 84, f. 409f, 1953.

Valve 20–27 μ long, 3.7 μ broad, and striae 13–14 in 10 μ . Hab. Panal Laban.

Eunotia praerupta EHRENB. var. ***bidens*** (W. SM.) GRUN. in HUSTEDT, Krypt. Fl. 7: 2, p. 281, f. 747Ai, 1932.

Two different forms have been observed: a slender and narrow form (92.5 μ long, 8.8 μ broad and striae 7–8 in 10 μ) and a robust and relatively broader form (34–92 μ long, 10–13.5 μ broad, and striae 9–10 in 10 μ). Both forms with truncate and convex apex and ventral margin slightly concave in the middle of the valve and not excavated. Hab. Tenom Pok; Panal Laban.

var. ***musciola*** PETERS. in HUSTEDT, Krypt. Fl. 7: 2, p. 280, f. 747Ah, 1932.

The ventral margin of valve in our specimens excavated in the middle and the dorsal margin has two elevations. This character differs from that of the form reported by B. PETERSEN of the specimens of Iceland. The specimens however, resemble var. *bidens* figured by HUSTEDT (f. 747Al) with a different nature of ventral margin. Valve 24 μ long, 7.5 μ broad, and striae 15–16 in 10 μ . Hab. Panal Laban.

Eunotia Rabenhorstiana HUSTEDT in Expl. Parc. National Albert 8, p. 72, 1949.—*Desmogonium Rabenhorstianum* GRUN. in SCHMIDT's Atlas Diat. pl. 293, f. 1–3, 1913.

Valve almost straight, lateral margins parallel in main part but attenuated

near the apex, extremity rounded, margin with a series of denticulations, 314–318 μ long, 7–8.5 μ broad and striae 12–13 in 10 μ . Hab. Gnong Arab.

Eunotia robusta RALFS var. *diadema* (EHRENB.) RALFS in HUSTEDT, l.c. p. 171, f. 205, 1930.

Valve 85–101 μ long, 22 μ broad, and striae 9–10 in 10 μ . Hab. Panal Laban, wet soil growing *Sphagnum*.

var. *tetraodon* (EHRENB.) RALFS in HUSTEDT, l.c. p. 171, f. 204, 1930.

Valve with 4 elevations on the dorsal margin, 70 μ long, 20 μ broad. The shorter forms of this variety have a tendency to reduce the number of elevations. Two elevations in the middle of the dorsal margin are of a normal size, while the outer two are reduced and smaller than the middle two. In the specimens of a still shorter form, the outer two elevations are quite destitute so that only the two middle elevations are presented. The size of the valve 17 μ long and 7 μ broad. Hab. Panal Laban and Paka cave, altitude 3,200 meters above the sea of Kinabalu.

Eunotia sudetica O. MÜLL. var. *incisa* (MAYER) A. CLEVE in l.c. p. 111, f. 447 h-k, 1953; H. KOBAYASHI, Jap. Journ. Bot. 20, p. 99, pl. 2, f. 26, 27, 1968.

Valve 44 μ long, 6 μ broad, and striae 8 in 10 μ . Hab. Paka cave, alt. 3,200 meters of Kinabalu.

Eunotia tenella (GRUN.) HUSTEDT in l.c. p. 175, f. 220, 1930; A. CLEVE, l.c. p. 104, f. 435 a, b, 1953.

Valve 18–33 μ long, 3.5–4 μ broad, and striae 12 in 10 μ . Hab. Tenom Pok and Panal Laban.

Eunotia gracilis (EHRENB.) RABENH. in HUSTEDT, Krypt. Fl. 7: 2, p. 305, f. 771, 1932.

Valve 54 μ long, 6 μ broad, and striae 12–13 in 10 μ . Hab. Keningan Hill.

Achnanthaceae

Cocconeis placentula EHRENB. var. *euglypta* (EHRENB.) GRUN. forma *pumila* A. CLEVE in K. V. A. Handl. 4: 5, p. 9, 1953.

Valve 12 μ long, 7 μ broad. Hab. Gnong Arab.

Achnanthes inflata KÜTZ. in HUSTEDT, l.c. p. 209, f. 307, 1930.

Valve 68 μ long, 17 μ broad, and striae 9 in 10 μ . Hab. Poring hot spring.

Achnanthes lanceolata BRÉB. var. *elliptica* CLEVE in HUSTEDT, l.c. p. 208, f. 306c, 1930.

Valve somewhat elliptic-lanceolate, 17 μ long, 9 μ broad and striae 12 in 10 μ . Hab. Sepulot.

Naviculaceae

Frustulia rhomboides (EHRENB.) de TONI var. *saxonica* (RABENH.) de TONI

in HUSTEDT, l.c. p. 221, f. 325, 1930.

Valve 63–70 μ long, 15–16 μ broad. Hab. Paka cave and Sepulot.

Frustulia vulgaris THWAITES in HUSTEDT, l.c. p. 221, f. 327, 1930.

Valve 33–40 μ long, 9–10 μ broad. Hab. Gnong Arab and Sungai Pin, Kinabatangan.

Caloneis silicula (EHRENB.) CLEVE var. ***intermedia*** MAYER in A. CLEVE, l.c. 5: 4, p. 100, f. 1144 i, l, 1955.

Valve 30 μ long, 6.5 μ broad, and striae 15 in 10 μ . Hab. Keningan Hill.

Neidium affine (EHRENB.) CLEVE var. ***amphirhynchus*** (EHRENB.) CLEVE in HUSTEDT, l.c. p. 243, f. 377, 1930.

Valve 70.5 μ long, 16.7 μ broad. Hab. Panal Laban.

Neidium gracile HUSTEDT in Arch. Hydrobiol. Suppl. 15, p. 406, pl. 16, f. 8, 9, 1938.

Valve moderate size, lateral margin with three undulations, end long prostrated and rounded at the extremity, striae obliquely disposed, central area oblong and obliquely disposed against the axial area which is narrow linear. Valve 58–60 μ long, 13.5 μ broad and striae 15 in 10 μ . Hab. Sungai Pin, Kinabatangan.

Neidium productum (W.SM.) CLEVE var. ***triundulatum*** HUSTEDT in A. CLEVE, l.c. 5: 4, p. 118, f. 1171 f, 1955.

Valve 59 μ long, 10 μ broad. The present specimens resemble *N. gracile* but is different from that species in the long capitate apex, the form of central area and the disposition of striation. Hab. Sepulot.

Diploneis elliptica (KÜTZ.) CLEVE in HUSTEDT, l.c. p. 250, f. 395, 1930.

Valve 30 μ long, 12 μ broad. Hab. Sepulot.

Diploneis subovalis CLEVE in HUSTEDT, Krypt. Fl. 7: 2, p. 667, f. 1063 a, b, 1937.

Valve 17–18 μ long, 10 μ broad. Hab. Sepulot and Keningan Hill.

Stauroneis anceps EHRENB. in HUSTEDT, Süßw.-fl. 10, p. 256, f. 405, 1930.

Valve 100 μ long, 17–18 μ broad, and striae 15–17 in 10 μ . Hab. Sungai Pin, Kinabatangan.

var. ***recta*** CLEVE in A. CLEVE, l.c. 4: 5, p. 208, f. 943 d, 1953.

Valve 37.5 μ long, 10 μ broad, and striae fine. Hab. Keningan Hill.

Stauroneis parvula GRUN. var. ***prominula*** GRUN. in A. CLEVE, l.c. 4: 5, p. 215, f. 955 f-i, 1953.

Valve small, linear and both margins parallel, end subcapitate, 25.5 μ long, 7 μ broad and striae very fine. Hab. Poring hot spring.

Stauroneis phoenicenteron EHRENB. var. ***cruminifera*** (MAYER) A. CLEVE, l.c. 4: 5, p. 210, f. 944 h, i, 1953.

Valve $120\ \mu$ long, $18\ \mu$ broad. Hab. Sungai Pin, Kinabatangan.

Stauroneis pygmaea KRIEGER in A. CLEVE, l.c. 4: 5, p. 206, f.938a-c, 1953.

Valve minute, lateral margin almost straight and parallel, end somewhat capitate, $13.5\text{--}15\ \mu$ long, $5\text{--}5.5\ \mu$ broad, and striae very fine and numerous. Hab. Keningan Hill; Poring hot spring.

Anomoeoneis seriens (BRÉB.) CLEVE var. *brachysira* (BRÉB.) HUSTEDT in l.c. p. 264, f. 427, 1930.

Valve $27\ \mu$ long, $7\ \mu$ broad and striae 18 in $10\ \mu$. Hab. Paka cave.

var. *distans* A. CLEVE in l.c. 4: 5, p. 198, f. 918h, 1953.

Valve $117\ \mu$ long, $17.7\ \mu$ broad, and striae 15 in $10\ \mu$. Hab. Sungai Pin, Kinabatangan.

Navicula bacilliformis GRUN. in HUSTEDT, l.c. p. 273, 1930; A. CLEVE, l.c. 4: 5, p. 188, f. 892a, 1953 (as var. *genuinum*).

Valve linear-oblong, slightly tumid in the middle, end broadly rounded and somewhat subcapitate, central area transversely rectangular, $32\text{--}34\ \mu$ long, $8\text{--}8.5\ \mu$ broad, and striae radial and somewhat separated each other in the central part of the valve. Hab. Keningan Hill; Sungai Pin, Kinabatangan.

Navicula cryptocephala KÜTZ. in HUSTEDT, l.c. p. 295, f. 496, 1930.

Valve $8\text{--}35\ \mu$ long, $5\text{--}7\ \mu$ broad. Hab. Sepulot; Sungai Pin, Kinabatangan.

Navicula cuspidata KÜTZ. in HUSTEDT, l.c. p. 268, f. 433, 1930.

Valve $85\ \mu$ long, $41\ \mu$ broad, and striae 12 in $10\ \mu$. Hab. Sungai Pin Kinabatangan.

Navicula dicephala (EHRENB.) W. SM. in HUSTEDT, l.c. p.302, f.526, 1930; A. CLEVE, l.c. 4: 5, p. 142, f. 792 a-c, 1953.

Valve $22\text{--}30\ \mu$ long, $7\text{--}12\ \mu$ broad, and striae $11\text{--}12$ in $10\ \mu$. Hab. Poring hot spring; Keningan Hill; Sungai Pin, Kinabatangan.

Navicula festiva KRASSKE in A. CLEVE, l.c. 4: 5, p. 172, f. 861, 1953.

Valve small, lanceolate, end rounded, $18\text{--}20\ \mu$ long, $6.5\text{--}7\ \mu$ broad, striae radial, about $28\text{--}30$ in $10\ \mu$, confined to the marginal area, axial area lanceolate. Hab. Keningan Hill.

