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The terrestrial algae of Glerárdalur Akureyri, Iceland

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ABSTRACT: 200 taxa of algae were recovered from cultures of 24 "terrestrial" and "hydro-terrestrial" soil and vegetation samples from Glerárdalur, northern Iceland. 22 of the samples were collected at heights of between 500 and 1300 m. The algae were divided between the classes as follows: Cyanophyceae 49, Cryptophyceae one, Dinophyceae one, Chrysophyceae seven, Xanthophyceae 12, Eustigmatophyceae three, Bacillariophyceae 45, Euglenophyceae one, Chlorophyceae 56 and Zygophyceae 25 taxa. Short descriptions and figures of 184 of these are given. 100 taxa are identified to the species level and a total of 176 to the genus level. Two new varieties are described. It is emphasized that much descriptive work on isolates in unialgal culture must be performed before the terrestrial flora is fully known.

The terrestrial algae of Iceland are incompletely known despite the extensive survey of PETERSEN (1928a and 1928b), in which over 150 wide-ranging terrestrial samples were examined, and the intensive survey of the new volcanic island, Surtsey, reported by SCHWABE (1970), BEHRE and SCHWABE (1970) and SCHWABE and BEHRE (1972), in which a long term study produced much valuable information regarding the colonization of the new substrata. PETERSEN's studies (1928a) were limited by the lack of utilization of culture techniques and only forms readily observable by microscopic examination of preserved samples were noted, although in an appendix a short list of algae subsequently recovered in cultures of 18 soil samples points to the potential of this technique. The details of this work are recorded by PETERSEN (1928b). Terrestrial algae were first reported on Surtsey by MAGUIRE (1968). SCHWABE (1970) summarizes the results of the examination of 212 cultures. BEHRE and SCHWABE (1970) present detailed descriptions of the terrestrial algae of Surtsey from enrichment and agar cultures and probably recovered the majority of algae present at that time. The continuing colonization of the island is described by SCHWABE and BEHRE (1972). BROCK (1973) regarded the blue-green algae as unimportant primary colonizers. Nitrogen fixation by the terres-

trial algae is reported by HENRIKSSON and others (1972) and HENRIKSSON and HENRIKSSON (1974) whilst SCHWABE (1974) describes the species involved and their ecology. CASTENHOLZ (1972) reports on the occurrence of a thermophilic cyanophycean on hot moist ash but such substrata are not dealt with in the present study. RODGERS and HENRIKSSON (1976) describe associations between terrestrial cyanophyceans and moss which could have importance in the colonization of Surtsey. Further information on the terrestrial algae of mainland Iceland is limited. 180 taxa of diatoms from "terrestrial" and "swamp" samples are included by FOGED (1974) in a wide survey of fresh water diatoms. HALLGRÍMSSON (1974) reports on the terrestrial algal genus *Trentepohlia* in Iceland.

The present study was undertaken in order to extend the work summarized above which is particularly sparse for mainland Iceland. The collection of samples and the microscopic examination of enrichment cultures and agar cultures was performed between June and September 1977 whilst the author was based at the Museum of Natural History, Akureyri. The survey was limited in that only algae in soil and amongst vegetation were included, epilithic forms were not sought, and only samples from one region were examined, these mostly being from relatively high altitude. However, it is hoped that by the use of culture techniques a large proportion of the algae in the area studied will have been recovered.

GENERAL FEATURES OF THE AREA STUDIED

Glerárdalur is a wide glacial valley stretching for about 17 km immediately behind and to the south-west of Akureyri in northern Iceland. It lies at about 65° 35′ N, 18° 10′ W and is 100 km south of the Arctic Circle. The valley is enclosed by high mountains except at the north-east where it opens out onto the coastal lowlands bordering Eyjafjörður at a height of *ca.* 150 m. At its head the base of the valley is at an altitude of *ca.* 800 m. The surrounding mountains attain a maximum height of 1538 m whilst most peaks are over 1100 m. The rock chiefly comprises basalts and liparite which decay to form raw mineral soils of *ca.* pH 5-6. Several small glaciers are present on the higher slopes as well as small permanent snow fields (Fig. 1).