Navicula gregaria DONK. in A. CLEVE, l.c. 4: 5, p. 130, f. 755a-c, 1953.

Valve small, elliptic-lanceolate with long rostrated and capitated ends, $20\ \mu$ long, $6\ \mu$ broad, and striae slightly radial, $13\text{--}14$ in $10\ \mu$, axial area narrow and linear. Hab. Keningan Hill.

Navicula placentula (EHRENB.) GRUN. var. *rostrata* MAYER in A. CLEVE, l.c. 4: 5, p. 146, f. 800e, 1953.

Valve of under medium size, elliptic-lanceolate with rostrate-capitated ends, $36\ \mu$ long, $12.5\ \mu$ broad, and striae $9\text{--}10$ in $10\ \mu$, radially disposed. Hab. Keningan Hill.

Navicula pupula KÜTZ. in A. CLEVE, l.c. 4: 5, p. 186, f. 890 a-c, 1953.

Valve 45 μ long, 9 μ broad and striae 28 in 10 μ . Valve somewhat capitate at the end, lateral margin slightly convex, axial area narrow-linear and abruptly spread at the central nodule to form a fascia which reaches to the margin, central striae very short and confined near the margin and slightly separated to each other. Hab. Sepulot.

Navicula radiosa KÜTZ. var. *tenella* (BRÉB.) V. H. in A. CLEVE, l.c. 4: 5, p. 156, f. 816 m, n, 1953.

Valve 32 μ long, 6 μ broad and striae 17-18 in 10 μ , valve lanceolate with rounded ends, striae radial but convergent at the end. Hab. Sungai Pin, Kinabatangan.

Pinnularia acrosphaeria BRÉB. in HUSTEDT, l.c. p. 330, f. 610, 1930.

Valve of under medium size, linear and slightly tumid in the middle, ends capitate and broadly rounded, axial area broad linear and slightly widened at the centre and irregularly punctated at the face of the axial area, terminal fissures comma-like, valve 100 μ long, 10.5 μ broad, and striae 11-13 in 10 μ . Hab Keningan Hill.

Pinnularia biceps GREGORY var. *minor* (B.PETERS.) A. CLEVE, l.c. 5: 4, p. 63, f. 1088 k-n, 1955.

Valve 41 μ long, 7.3 μ broad and striae 15 in 10 μ . Hab. Sungai Pin, Kinabatangan.

Pinnularia gibba EHRENB. var. *sancta* GRUN. in HUSTEDT, Arch. Hydrobiol. Suppl. 15, p.395, pl.20, f.35, 1938; FOGED, Biol. Skr. Det. Kongel. Dansk. Vidensk. Selsk. 15: 1, p. 100, pl. 17, f. 9, 1966.

Valve linear-lanceolate with somewhat acuminate-rounded ends, axial area broad lanceolate, striae fairly short, especially in the middle, radial in the middle and strong convergent at the end. In some specimens striae interrupted in the middle but in some specimens striae continuing. Valve 90 μ long, 12 μ broad, and striae 9 in 10 μ . Hab. Sungai Pin, Kinabatangan and Panal Laban, in mossy soil.

Pinnularia graciloides HUSTEDT in Arch. Hydrobiol. Suppl. 15, p. 293, pl. 22, f. 9,10, 1938.

Valve linear-lanceolate, lateral margin slightly triundulate, median undulation larger than the other two, all undulations very slight, axial area linear and gradually dilated toward the central area and rapidly dilated near the central area which becomes a broad fascia, striae strong radial in the centre and convergent at the end. Valve 78 μ long, 11.5 μ broad, and striae 12 in 10 μ . Hab. Sepulot.

Pinnularia lanceolata A. CLEVE var. *interrupta* A. CLEVE in l.c. 5: 4, p. 21, f. 1011 c, d, 1955.

Valve lanceolate, gradually attenuated toward the end which is acutely rounded, axial area narrow-linear, slightly dilated near the centre, central part of the valve with a transverse fascia which is dilated to the margin, striae distinctly radial but

strong convergent at the end. Valve 51–71 μ long, 8.5–10 μ broad and striae 10 in 10 μ . Hab. Gngong Arab.

Pinnularia major (KÜTZ.) CLEVE in HUSTEDT, Süsw.-fl. **10**, p. 331, f. 614, 1930.

Valve large, linear with the inflated median part, axial area fairly broad and linear, slightly dilated asymmetric on both side. Valve 200–325 μ long, 27–35 μ broad and striae 9 in 10 μ . The present specimens show a slightly tumid median part of the valve and coincide more with the figure given by A. CLEVE as var. *lacustris* MEISTER than the figure given by HUSTEDT as the typical form. Hab. Sepulot.

Pinnularia microstauron (EHRENB.) CLEVE in A. CLEVE, l.c. **5**: 4, p. 55, f. 1073 a-c, 1955.

Valve linear-lanceolate, 40 μ long, 8.5 μ broad and striae 10 in 10 μ . Hab. Sepulot, a rivulet and Keningan Hill.

Pinnularia Oestrupii A. CLEVE in l.c. **5**: 4, p. 45, f. 1061b, 1955.

Valve small, linear-lanceolate with somewhat rostrated end, lateral margin triundulate, central undulation slightly larger than the others, axial area broad linear, not or very slightly dilated in the middle, with a transverse fascia which is dilated toward the margin. Valve 32 μ long, 7 μ broad and striae 18 in 10 μ , slightly radial but convergent at the end. The present specimens are somewhat different from the European description and figures in the possession of a broad axial area. Hab. Keningan Hill.

Pinnularia stauroptera (RABENH.) CLEVE var. ***longa*** (A.CL.) A. CLEVE, l.c. **5**: 4, p. 67, f. 1091 g, h, 1955.

Valve of under medium size, sublinear with rostrated and capitated ends, gradually attenuated toward the end, lateral margin slightly triundulate, axial area fairly broadly linear and gradually dilated in the central area which is rhomboid and forming a fascia, striae strongly radial in the centre and convergent at the end. Valve 80 μ long, 10 μ broad and striae 12–14 in 10 μ . Hab. Sepulot.

var. ***minuta*** MAYER in A. CLEVE, l.c. **5**: 4, p. 68, f. 1091 o, p, 1955.

Valve small, linear lanceolate with somewhat long rostrated ends, axial area narrow linear at the end, gradually and rapidly dilated toward the centre, central area broad rhomboid, striae radial in the centre and lacking, convergent at the end. Valve 37.5 μ long, 7 μ broad and striae 9–11 in 10 μ . Hab. Sungai Pin, Kinabatangan.

var. ***parva*** GRUN. in A. CLEVE, l.c. **5**: 4, p.68, f.1091 m, 1955.

Valve 68–76 μ long, 10 μ broad, and striae 9 in 10 μ . Valve sublinear with slightly convex sides, ends long rostrated and rounded at the extremity, axial area gradually dilated toward the central area which is rhomboid, fascia reached to the lateral side, terminal fissures semi-circular. Hab. Sungai Pin, Kinabatangan and Panal Laban.

var. ***recta*** (MAYER) A. CLEVE in l.c. **5**: 4, p. 67, f. 1091 x-z, 1955.

Valve linear with rounded ends, margins almost straight and parallel, gradually attenuated near the ends, 82–131 μ long, 12–17 μ broad, and striae 10 in 10 μ , radial in the centre of valve and convergent near the end. The specimens from Keningan hill have a slight inflation in the median part of the valve. Hab. Sepulot and Keningal hill, a small stream; Tenom Pok.

var. *subparallela* MAYER in A. CLEVE, l.c. 5: 4, p. 68, f. 1091n, 1955.

Valve linear, not attenuated to the ends except an apical part, ends suddenly attenuated and somewhat rostrate-capitate, margin almost straight and parallel, central area rhomboid, the other part of axial area fairly broad linear, not beyond the one-fifth of the valve breadth. Valve 64.5 μ long, 10 μ broad and striae 12 in 10 μ . Hab. Keningan Hill.

Pinnularia subcapitata GREGORY in A. CLEVE, l.c. 5: 4, p. 64, f. 1090a, b, 1955.

Valve linear-lanceolate with long rostrated and acuminate ends, axial area narrow-lanceolate, gradually dilated toward the central area which is somewhat elliptic, lateral margin almost straight, striae radial in the centre and convergent at the end, 12 in 10 μ . Valve 45–50 μ long, 9 μ broad. Hab. Paka cave; Panal Laban.

forma *constricta* A. BERG in A. CLEVE, l.c. 5: 4, p. 65, f. 1090f, 1955; FUKUSHIMA & KISHIMOTO, Journ. Yokohama City Univ. C-58, p. 13, pl. 8, f. III, 1968.

Valve 37–40 μ long, 4.7–6 μ broad, and striae 12–13 in 10 μ . Hab. Panal Laban and Gnong Arab.

var. *stauroneiformis* V. H. in A. CLEVE, l.c. 5: 4, p. 64, f. 1090 c-e, 1955.

Valve 40 μ long, 7.5 μ broad and striae 12–13 in 10 μ . Hab. Sepulot.

var. *hilseana* (JAN.) O. MÜLL. in A. CLEVE, l.c. 5: 4, p. 65, f. 1090 n-r, 1955.

Valve 24 μ long, 4.3 μ broad and striae 9–10 in 10 μ . Hab. Poring hot spring.

Pinnularia sudetica HILSE in A. CLEVE, l.c. 5: 4, p. 75, f. 1105a, 1955.

Valve 70–107 μ long, 12–15 μ broad, and striae 12 in 10 μ . Hab. Panal Laban and Gnong Arab.

Pinnularia viridis (NITZSCH) EHRENB. var. *mayeri* A. CLEVE, l.c. 5: 4, p. 74, f. 1103 e-g, 1955.

Valve 75 μ long, 18 μ broad, and striae 9 in 10 μ . Hab. Sepulot and Sungai Pin, Kinabatangan.

Cymbellaceae

Amphora coffaeiformis AG. in HUSTEDT, Süsw.-fl. 10, p. 345, f. 634, 1930.

Valve 30 μ long, 5 μ broad. Hab. Poring hot spring.

Amphora ovalis Kütz. var. *pediculus* Kütz. in HUSTEDT, l.c. p. 343, f. 629, 1930.

Valve 8 μ long, 2.3 μ broad. Hab. Gnong Arab.

Cymbella angustata (W.S.M.) CLEVE var. *inaequilatera* (LAGERST.) A. CLEVE in l.c. 5: 4, p. 135, f. 1191 b-d, 1953.

Valve 32 μ long, 6 μ broad and striae 11 in 10 μ . Hab. Gngong Arab and Panal Laban.

Cymbella bernensis MEISTER var. *minuta* A. CLEVE in l.c. 5: 4, p. 141, f. 1202 c, 1955.

Valve 29 μ long, 5.4 μ broad and striae 12 in 10 μ . Hab. Panal Laban.

Cymbella gracilis (RABENH.) CLEVE in HUSTEDT, l.c. p. 359, f. 663, 1930.

Valve 48.5–50 μ long, 8–9 μ broad and striae 7–8 in 10 μ . Hab. Sepulot and Tenom Pok.

Cymbella similis KRASSKE in A. CLEVE, l.c. 5: 4, p. 135, f. 1191A, 1953.

Valve 15 μ long and 5 μ broad. The present specimens are somewhat different from the figure given by A. CLEVE in the smaller size and the robust ends of valve. Hab. Poring hot spring.

Cymbella turgida (GREGORY) CLEVE in HUSTEDT, l.c. p. 358, f. 660, 1930.

Valve 40–63 μ long, 12 μ broad and striae 10 in ventral side and 8 in dorsal one. Hab. Sungai Pin, Kinabatangan.

Cymbella ventricosa KÜTZ. in HUSTEDT, l.c. p. 359, f. 661, 1930.

Valve 20–41 μ long, 6–11 μ broad and striae 9 in 10 μ . Hab. Keningan hill and Sungai Pin, Kinabatangan.

Gomphonema angustata (KÜTZ.) RABENH. var. *producta* GRUN. in HUSTEDT, l.c. p. 373, f. 693, 1930.

Valve 30–31 μ long, 8 μ broad and striae 9–10 in 10 μ . The present specimens differ from *Gomphonema parvulum* in the coarser arrangement of the striae. Hab. Sepulot.

Gomphonema gracile EHRENB. in A. CLEVE, l.c. 5: 4, p. 185, f. 1281a, b, 1955.

Valve 29–43 μ long, 5.5–8 μ broad and striae 12–15 in 10 μ . Hab. Sungai Pin, Kinabatangan and Gngong Arab.

var. *lanceolatum* (KÜTZ.) CLEVE in A. CLEVE, l.c. 5: 4, p. 186, f. 1281 m-o, 1955.

Valve 39 μ long, 8.5 μ broad and striae 12 in 10 μ . Hab. Sepulot.

var. *major* GRUN. in A. CLEVE, l.c. 5: 4, p. 186, f. 1281d, e, 1955.

Valve 66–100 μ long, 10–11 μ broad and striae 12–13 in 10 μ . Hab. Keningan Hill.

Gomphonema montanum SCHUM. var. *acuminatum* MAYER in A. CLEVE, l.c. 5: 4, p. 183, f. 1276 e-k, 1955.

Valve 48–53 μ long, 10 μ broad, and striae 9–10 in 10 μ . Hab. Keningan Hill.

Gomphonema parvulum (KÜTZ.) V. H. in A. CLEVE, l.c. 5: 4, p. 177, f. 1269a-c, 1955.

Valve 15 μ long, 5 μ broad. Hab. Sungai Pin, Kinabatangan.

var. *exilissimum* GRUN. in A. CLEVE, l.c. 5: 4, p. 178, f. 1269 d-f, 1955.

Valve 25 μ long, 5 μ broad and striae 13–14 in 10 μ . Hab. Sepulot and Keningan Hill.

Gomphonema sphaerophorum EHRENB. in A. CLEVE, l.c. 5: 4, p. 176, f. 1267, 1955.

Valve 47.5 μ long, 8.5 μ broad and striae 12–13 in 10 μ . Valve narrow cuneiform, narrow from the middle toward the both ends, apical end markedly rostrated and constricted, and extremity capitate, posterior end long rostrate, striae radial and middle stria somewhat separated from both adjacent striae and an isolated puncta on one side and a stria on the opposite side distinctly short, all the striae distinctly punctate, axial area narrow-linear and expanded somewhat in the middle. Hab. Sepulot.

Epithemiaceae

Rhopalodia gibberula (EHRENB.) O. MÜLL. var. *producta* (GRUN.) A. CLEVE, l.c. 3: 3, p. 43, f. 1415 d-i, 1952.

Valve 34 μ long, 8.5 μ broad and striae 12 in 10 μ . Hab. Sungai Pin, Kinabatangan; Sepulot; Keningan Hill.

Nitzschiaceae

Hantzschia amphioxys (EHRENB.) GRUN. in A. CLEVE, l.c. 3: 3, p. 47, f. 1419 a-c, 1952. (as var. *genuina* Grun.)

Valve 71 μ long, 8 μ broad and striae 18 in 10 μ . Hab. Sungai Pin, Kinabatangan.

Nitzschia Lorentziana GRUN. var. *subtilis* GRUN. in HUSTEDT, l.c. p. 423, f. 820, 1930.

Valve 80 μ long, 3 μ broad. Hab. Keningan Hill.

Nitzschia palea (KÜTZ.) W.SM. in HUSTEDT, l.c. p. 416, f. 801, 1930.

Valve 22 μ long, 4.3 μ broad. Hab. Poring hot spring and Keningan Hill.

Nitzschia sublinearis HUSTEDT in l.c. p. 411, f. 786, 1930.

Valve 68 μ long, 4.3 μ broad. Hab. Panal Laban.

Surirellaceae

Surirella angustata KÜTZ. in HUSTEDT, l.c. p. 435, f. 844, 845, 1930.

Valve 35.7–41 μ long, 8–12 μ broad. Hab. Panal Laban; Gngong Arab.

var. *constricta* HUSTEDT, l.c. p. 435, 1930.

Valve 57 μ long, 13 μ broad. Hab. Panal Laban.

Surirella Elgeri HUSTEDT in CHOLNOKY, Oesterr. Bot. Ztschr. 104, p. 85, f. 280, 281, 1957.

Valve $54\ \mu$ long, $15\ \mu$ broad. Hab. Sepulot.

Surirella tenuissima HUSTEDT in Arch. Hydrobiol. Suppl. 15, p. 504, pl. 43, f. 8,9, 1938.

Valve $28\text{--}30\ \mu$ long, $7\text{--}7.5\ \mu$ broad. Hab. Sepulot.

CHLOROPHYTA

Gonatozygaceae

Gonatozygon monotaenium DeBARY in W. & G. S. WEST, Monogr. Brit. Desm. 1, p. 30, pl. 1, f. 1-7, 1904.

Cell $185\ \mu$ long, $11.5\ \mu$ broad and apices $12.3\text{--}13\ \mu$ broad. Hab. Sungai Pin, Kinabatangan.

Mesotaeniaceae

Mesotaenium macrococcum (KÜTZ.) ROY & BISSET in W. & G.S. WEST, l.c. 1, p. 51, pl. 3, f. 34-36, 1904.

Cell $35\ \mu$ long, $16.3\ \mu$ broad. Hab. small pond near summit of Mt. Kinabalu and Panal Laban, mossy place.

var. ***micrococcum*** (KÜTZ.) W. & G.S. WEST, l.c. 1, p. 52, pl. 4, f. 1-3, 1904.

Cell $22\text{--}23.5\ \mu$ long, $9\text{--}9.5\ \mu$ broad. Hab. small pond near the summit of Mt. Kinabalu; Paka cave and Panal Laban.

Cylindrocystis Brebissonii MENEGH. var. ***Jenneri*** (RALFS) HANSG. in KRIEGER, Krypt. Fl. 13, Abt. 1, p. 210, pl. 6, f. 12,13, 1933.

Cell $48\text{--}49\ \mu$ long, $13\text{--}13.5\ \mu$ broad. Hab. Tenom Pok; Panal Laban.

Cylindrocystis crassa DeBARY in KRIEGER, l.c. p. 211, pl. 6, f. 16,17, 1933.

Cell $44\ \mu$ long, $25.5\ \mu$ broad. Hab. Panal Laban.

Desmidiaceae

Penium rufescens CLEVE in KRIEGER, l.c. p. 240, pl. 10, f. 13, 14, 1935.

Cell $52\ \mu$ long, $19\ \mu$ broad. Hab. Panal Laban.

Closterium dianae EHRENB. in KRIEGER, l.c. p. 294, pl. 19, f. 9-11, 1935.

Cell $295\ \mu$ long, $26.5\ \mu$ broad, and median part of cell slightly tumid. Hab. Sungai Pin, Kinabatangan.

Closterium Kutzingii BRÉB. in KRIEGER, l.c. p. 351, pl. 32, f. 8, 9, 1935.

Cell $217\ \mu$ long, $20\ \mu$ broad. Hab. Sungai Pin, Kinabatangan.

Closterium Leibleinii KÜTZ. in KRIEGER, l.c. p. 283, pl. 17, f. 5-7, 1935.
Cell 198 μ long, 35 μ broad and slightly tumid in the middle. Hab. Sungai Pin, Kinabatangan.

Closterium navicula (BRÉB.) LÜTKEM. in KRIEGER, l.c. p. 257, pl. 12, f. 8-10, 1935.

Cell 42 μ long, 10.6 μ broad. Hab. Gnong Arab.

Closterium nematodes JOSHUA in KRIEGER, l.c. p. 370, pl. 37, f. 1, 2, 1935.
Cell 242 μ long, 28.5 μ broad. Hab. Sungai Pin, Kinabatangan.

Closterium striolatum EHRENB. in KRIEGER, l.c. p. 337, pl. 28, f. 8, 9, 1935.
Cell 205 μ long, 26.5 μ broad. Hab. Gnong Arab.

Pleurotaenium gloriosum (TURNER) W. & G. S. WEST in KRIEGER, l.c. p. 420, pl. 45, f. 5, 1937.

Cell 634 μ long, 35 μ broad and apex 30.8 μ broad. Hab. Stagnant pool along the railroad of Sungai Pin, Kinabatangan. The present specimens are slightly smaller than those of the SE Asian reports given by TURNER, WEST and KRIEGER.

Pleurotaenium ingens HINODE in Hikobia 4, p. 79, pl. 4, f. 15, 16, 1964.

Cell 1068-1470 μ long, 61.5-69 μ broad and apex 42-44 μ broad. Hab. Sungai Pin, Kinabatangan.

Pleurotaenium Trabecula (EHRENB.) NÄG. in KRIEGER, l.c. p. 395, pl. 40, f. 1-4, 1937.

Cell 607-660 μ long, 31-35 μ broad and apex 20-21 μ broad. Hab. Sungai Pin, Kinabatangan.

Pleurotaenium Wallichianum (TURNER) KRIEGER, l.c. p. 427, 1937.

var. ***undulatum*** HIRANO, var. nov.