At Akureyri the generally oceanic Icelandic climate, with cool summers and relatively warm winters, takes on a comparatively continental character. Table I summarizes data collected for 1966-1975 at Akureyri. Above 600 m, where most of the samples were taken, conditions are more severe with lower temperatures, higher precipitation and longer lying snow cover. Precipitation is low compared with southern Iceland but the high relative humidity prevents rapid evaporation. In summer the generally high moisture content of the ground is also maintained by water from the melting of late-lying snowdrifts. However, the surfaces of freely-drained slopes not under such an influence can become dry during periods without precipitation. Above 600 m there may be extensive snow cover by late September and this usually persists until May or June when rapid melting occurs. Sheltered snow accumulations may remain throughout summer. In the lowland regions in winter thaws often occur up to *ca.*350 m but rarely above this altitude.

TABLE I: Meteorological data collected at Akureyri for 1966-1975[1])

Mean monthly temp. (°C)[2])												Means			
J	F	M	A	M	J	J	A	S	O	N	D	Temp. (°C)	R.H. (%)	Snow cover[3]) (%)	Cloudiness (oktas)
-2.0	-2.4	-1.7	1.6	5.2	8.7	10.0	9.8	6.8	2.5	-0.7	-2.1	3.0	84	39	6.2

[1]) Abstracted from Ársyfirlit samið á Veðurstofunni.
[2]) Calculated from temperature readings every three hours.
[3]) Percentage number of days per year with snow cover at Akureyri.

The vegetation of Iceland is generally of a subarctic type and becomes increasingly arctic at higher elevations (GRÖNTVED, 1942). In Glerárdalur the vegetation becomes clearly arctic above 600 m. The *Betula pubescens* limit for this region of Iceland is *ca.* 450-500 m.

In summer sheep graze throughout Glerárdalur although most tend to remain on the lower slopes and in the base of the valley where the pasture is richest.

SITES EXAMINED FOR ALGAE

A total of 24 samples were removed from Glerárdalur or on the slopes and mountains bordering the valley (see Fig. 1 for the approximate locations). These varied from being raw mineral soils devoid of vegetation to soils and vegetation from areas of complete cover of bryophytes or phanerogams. The moisture content varied from damp to very wet but care was taken to ensure that no samples were removed from truly aquatic habitats. Some of the bryophyte samples in particular were almost water saturated and could be termed "hydro-terrestrial". The samples were removed in mid-June when extensive snow drifts still remained from winter although 1977 was a rather exceptional year in this respect. By late July the large majority of these had melted and the soils and vegetation were generally drier than at the time of sampling.

1. *Rhacomitrium lanuginosum* from the summit immediately north of the mountain Kerling; 1300 m altitude.
2. *Polytrichum* sp. growing sparsely in a bright red mineral soil below the summit; moss and soil sampled; 1290 m.
3. Yellowish raw mineral soil devoid of macroscopic vegetation; 1250 m.
4. Reddish-brown raw mineral soil devoid of macroscopic vegetation, the dominant soil type covering large areas of the slopes; 1210 m.
5. Soil from below a small growth of *Saxifraga oppositifolia*, scattered growths of which occur on more stable areas of the slopes; 900 m.
6. *Rhacomitrium canescens* and *Drepanocladus* sp. below a snow drift and affected by water seepage; 850 m.
7. *Polytrichum* sp. and hepatics below a mixed cover of monocotyledons and di-

cotyledons, damp, with some sheep droppings present; 750 m.