Cellulae breviores quam in forma typica, circiter 6-7 plus longiores quam latiores; semicellulae non attenuatae cum inflatione prominenti basali sed leviter dilatatae ad apicem, marginibus lateralibus paullo et multo undulatis, apice truncato, tuberculis ellipticis (circa visibiles 15) ordinatis, 484 μ longae et 70.5 μ latae. Hab. Keningan Hill.

The present specimens resemble *Pl. subcoronulatum* but the breadth of the cell is larger than that of the *Pl. subcoronulatum* and the tubercles of the apex are elliptic and densely disposed.

Cosmarium amoenum BRÉB. in W. & G.S. WEST, l.c. 4, p. 29, pl. 102, f. 1-4, 1911.

Cell 52 μ long, 26.5 μ broad and isthmus 20 μ . Hab. Keningan Hill.

Cosmarium binum NORDST. in W. & G.S. WEST, l.c. 3, p. 246, pl. 88, f. 10-14, 1908.

Semicells pyramidate-trapeziform, apex 6-crenate, lateral margin 8-crenate including a basal angle; cell wall with a large tumour, granulate ridge consists of

about 7–8 and below these ridges there is a distinct horizontal series of granules separated from each ridge. This species somewhat resembles *C. subspeciosum* var. *validius* and *C. miscellum* but differs from the former in the possession of large size and differs from the latter in the different number of lateral crenae (*C. miscellum* about 10, while the present forms about 8). Also I feel some hesitation in referring to the resemblance of these species, considering the different habitats (*C. miscellum* reported from North Europe grows in a cold climate region, while the present form is growing in a warm lowland of tropical region). Hab. Keningan Hill.

Cosmarium blyttii WILLE in W. & G.S. WEST, l.c. 4, p. 225, pl. 86, f. 1–4, 1908.
Cell 15 μ long, 13.6 μ broad and isthmus 4.5 μ broad. Hab. Keningan Hill.

Cosmarium capax JOSHUA var. *minus* (SCHMIDLE) HIRANO in Nature & Life SE Asia 5, p. 44, pl. 8, f. 2, 1967.

Cell 77–81.5 μ long, 39.5–44 μ broad and isthmus 31–42 μ broad. Hab. Sepulot.

Cosmarium crassiusculum (DeBARY) INSAM & KRIEGER, Hedw. 76, p. 98, pl. 1, f. 5, 1936; GRÖNBLAD, Soc. Sci. Fenn. Comm. Biol. 26 : 1, p. 23, pl. 1, f. 12, 1963; GERLOFF, Gatt. Cosm. p. 392, pl. 67, f. 10, 11, 1969.

Cell 160 μ long, 19 μ broad and median constriction very slight. Hab. Panal Laban, a mossy place at the 3,300 meters of Kinabalu.

Cosmarium cruciferum DeBARY in GERLOFF, Gatt. Cosm. p. 393, pl. 67, f. 13–16, 1969.—*Penium cruciferum* (DeBARY) WITTR. in NORDSTEDT, K.Sv.Vet.-Akad. Handl. 22 : 8, p. 71, pl. 7, f. 19, 1888 (as forma); W. & G.S. WEST, Monogr. Brit. Desm. 1, p. 100, pl. 10, f. 18, 19, 1904.

Cell 20 μ long, 10.6 μ broad and isthmus 9.7 μ broad. Hab. Panal Laban, a wet ground growing *Sphagnum*.

Cosmarium cucurbita BRÉB. in W. & G.S. WEST, l.c. 3, p. 106, pl. 73, f. 31–33, 1908.

There is two different forms in the same place: one is a large form (cell 40.5–51 μ long, 20–25.5 μ broad, isthmus 17.6–22 μ broad) and other is a rather smaller form (34.3 μ long, 17.6 μ broad and isthmus 15 μ broad). Hab. Panal Laban, wet ground of altitude 3,300 meters of Kinabalu.

var. ***rotundatum*** KRIEGER in Arch. Hydrobiol. Suppl. 11, p. 174, pl. 8, f. 13, 1932.

Cell 48.5 μ long, 26.5 μ broad and isthmus 22 μ broad. KRIEGER reported this variety as a forma of *C. cucurbita*, but I include the large form than the original dimension and the lateral margins of the present specimens are more convex than that of the original form. Hab. Panal Laban and small pond near the top of the Kinabalu, about 4,000 meters above the sea.

Cosmarium decedens (REINSCH) RACIB. var. ***sinuosum*** (LUND.) RACIB. in W. & G.S. WEST, l.c. 3, p. 44, pl. 69, f. 5, 1908.

Cell 35 μ long, 17.6 μ broad, and isthmus 12.3 μ broad. The present specimens are somewhat smaller than those of the British description, and the apical and basal angles are somewhat produced and the apical angles are not rounded. Therefore the Bornean specimens examined are identified as the present variety, which seems to be an alpine inhabitant. Hab. Panal Laban.

Cosmarium Dybowskii GUTW. in FÖRSTER, Rev. alg. 7, p. 225, pl. 1, f. 29, pl. 2, f. 13,14, 1964.

Semicells semicircular-pyramidate, apex 6-undulate, lateral margin crenate, upper two crenae large and distinct but indistinct in lower crenae. Cell 33–36.5 μ long, 29.5–31 μ broad and isthmus 6.5–7.5 μ broad. Hab. Poring hot spring, at 45°C.

Cosmarium geometricum W. & G.S. WEST var. *suecicum* BORGE in HIRANO, Contr. Biol. Lab. Kyoto Univ. 4, p. 150, pl. 25, f. 10, 1957; RYBNICEK, Prace 32 : 4, p. 139, f. 91, 1960.

The present specimens somewhat resemble the minute forms of *Cosmarium*. PRINTZ reported a form of *C. quadratum* from Norway. His form is not concave with a straight apex, sinus acutely open. The size of the cell is 15–16 μ long, 11–12 μ broad. The present form differs from the Norwegian one in three points. GRÖNBLAD, SCOTT, CROASDALE reported *C. quadratum* var. *applanatum* INSAM & KRIEGER (Act. Bot. Fenn. 66, p.23, pl.4, f.82,83, 1964) but the present form with the retuse apex and the apical and basal angles are not obliquely truncate. From this it is considered that the present form is different from *C. quadratum*. PRINTZ reported *C. geometricum* var. *latum* also in the same paper but his form differs from the present specimens in the following appearances: almost straight apex, the lateral margin not retuse and the length of the cell is shorter than the breadth and the outline of the cell rather resemblances that of *C. quadratum*. The cell size of the present specimens is 11 μ long, 8.8 μ broad and isthmus 3 μ broad. Hab. Panal Laban, among *Sphagnum* at the 3,300 meters above the sea.

Cosmarium globosum BULNH. in W. & G. S. WEST, l.c. 3, p. 29, pl. 68, f. 1, 2, 1908.

Cell 44 μ long, 26.5 μ broad and isthmus 22 μ broad. Hab. Small pool near the top of the Mt. Kinabalu.

Cosmarium margaritatum (LUND.) ROY & BISS. forma *minor* (BOLDT) W. & G. S. WEST, l.c. 4, p. 19, pl. 99, f. 9, 1911.

Cell 46 μ long, 40 μ broad and isthmus 13 μ broad. Hab. Small stream at Sepulot.

Cosmarium minimum W. & G. S. WEST, l.c. 3, p. 66, pl. 71, f. 1, 2, 1908.

Cell 11–12.3 μ long, 9.8–12 μ broad and isthmus 4–6 μ broad. Hab. Paka cave; Panal Laban; small pool near the top of Mt. Kinabalu.

Cosmarium norimbergense REINSCH in W. & G.S. WEST, l.c. 3, p. 52, pl. 69, f. 25–27, 1908.

Cell 15.4 μ long, 12.3 μ broad and isthmus 6.5 μ broad. The present form has a little broader isthmus than that of the European form. Hab. Panal Laban on the wet ground growing *Sphagnum*.

Cosmarium obsoletum (HANTZSCH) REINSCH var. *sitvense* GUTW. in W. & G.S. WEST, l.c. 2, p. 134, 1905; HIRANO, Contr. Biol. Lab. Kyoto Univ. 4, p. 110, pl. 21, f. 5, 1957.

Cell 65 μ long, 67 μ broad and isthmus 40 μ broad. Hab. Sungai Pin, Kinabatangan.

Cosmarium parvulum BRÉB. in W. & G.S. WEST, l.c. 3, p. 110, pl. 74, f. 8–10, 1908.

Cell 26.5 μ long, 13.2 μ broad. Hab. Tenom Pok.

Cosmarium pseudoprotuberans KIRCHN. var. *minus* KOSSINSKAJA in MESSIKOMMER, Beitr. geobot. Landesaufn. Schweiz 24, p. 146, pl. 5, f. 6, 1942.

Cell 10 μ long, 8.8 μ broad and isthmus 7.5 μ broad. The present form resembles *C. obliquum* var. *corribense* MESSIK. figured by RYBNICEK (Prace 32:4, p.140, f.83, 1960) but differs from it in the vertical shape of the cell which is elliptic, and having a shallow and open sinus. The specimens examined do not seem to have a semielliptic form. Hab. Panal Laban, on the wet ground at 3,300 meters above the sea.

var. ***pygmaeum*** GUTW. in MESSIKOMMER, Beitr. geobot. Landesaufn. Schweiz 24, p.147, pl.5, f.7, 1942.

Cell 15.4 μ long, 15 μ broad and isthmus 6.5 μ broad. The present specimens resemble *C. minimum* but the lateral margin slightly divergent and broadest part of the semicell is rather in a upper part. Hab. Paka cave.

Cosmarium pseudopyramidatum LUND. in W. & G.S. WEST, l.c. 2, p. 201, pl. 64, f. 9–12, 1905.

Cell 44–51 μ long, 26.5–30 μ broad and isthmus 11–15 μ broad. The outline of the semicell variable and two semicell of the same individual are quite different from each other. One semicell show the typical form of *C. pseudopyramidatum*, while the other semicell resembles that of *C. holmiense* var. *integrum*. The latter has the lateral margin with a slight constriction or retuseness below the apex. The semicell seems to have a capitate apical part. Also the semicells of some specimens has an appearance of *C. quadratum* forma *Willei* and the lower lateral margin vertical and both sides parallel at least as to the lower half of the lateral margin and then rapidly convergent and narrowed upward. The semicell of the present specimens has the appearance ranging from *C. pseudopyramidatum* to *C. quadratum* f. *Willei*.

Cosmarium Regnesi REINSCH var. ***montanum*** SCHMIDLE in W. & G.S. WEST, l.c. 3, p. 39, pl. 68, f. 29–31, 1908; DICK, Mitt. Pfälz Vereins Naturk. Pollichia n. folg. 3, p. 132, pl. 7, f. 11, 1930.

Cell 11 μ long, 9.5 μ broad and isthmus 4.5 μ broad. Hab. Panal Laban, on the wet ground growing *Sphagnum*.

Cosmarium subauriculatum W. & G.S. WEST in Trans. Linn. Soc. Bot. 5, p. 55, pl. 6, f. 31, 1895; SCHMIDLE, Engl. Bot. Jahrb. 32, p. 68, pl. 1, f. 24, 1902.

Cell 48.5 μ long, 48.5 μ broad and isthmus 27.3 μ broad. Hab. Stagnant water along the railroad at Sungai Pin, Kinabatangan.

Cosmarium subcrenatum HANTZSCH in W. & G.S. WEST, l.c. 3, p. 228, pl. 86, f. 10-14, 1908.

Cell 33 μ long, 26.5 μ broad and isthmus 8.8 μ broad. Cell truncate-pyramidate, lateral margin convex and crenate, lateral crenae six, of which upper three crenae are slightly larger than the lower ones and distinctly emarginate, lower crenae entire and indistinct of its crenation; cell wall with 3 radial series of granules within each crena, outer two series binate and inner one single; semicell with a granulate tumour just above the isthmus, granulate tumour consisting of 5 vertical series of granules, apex truncate and 4-undulate between both apical crenate angles. The present specimens resemble *C. Dybowskii* but the number of the apical undulation of *C. Dybowskii* is 3 and the arrangement of central granulated tumour is different from that of the present specimens. Hab. Keningan hill.

Cosmarium subprotumidum NORDST. var. *gregorii* (ROY & BISS.) W. & G. S. WEST in l.c. 3, p. 232, pl. 86, f. 23-25, 1908.

Cell 22 μ long, 20 μ broad and isthmus 7.5 μ broad. The apex of semicell truncate and 4-undulate, median two shallow and subundulate, both apical angles large that look like a crenation, lateral margin crenate, including an apical angle, upper three crenations distinct and uppermost two large, lower crenations three, indistinct and small, within each crenae two series of marginal granules are radially disposed. Semicell with a cruciate arrangement of 4 granules just above the isthmus. This arrangement of granules does not coincide with the WEST's description. Also the present specimens resemble *C. Boeckii* but differ from it in the smaller size and the different shape of marginal crenae. SKUJA reported a similar form from Burma as *C. incavatum* TURNER but it differs from the present form in the difference of apical undulation (present specimens are fewer in number) and the different arrangement of granules in the central granulate tumour. Hab. Keningan Hill.

Cosmarium tatricum RACIB. var. *novizelandicum* NORDST. in W. & G.S. WEST, l.c. 3, p. 46, pl. 69, f. 11,12, 1908.

Cell 44 μ long, 24.5 μ broad and isthmus 13.2 μ broad. Semicell truncate-pyramidate, lateral margin retuse in the middle, apex retuse, basal and apical angles well rounded, sinus narrowly linear; cell wall distinctly punctate-scrobiculate. The present specimens are slightly smaller than those of the original dimension given by NORDSTEDT. Hab. Panal Laban.

Cosmarium trilobulatum REINSCH var. *Printzii* MESSIKOMMER in Viertelj. naturf. Ges. Zürich 74, p. 156, pl. 1, f. 12, 1929.

Cell 17.6 μ long, 13 μ broad and isthmus 4.5 μ broad. Hab. Keningan Hill.

Euastrum dubium NÄG. in W. & G.S. WEST, l.c. 2, p. 43, pl. 38, f. 5-8, 1905.
Cell 26.5 μ long, 17.6 μ broad and isthmus 6.5 μ broad. Hab. Gnong Arab.

Euastrum insulare (WITTR.) ROY var. *silesiaca* GRÖNBLAD in HIRANO, Contr. Biol. Lab. Kyoto Univ. 7, p. 228, pl. 36, f. 11, 1959.

Cell 23 μ long, 20.7 μ broad and isthmus 8.8 μ broad. Hab. Tenom Pok.

Euastrum laticolle G. S. WEST in KRIEGER, l.c. p. 543, p. 73, f. 22, 23, 1937.

Cell 42-49 μ long, 31-35 μ broad, and isthmus 13-14 μ broad. In the British form the cell has a divergent lateral margin in the lowermost part while in the Bornean form it has two types of lateral margin: one is the same as that of the British form and the other has a broad rounded basal angle and both forms have a minute papilla or an acute granule. Apical angles of the semicell with the same papilla or acute granule as the basal one are found in one specimen and are wanting in the other. I could not ascertain which of the two is the true nature, for the number of the specimens were extremely limited. Hab. Tenom Pok, about 1,500 meters above the sea.

Euastrum spinulosum DELP. in KRIEGER, l.c. p. 633, pl. 93, f. 1-3, 1937.

var. *compactum* HIRANO, var. nov.

Semicellulae semicirculari-pyramidatae, 5-lobatae, incisuris lateralibus profunde angusto-lineari, lobis polaribus late cuneatis cum angulis apicalibus late rotundatis, apice mediocriter retuso in medio, lobis lateralibus superioribus et inferioribus aequalibus et late rotundatis, incisuris inter lobos lateralem superiorem et inferiorem mediocriter profundis et late apertis, granulis 4-6 ad marginem loborum lateralium polarumque et granulis 4-6 in seriebus 2-3 intra marginem, granulis in serie exterius radialiter et in serie interius irregulariter ordinatis, in centro semicellularum tumore granulato, annulo granulorum 11-12 et 4-5 intra annulum in medio situs, granulis leviter magnis. Cellulis 66 μ longis, 59 μ latis, isthmis 15 μ latis. Hab. Keningan Hill.

The present specimens differ from all other varieties of this species in having the broad and well rounded polar and lateral lobes, closed and deep incision between the polar and upper lateral lobules, and a semicircular shape of the upper and lower lateral lobules. Granules rounded and not acutely conical and arranged radially on the face of the cell. The present species resemble var. *bellum* in outline of the cell and the shape of lobes, but differ from that variety in the closed incision between the polar and the upper lateral lobules, smaller size of the cell, and rounded granules.

Euastrum subalpinum MESSIK. var. *quadratum* Skuja, Krypt. Fl. 13, p. 569, pl. 77, f. 38-40, 1937.

Cell 22 μ long, 17.6-18 μ broad and isthmus 4.5 μ broad. Hab. Paka cave.

Micrasterias apiculata (EHRENB.) MENEGH. in W. & G. S. WEST, l.c. 2, p. 97, pl. 47, f. 1, 2, 1905.

Cell 229 μ long, 185 μ broad and isthmus 40 μ broad. Hab. Keningan Hill.

Staurastrum acarides NORDST. var. *dyscritum* SCOTT & GRÖNBLAD in Act. Soc. Sci. Fenn. n.ser. **B**, 2:8, p. 31, pl. 25, f. 4-6, 1957.

Cells hexagonal, moderately constricted, sinus narrowly linear; semicells truncate-pyramidate, lateral margin slightly convex and delicately undulate by the granules, apex truncate, basal angles well rounded, apical angles obtuse; cell wall furnished with the marginal series of granules which are binate and radial, about 3 series of granules are visible; vertical view triangular, sides slightly convex, angles obtuse, granules arranged in the concentric series around the angles, in the centre of apex with the annular series of binate granules. Cell $35\ \mu$ long, $24\ \mu$ broad and isthmus $13\ \mu$ broad. Hab. Gnong Arab.

Staurastrum dilatatum EHRENB. in W. & G.S. WEST, Monogr. Brit. Desm. **4**, p. 172, pl. 126, f. 10-15, 1911.

Cell $22\ \mu$ long, $22.5\ \mu$ broad and isthmus $6.5\ \mu$ broad. Hab. Keningan Hill.

Staurastrum punctulatum BRÉB. in W. & G. S. WEST, l.c. **4**, p. 179, pl. 127, f. 8-11, 13, 14, 1911.

Cell $31\ \mu$ long, $22\ \mu$ broad, and isthmus $8.7\ \mu$ broad. Hab. Gnong Arab.

Staurastrum Zachariasi SCHRÖDER in GRÖNBLAD, Soc. Sci. Fenn. Comm. Biol. **26:1**, p. 31, pl. 5, f. 43, 1963.

var. *minor* HIRANO, var. nov.

Cellulae minores, $13.2\ \mu$ long, $11\ \mu$ lat., et lat. isth. $6.6\ \mu$; semicellulae obverse triangulares, sinu late aperto et obtuso, apice convexo cum spinis brevibus et convergentibus; in vertice visae trigonae, lateribus paene rectis vel levissime retusis in medio, angulis obtuse rotundatis cum spinis brevibus. Hab. small pool near the summit of Mt. Kinabalu, at 4,000 meters above the sea.

Acknowledgements. The author expresses his cordial thanks to Drs. G. IMADATÉ of Tokyo Dental and Medical University and Dr. M. HOTTA of Kyoto University for their kindness giving him the rare opportunity to examine the collections of Bornean algae.

Plate 1

- 1-4. *Eunotia monodon* EHRENB.
5. *Stauroneis anceps* EHRENB.
- 6-8. *Melosira roeseana* RABENH.
- 9, 10. *Eunotia sudetica* O. MÜLL. var. *incisa* (MAYER) A. CLEVE
11. *Eunotia exigua* (BRÉB.) GRUN.
12. *Tabellaria fenestrata* (LYNGB.) KÜTZ.
13. *Eunotia pectinalis* (KÜTZ.) RABENH. var. *curta* V. H.
14. *Cyclotella stelligera* CLEVE
- 15, 16. *Eunotia fallax* A. CL. var. *dispersa* A. CLEVE
- 17, 18. *Synedra vaucheriae* KÜTZ. var. *capitellata* GRUN.
19. *Pinnularia oestrupii* A. CLEVE
- 20-22. *Eunotia fallax* A. CLEVE var. *dispersa* A. CL.
23. *Eunotia parallela* EHRENB.