8. *Pohlia wahlenbergii* in a bright green flush where spring water emerges from the hillside; 750 m.
9. *Andreaea rupestris*, small cushion removed from a rock face, probably prone to desiccation; 730 m.
10. *Catoscopium hypnoides* from the relatively dry summit of a hummock of the formation known as "thúfur"; 700 m.
11. Raw mineral soil from a frost sorted polygon devoid of macroscopic vegetation; 1300 m.
12. *Kiaeria* sp. and *Rhacomitrium canescens* from a damp situation between hummocks of "thúfur"; 700 m.
13. *Carex* sp. and *Sphagnum* sp. on wet hummocky ground affected by water seepage; 700 m.

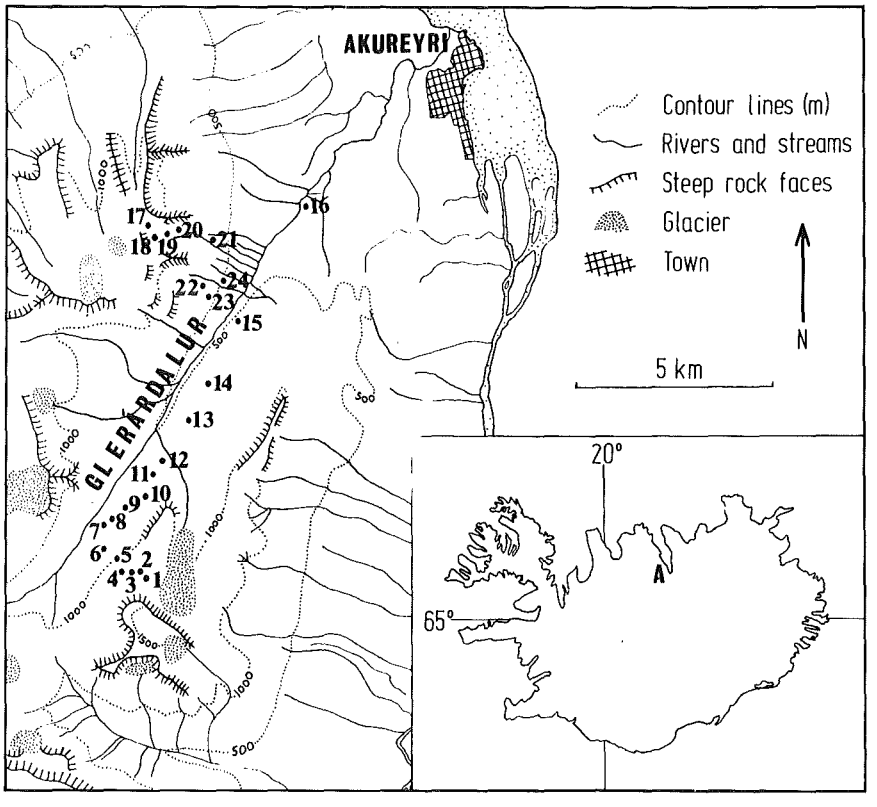


Fig. 1. Map of sampling locations. The inset shows the position of Akureyri (A) in northern Iceland.

14. *Calliergon sarmentosum* from a flat but water-flushed area, reddish iron deposits on the surface; 600 m.
15. *Rhytidiadelphus squarrosus*, soil and other bryophytes in the understorey of grass and dicotyledonous pasture, damp, sheep droppings present; 400m.
16. *Sphagnum teres* and soil from the understorey of a grass and dicotyledonous pasture, damp; 220 m.
17. *Rhacomitrium* sp. from a small cushion on gently sloping ground generally devoid of macroscopic vegetation; 1300 m.
18. Brown, raw mineral soil devoid of macroscopic vegetation; 1300 m.
19. *Drepanocladus* sp. in a moist situation below an extensive snow drift, with *Carex* sp. and other bryophytes; 900 m.
20. Soil from below *Carex* sp. and dicotyledons, slightly damp, sheep droppings present.
21. Peaty eroded soil devoid of vegetation cover but surrounded by dicotyledonous vegetation; 700 m.
22. Soil from below an extensive area of *Empetrum nigrum*, damp; 650 m.
23. *Pohlia wahlenbergii* from a bright green flush where spring water emerges from the hillside; 600 m.
24. Soil from below a dense cover of grasses and dicotyledons, damp; 500 m.