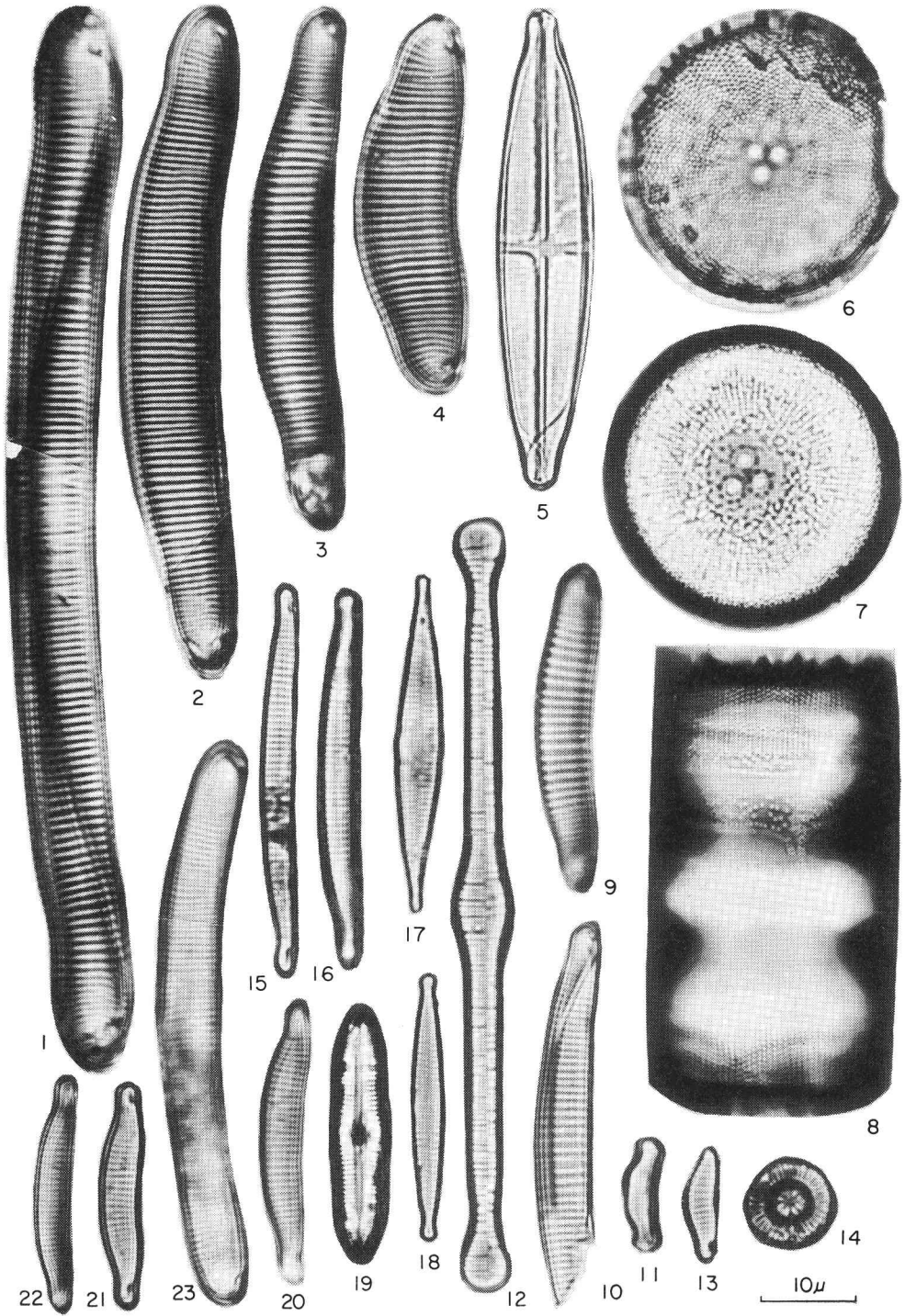


Plate 2

- 1-4. *Eunotia Rabenhorstiana* (GRUN.) HUSTEDT
- 5-7. *E. lineolata* HUSTEDT
- 8, 9. *E. alpina* (NÄG.) HUSTEDT
- 10. *E. lunaris* (EHRENB.) GRUN.
- 11, 12. *E. faba* (EHRENB.) GRUN. var. *nipponica* SKVORTZOW
- 13, 14. *E. faba* var. *intermedia* (KRASSKE) A. CLEVE
- 15. *E. alpina* (NÄG.) HUSTEDT
- 16. *E. damasi* HUSTEDT

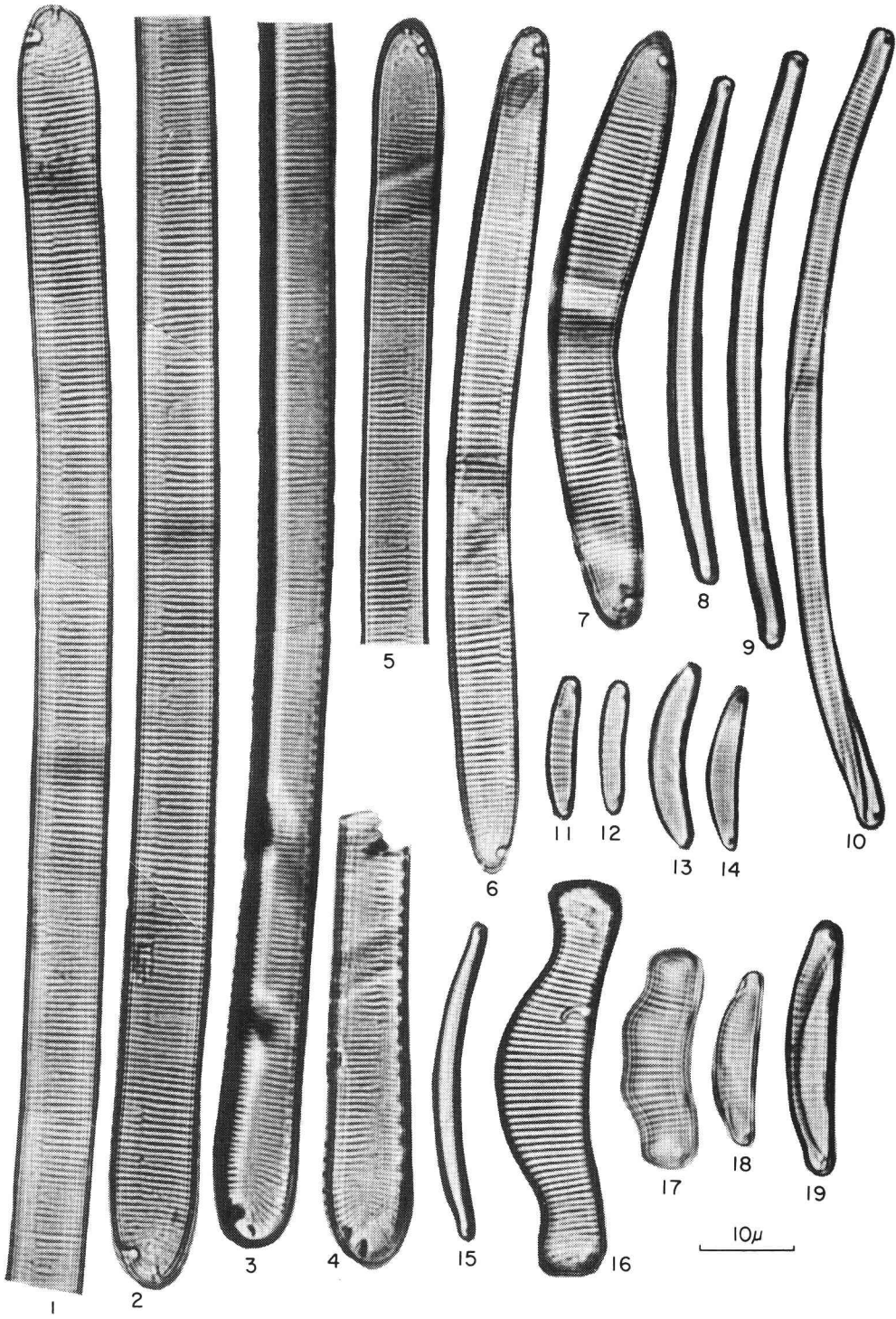


Plate 3

- 1, 2. *Eunotia praerupta* EHRENB. var. *bidens* (W. SM.) GRUN.
- 3-5. *E. robusta* RALFS var. *tetraodon* (EHRENB.) RALFS
- 6, 7. *E. diodon* EHRENB.
8. *Pinnularia subcapitata* GREGORY var. *stauroneiformis* V. H
9. *Navicula cryptocephala* KÜTZ.
10. *Stauroneis pygmaea* KRIEGER.
11. *Nitzschia fonticola* GRUN. var. *capitata* A. CLEVE

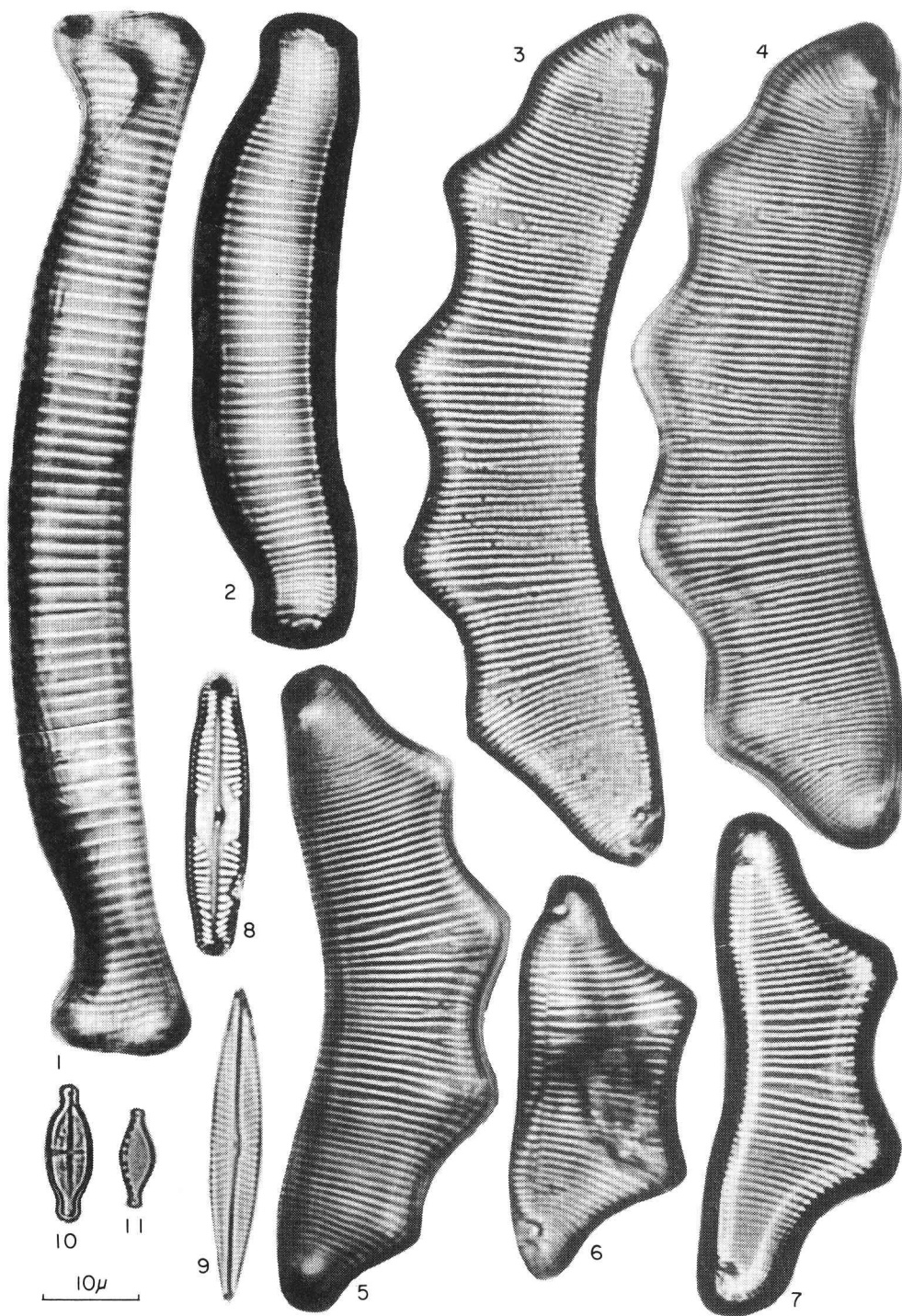


Plate 4

1. *Pinnularia stauoptera* (RABENH.) CLEVE var. *parva* GRUN.
2. *P. stauoptera* var. *longa* (A. CLEVE) A. CLEVE
- 3, 4. *P. stauoptera* var. *subparallela* MAYER
- 5-11. *P. subcapitata* GREGORY
- 12, 13, 15. *P. gibba* EHRENB. var. *sancta* GRUN.
14. *P. acrosphaeria* BRÉB.
16. *P. stauoptera* (RABENH.) CLEVE var. *minuta* MAYER
- 17, 18. *P. subcapitata* GREGORY forma *constricta* A. BERG

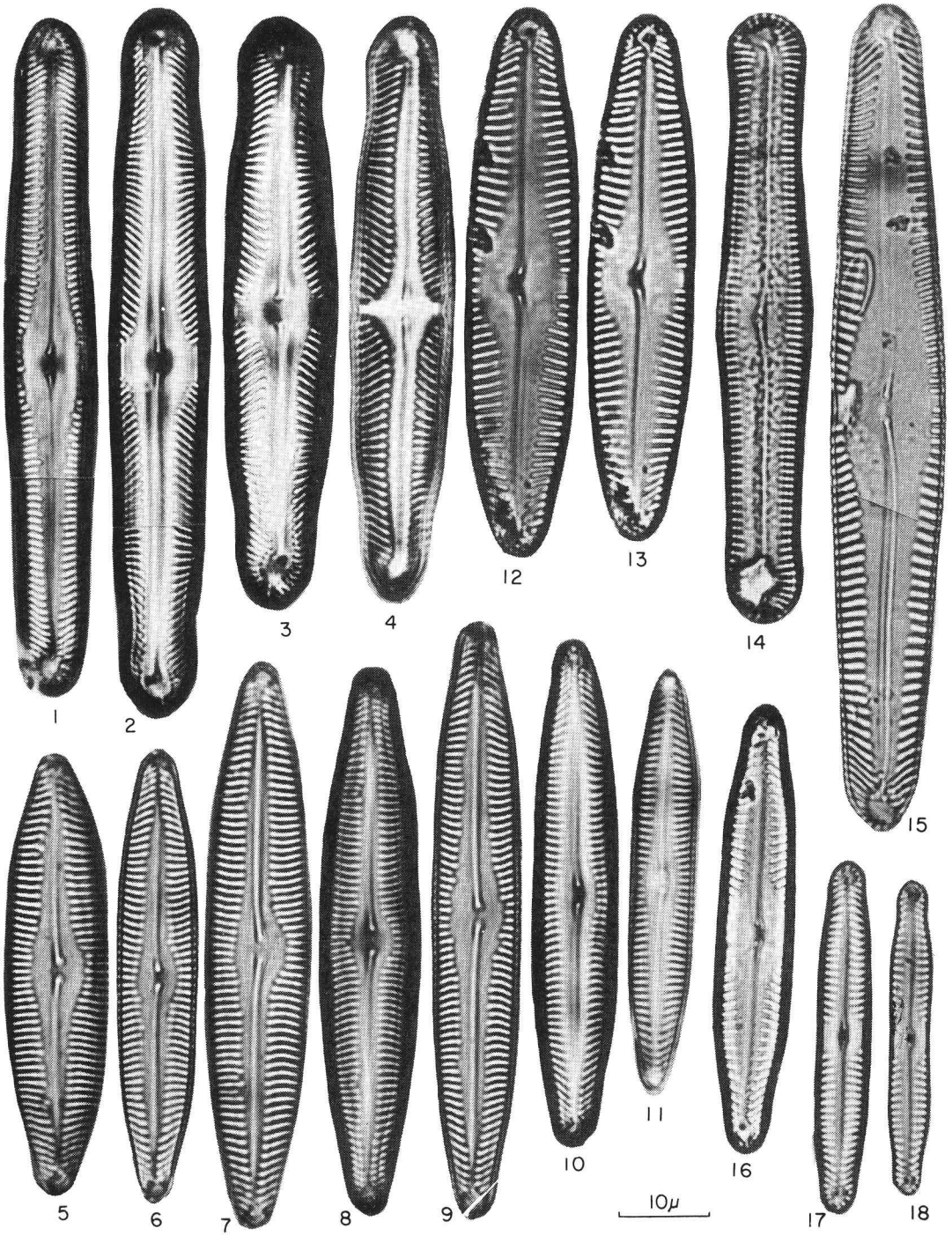


Plate 5

1. *Pinnularia stauroptera* (RABENH.) CL. var. *recta* (MAYER) A. CL.
2. *Neidium productum* (W. SM.) CLEVE var. *triundulatum* HUSTEDT
- 3, 4. *Gomphonema montanum* SCHUM. var. *acuminatum* MAYER
5. *Cymbella gracilis* (RABENH.) CLEVE
6. *C. turgida* (GREGORY) CLEVE
7. *Nitzschia Lorentziana* GRUN. var. *subtilis* GRUN.
8. *Surirella tenuissimum* MAYER
9. *S. angustata* KÜTZ.
10. *S. angustata* var. *constricta* HUSTEDT
11. *S. Elgeri* HUSTEDT
12. *Amphora coffaeiformis* AG.
13. *Navicula placentula* (EHRENB.) GRUN. var. *rostrata* MAYER
14. *N. bacilliformis* GRUN.
15. *N. pupula* KÜTZ.
16. *Stauroneis phoenicenteron* EHRENB. var. *cruminifera* (MAYER) A. CL.
17. *Nitzschia palea* (KÜTZ.) W. SM.
18. *Cymbella ventricosa* KÜTZ.
19. *Diploneis elliptica* (KÜTZ.) CLEVE
20. *D. subovalis* CLEVE
21. *Navicula dicephala* (EHRENB.) W. SM.
22. *Amoeneis seriens* (BRÉB.) CLEVE var. *brachysira* (BRÉB.) HUST.
23. *Gomphonema parvulum* (KÜTZ.) V. H.
24. *Amphora ovalis* KÜTZ. var. *pediculus* KÜTZ.
- 25, 26. *Cymbella angustata* (W. SM.) CL. var. *inaequilatera* (LAGERST.) A. CLEVE

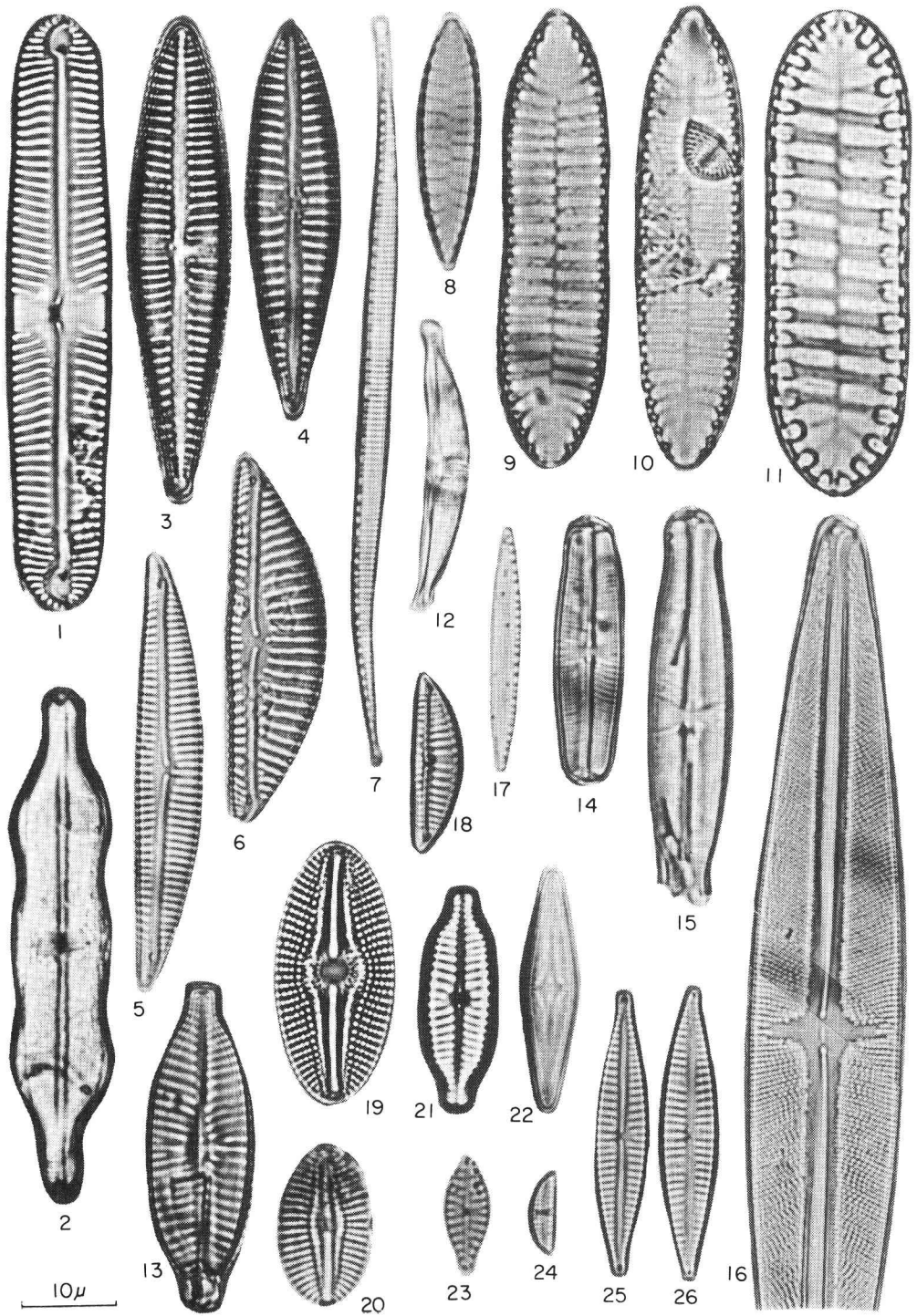


Plate 6

1. *Pinnularia major* (KÜTZ.) CLEVE
- 2-5. *P. sudetica* HILSE
6. *Gomphonema gracile* EHRENB. var. *lancoiatum*
- 7, 8. *G. gracile* forma *major* GRUN.
9. *G. parvulum* (KÜTZ.) V. H.
10. *G. parvulum* var. *exilissimum* GRUN.
- 11, 12. *Navicula dicephala* (EHRENB.) W. SM.
13. *N. festiva* KRASSKE
14. *Caloneis silicula* (EHRENB.) CL. var. *intermedia* MAYER
15. *Navicula gregaria* DONK.