The sites can be grouped according to the nature of the macroscopic vegetation, the water relations and the altitude. This information is presented in Table II. For the purpose of the present study "hydro-terrestrial" sites are those where the soil and

TABLE II: General characteristics of the sites.

Characteristics	Site numbers
Soils devoid of macroscopic vegetation	3, 4, 11, 18, 21
Bryophytes as dominant vegetation	1, 2, 6, 8, 9, 10, 14, 17, 19, 23
Phanerogams dominant with many bryophytes in understorey	7, 12, 13, 15, 16
Phanerogams dominant with few bryophytes in understorey	5, 20, 22, 24
"Hydro-terrestrial"	6, 8, 13, 14, 23
"Terrestrial"	All remaining sites
Altitude 0 - 500 m	15, 16
501 - 1000 m	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 19, 20, 21, 22, 23
1001 - 1500 m	1, 2, 3, 4, 17, 18, 24

vegetation approached water saturation but were not covered by water, they were in areas of groundwater seepage and poor drainage. "Terrestrial" sites are those which did not approach water saturation and were not affected by seepage of groundwater.

METHODS AND MATERIALS

a. Sampling. Normal precautions were taken to avoid contamination of sample material. Vegetation, litter and soil were removed down to the depth below which it was thought no light could penetrate, e.g. the mineral soils were sampled to a depth of *ca.* 1 cm but below phanerogamic vegetation the looser, less dense moss, litter and soil was sampled to a depth of *ca.* 5 cm. A total surface area of *ca.* 100 cm^2 was removed each site.

b. Examination of samples. The methods used largely followed those of BROADY (1977b). First, fresh sample material was microscopically examined. Secondly, two types of culture were set up within 24 hours of sampling, namely moist plate enrichment cultures (LUND, 1945), in which the sample was kept moist using half-strength Bold's modified Bristol's medium (BBM) (CHANTANACHAT and BOLD, 1962), and Petri plate cultures using full strength BBM solidified with 2.5% agar. About one gram of sample material was spread over the latter. Cultures were incubated under constant day-light fluorescent tube illumination at room temperature (*ca.* 20-25°C.). Each moist plate enrichment culture was microscopically examined four or more times over a period of two months. Algal growths appearing as colonies on the agar cultures were removed for microscopic identification and used to innoculate unialgal cultures. Material from fresh samples and moist plate enrichment cultures was treated with concentrated sulphuric acid in order to remove organic material prior to making permanent microscopic preparations for examination of diatoms. The diatoms, however, remain incompletely studied as time was not available for the examination of all samples.

ALGAE RECOVERED

In the following section the algae are first listed according to the general classification of BOURRELLY (1966, 1968, 1970) although the Euchlorophyceae and Ulothricophyceae of BOURRELLY (1966) are combined into the Chlorophyceae as described by ROUND (1973). The algae have been identified as far as available literature and time allowed. Of the 200 taxa recovered from the samples 100 are identified to species or variety, 176 to genus, species or variety, eight are compared with described genera, their exact generic position remains doubtful, and 16 remain unidentified. Eleven of the latter are unicellular free-living members of the Chlorococcales of which cultures have been obtained. It is hoped that these will be identified to a higher level after further examination. It is apparent that much critical work, especially the examination of algae in unialgal cultures, remains to be performed before the terrestrial flora is fully known.

In the descriptive section the algae are listed alphabetically within their orders. Below the name is given the figure reference followed by a list of the sites from which the alga was recovered and finally a reference to the literature from which the identification was made. The Fritsch Collection of algal drawings lodged

at the Freshwater Biological Association, Ambleside, Cumbria, United Kingdom, was also of great help with the identifications. References to other recoveries of the alga from "terrestrial" and "hydro-terrestrial" sites in Iceland are given after each description. In several of the diatom figures not all striae and punctae are illustrated, however, the regions they occupy on the valves are delineated e.g. Fig. 7.12.

CLASSIFICATION OF THE ALGAE OF GLERÁRDALUR

SCHIZOPHYTA

CYANOPHYCEAE

CHROOCOCCALES

Chroococcaceae

Aphanocapsa (2 spp.)
Aphanothece (1 sp.)
Chroococcus (2 spp.)
Cyanothece (2 spp.)
Gloeocapsa (1 sp.)
Gloeothece (1 sp.)
Merismopedia (1 sp.)
Synechococcus (1 sp.)
Synechocystis (1 sp.)

NOSTOCALES

Scytonemataceae

Plectonema (2 spp.)
Tolypothrix (2 spp.)

Rivulariaceae

Calothrix (2 spp.)
Dichothrix (1 sp.)

Microchaetaceae

Microchaete (2 spp.)

Nostocaceae

Anabaena (1 sp.)
Cylindrospermum (1 sp.)
Nodularia (1 sp.)
Nostoc (4 spp.)

Oscillatoriaceae

Isocystis (1 sp.)
Lyngbya (6 spp.)
Microcoleus (2 spp.)
Oscillatoria (6 spp.)
Phormidium (3 spp.)
Porphyrosiphon (1 sp.)

STIGONEMATALES

Stigonemataceae

Hapalosiphon (1 sp.)
Stigonema (1 sp.)

PYRRHOPHYTA

CRYPTOPHYCEAE

CRYPTOMONADALES

Cryptomonadaceae

Cryptomonas (1 sp.)

DINOPHYCEAE

DINOCOCCALES

Gloeodiniaceae

Gloeodinium (1 sp.)

CHROMOPHYTA

CHRYSOPHYCEAE

CHRYSOSACCALES

Chrysosaccaceae

Chrysosaccus (2 spp.)

RHIZOCHRYSIDALES

Rhizochrysidaceae

Rhizochrysis (1 sp.)

CHROMULINALES

Chrysococcaceae

Chrysococcus (1 sp.)

OCHROMONADALES

Ochromonadaceae

Ochromonas (1 sp.)
Unidentified cysts (2 spp.)

XANTHOPYCEAE

MISCHOCOCCALES

Pleurochloridaceae

Botrydiopsis (1 sp.)
Chloridella (1 sp.)
Ellipsoidion (2 spp.)

Chlorobotrydaceae

Gloeobotrys (1 sp.)

Characiopsidaceae

Characiopsis (2 spp.)

TRIBONEMATALES

Tribonemataceae

Heterothrix (2 spp.)
cf. *Heterotrichella* (1 sp.)
Tribonema (2 spp.)

EUSTIGMATOPHYCEAE

Monodus (1 sp.)
Vischeria (1 sp.)
Unidentified genus (1 sp.)

BACILLARIOPHYCEAE

DIATOMALES

Diatomaceae

Diatoma (1 sp.)

EUNOTIALES

Eunotiaceae

Eunotia (4 sp.)

ACHNANTHALES

Achnanthaceae

Achnanthes (2 spp.)

NAVICULALES

Naviculaceae

Cymbella (2 spp.)
Diatomella (1 sp.)
Diploneis (2 spp.)
Frustulia (1 sp.)
Navicula (11 spp.)
Neidium (1 sp.)
Pinnularia (10 spp.)
Stauroneis (3 sp.)

Nitzschiaceae

Hantzschia (1 sp.)
Nitzschia (1 sp.)

Epithemiaceae

Epithemia (1 sp.)

EUGLENOPHYTA

EUGLENOPHYCEAE

EUGLENALES

Euglenaceae

Euglena (1 sp.)

CHLOROPHYTA

CHLOROPHYCEAE

VOLVOCALES

Unidentified family (1 sp.)

Chlamydomonadaceae

Carteria (2 spp.)
Chlamydomonas (4 spp.)
Chloromonas (1 sp.)

TETRASPORALES

Gloeocystaceae

Asterococcus (1 sp.)
Chlamydomonas (2 spp.)

Hypnomonadaceae

Hypnomonas (1 sp.)

CHLOROCOCCALES

Unidentified spherical unicells (11 spp.)

Chlorococcaceae

Characium (1 sp.)
Fernandinella (1 sp.)
Kentrosphaera (1 sp.)
Rhopalocystis (1 sp.)
cf. *Rhopalocystis* (1 sp.)
cf. *Spongiococcum* (1 sp.)

Oocystaceae

Chlorella (2 spp.)
cf. *Jaagiochlorella* (1 sp.)
Muriella (1 sp.)
cf. *Oocystis* (1 sp.)
Planktosphaerella (1 sp.)
Scotiella (1 sp.)

Radiococcaceae

Sphaerocystis (3 spp.)

Dictyosphaeriaceae

Dictyosphaerium (1 sp.)

ULOTHRICALES

Ulothricaceae

Chlorhormidium (3 spp.)
Fottea (1 sp.)
Heterothrichopsis (1 sp.)
Stichococcus (2 sp.)
Unidentified genus (1 sp.)

CHAETOPHORALES

Chlorosarcinaceae

Chlorosarcinopsis (2 spp.)
cf. *Pseudendocloniopsis* (1 sp.)

Chaetophoraceae

cf. *Desmococcus* (1 sp.)
cf. *Gongrosira* (1 sp.)
Microthamnion (2 spp.)

ZYGOPHYCEAE

ZYGNEMATALES

Mesotaeniaceae

Cylindrocystis (1 sp.)
Mesotaenium (2 spp.)
Netrium (1 sp.)

Desmidiaceae

Actinotaenium (1 sp.)
cf. *Actinotaenium* (1 sp.)
Closterium (1 sp.)
Cosmarium (9 spp.)
Euastrum (4 spp.)
Spondylosium (1 sp.)
Staurastrum (1 sp.)
Tetmemorus (1 sp.)

DESCRIPTIONS OF THE ALGAE

CYANOPHYCEAE

CHROOCOCCALES

APHANOCAPSA ELACHISTA West and West
(Fig. 2.1,2; S2, 6, 7, 10, 11, 14-16, 19, 22-24; GEITLER, 1932)

Colonies small, approximately spherical; cells blue-green, 1.8-3 µm diameter, irregularly arranged throughout hyaline mucilage which is usually homogeneous (Fig. 2.1) but may have a faint stratification around each cell (Fig. 2.2).

APHANOCAPSA GREVILLEI (Hass.) Rabenh.
(Fig. 2.3; S6, 12, 16, 19; GEITLER, 1932)

Cells blue-green, 3.5-5 µm diameter, single or in pairs throughout hyaline, homogeneous mucilage.
BEHRE and SCHWABE (1970), SCHWABE and BEHRE (1972).

APHANOTHECE CLATHRATA West and West f.
(Fig. 2.4; S7, 21; GEITLER, 1932)

Cells pale blue-green, ellipsoidal to cylindrical, often slightly curved, 1-3.5 µm long by 0.75 µm wide, irregularly arranged throughout hyaline homogeneous mucilage.
A. clathrata has somewhat longer cells of 3.5-4.5 µm.

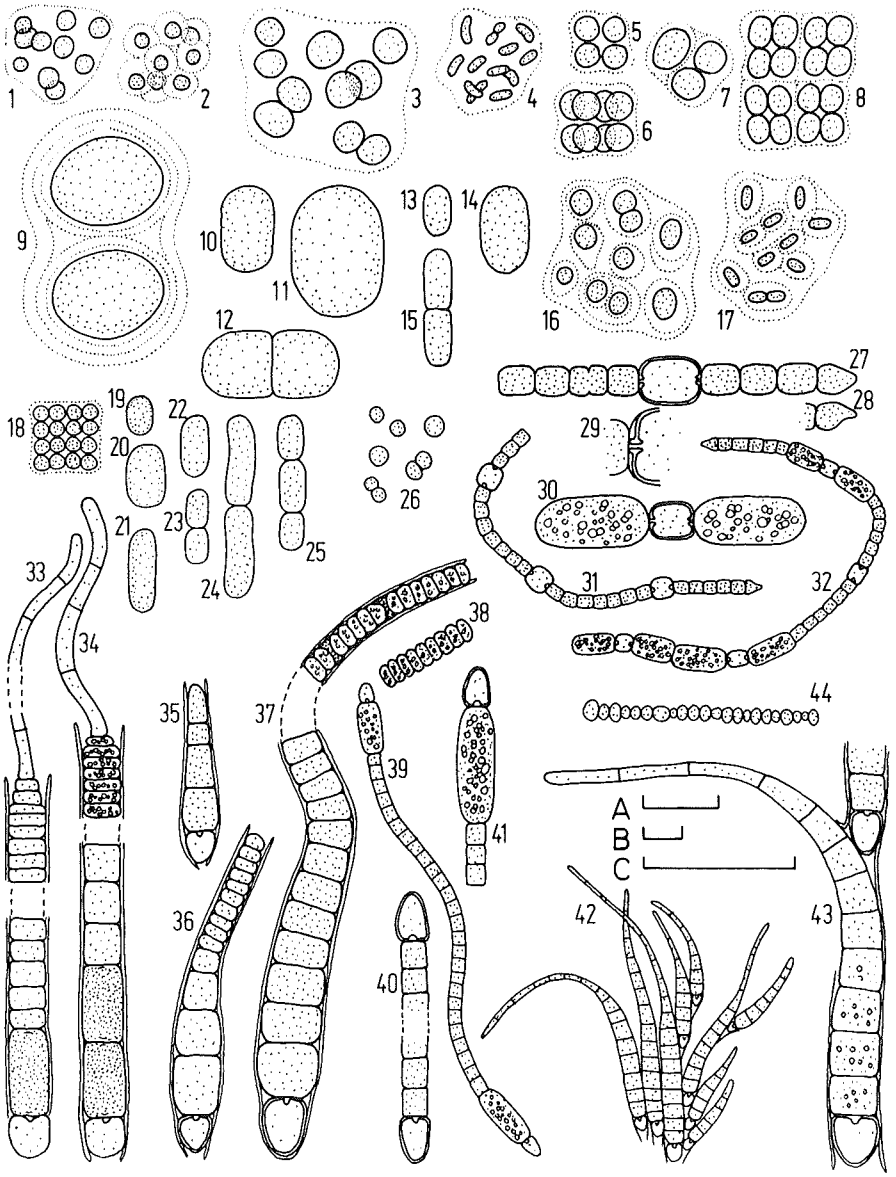
CHROOCOCCUS MINOR (Kuetz.) Naeg.
(Fig. 2.5-8; S3, 11, 13, 14, 16, 17, 21; GEITLER, 1932)

Cells blue-green, spherical to ellipsoidal, 3-5 µm diameter, in colonies of 1-4, rarely more, cells; occasionally remaining in *Merismopedia*-like aggregates (Fig. 2.8).

CHROOCOCCUS TURGIDUS (Kuetz.) Naeg.
(Fig. 2.9; S14; GEITLER, 1932)

Cells pale blue-green, ellipsoidal, 14-16 µm by 11-12.5 µm, in pairs in stratified hyaline mucilage.
PETERSEN (1928a).

Fig. 2. 1,2, *Aphanocapsa elachista*. 3, *A. grevillei*. 4, *Aphanothece clathrata* f. 5-8, *Chroococcus minor*. 9, *C. turgidus*. 10-12, *Cyanothece aeruginosa*. 13-15, *C. cedrorum*. 16, *Gloeocapsa gelatinosa*. 17, *Gloeothece* sp. 1. 18, *Merismopedia tenuissima*. 19-25, *Synechococcus elongatus*. 26, *Synechocystis minuscula*. 27-32, *Anabaena oscillarioides* f. 33, 34, *Calothrix simulans* f. 35-38, *C. elenkinii*. 39-41,



Cylindrospermum muscicola. 42,43, *Dichothrix* cf. *orsiniana*. 44, *Isocystis pallida*. Scales equal 10 µm; A, all figures except: B, 23, 31, 39, 42; C, 29.

CYANOTHECE AERUGINOSA (Naeg.) Kom.
Syn. *Synechococcus aeruginosa* Naeg.
(Fig. 2.10-12; S2, 9, 18, 19; KOMÁREK, 1976)

Cells bright blue-green, broadly ellipsoidal to short cylindrical, 11-34 µm long by 8-30 µm wide.
PETERSEN (1928a and 1928b).

CYANOTHECE CEDRORUM (Sauv.) Kom.
Syn. *Synechococcus cedrorum* Sauv.
(Fig. 2.13-15; S3, 5; KOMÁREK, 1976)

Cells blue-green, broadly ellipsoidal to short cylindrical, 6.5-11 µm long by 3.5-7.5 µm wide.

GLOEOCAPSA GELATINOSA Kuetz.
(Fig. 2.16; S 21; GEITLER, 1932)

Cells blue-green, spherical to ellipsoidal, 2-3.5 µm diameter, single and in pairs throughout hyaline, clearly stratified mucilage.

GLOEOTHECE sp. 1
(Fig. 2.17; S11, 17)

Cells pale blue-green, cylindrical, 2-3 µm long by 1 µm wide, irregularly distributed throughout hyaline, faintly stratified mucilage.

MERISMOPEDIA TENUISSIMA Lemm.
(Fig. 2.18; S3, 13; GEITLER, 1932)

Cells blue-green, spherical, 2 µm diameter, in groups of multiples of four throughout small colonies.

SYNECHOCOCCUS ELONGATUS Naeg.
(Fig. 2.19-25; S11; KOMÁREK, 1976)

Cells blue-green, ellipsoidal to cylindrical, 5-12 µm long by 3-3.5 µm wide, single, in pairs and occasionally in short chains.

SYNECHOCYSTIS MINUSCULA Vor.
(Fig. 2.26; S13; GEITLER, 1932)

Cells pale blue-green, spherical, 1.5-2.5 µm diameter.

NOSTOCALES

ANABAENA OSCILLARIOIDES Bory f.
(Fig. 2.27-32; S2-6, 8, 11, 13, 14, 16, 19, 20; GEITLER, 1932)

Trichomes blue-green, 3.5-6.5 µm wide, with or without a thin sheath, occasionally forming *Microcoleus*-like strands with several trichomes inside a single sheath; cells barrel-shaped, 2.5-6.5 µm

long, terminal cell conical (Fig. 2.27, 28); heterocysts slightly larger than vegetative cells, 6-7.5 µm wide by 8-9.5 µm long (Fig. 2.27, 29, 31); akinetes ellipsoidal to cylindrical, 4.5-7.5 µm wide by 6-17 µm long, usually produced on either side of the heterocysts, singly or in short chains (Fig. 2.30, 32) but occasionally between vegetative cells.

PETERSEN (1928a) records *A. oscillarioides* var. *tenuis* Lemm.

CALOTHRIX SIMULANS Gardner f.
(Fig. 2.33, 34; S8, 14; GEITLER, 1932)

Trichomes blue-green, up to 200 µm long, in a thin, hyaline, close-fitting sheath, width at base 5-7 µm, tapering suddenly at apex to a colourless hair 1.5-2.5 µm wide, slightly constricted at transverse walls except in region of terminal hair; cells usually shorter than wide, except along hair, though occasionally longer at base (Fig. 2.34), 2-5 (-14) µm long; heterocyst single, basal, same width as vegetative cells; akinetes single, or a pair, immediately above heterocyst, same width as cells, 9-14 µm long.

CALOTHRIX ELENKINII