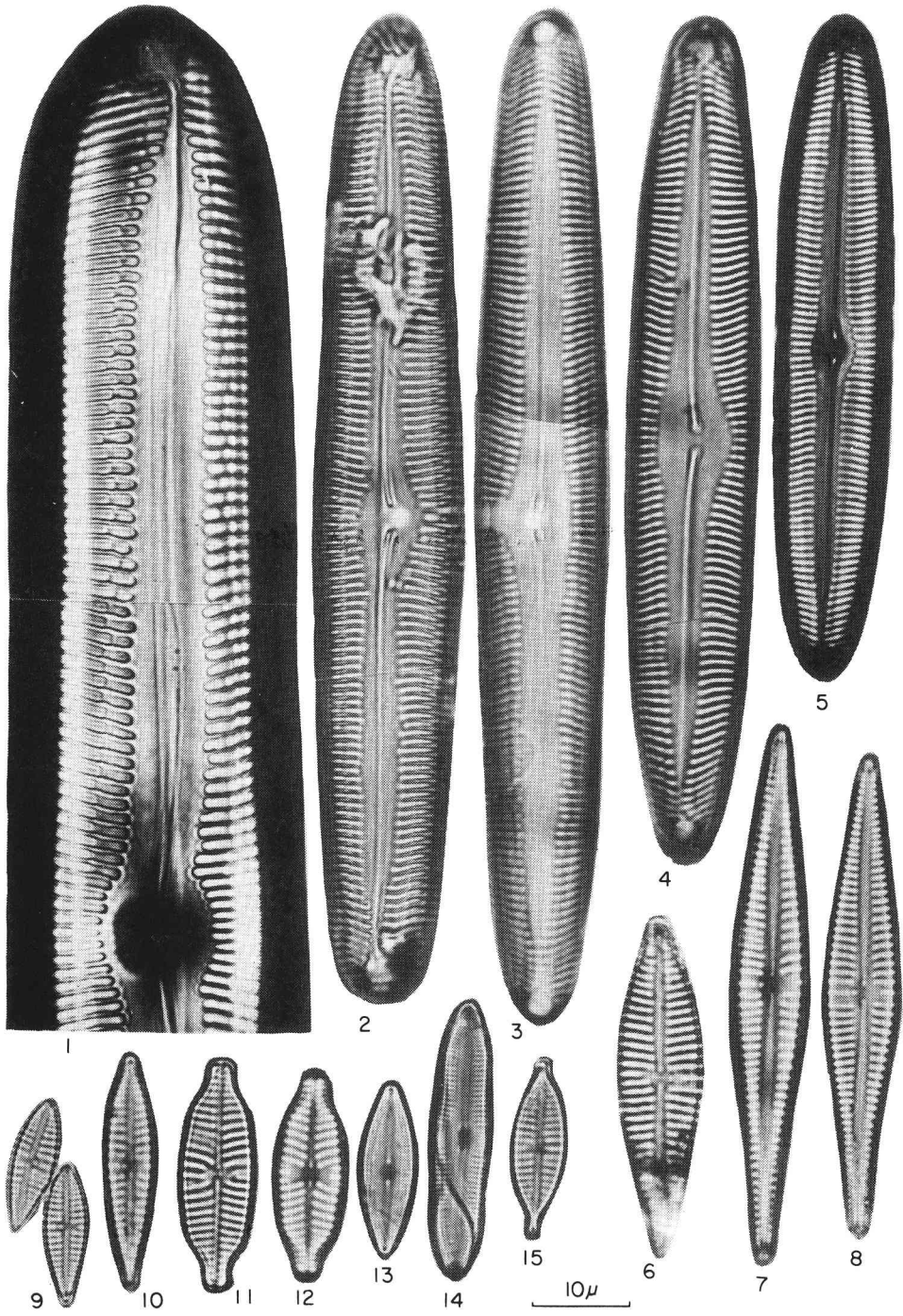


Plate 7

1. *Pleurotaenium Wallichianum* (TURNER) KRIEGER var. *undulatum* HIRANO, var. nov.
2. *Pl. ingens* HINODE
3. *Pl. gloriosum* (TURNER) W. & G. S. WEST
4. *Euastrum subalpinum* MESSIK. var. *quadratum* SKUJA
5. *Cosmarium cruciferum* De BARY
6. *C. geometricum* W. & G. S. WEST var. *suecicum* BORGE
7. *Euastrum insulare* (WITTR.) ROY var. *silesiacum* GRÖNBL.
8. *C. pseudoprotuberans* KIRCHN.
9. *C. taticum* RACIB. var. *novizelandicum* NODRST.
10. *C. capax* JOSHUA var. *minus* (SCHMIDLE) HIRANO
11. *Cylindrocystis Brebissonii* MENEGH. var. *Jenneri* (RALFS) HANSG.
12. *Cosmarium norimbergense* REINSCH
13. *C. parvulum* BRÉB.
14. *C. quadratum* (GAY) De TONI
15. *C. pseudoprotuberans* KIRCHN. var. *pygmaeum* GUTW.
16. *C. decedens* (REINSCH) RACIB. var. *sinuosum* (LUND.) RACIB.
17. *C. cucurbita* BRÉB
18. *C. cucurbita* var. *rotundatum* KRIEGER

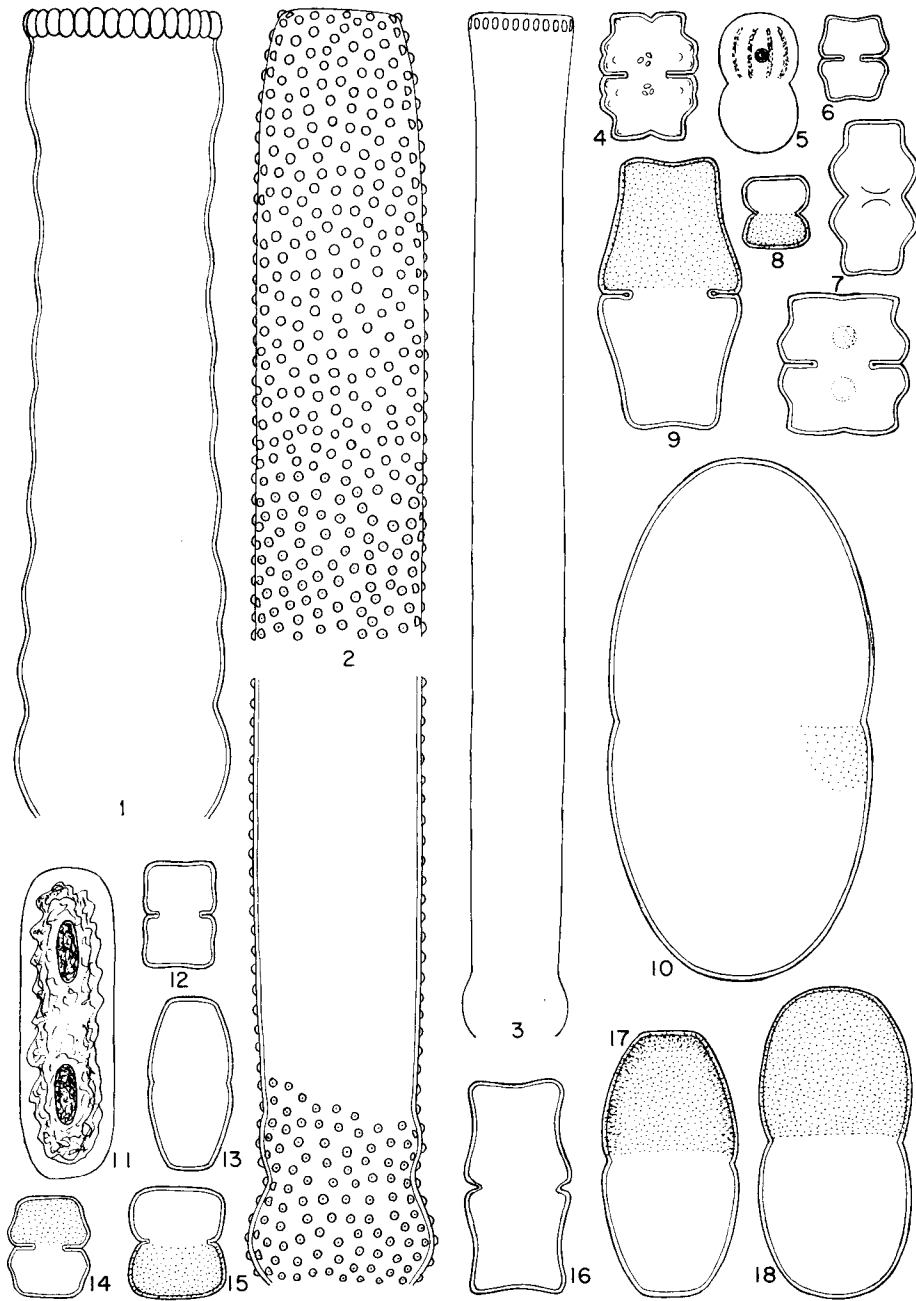


Plate 8

- 1-3. *Cosmarium pseudopyramidatum* LUND.
4. *C. crassiusculum* (De BARY) INSAM & KRIEGER
- 5, 6. *Euastrum laticolle* G. S. WEST
7. *Staurastrum zachariasii* SCHRÖD. var. *minor* HIRANO, var. nov.
8. *Cosmarium pseudopyramidatum* LUND.
9. *Euastrum spinulosum* DELP. var. *compactum* HIRANO, var. nov.
10. *C. Dybowskii* GUTW.
11. *C. subprotumidum* NORDST. var. *gregorii* (ROY & BISS.) W. & G. S. WEST
12. *Staurastrum acarides* NORDST. var. *dyscritum* SCOTT & GRÖNBLAD
13. *C. binum* NORDST.

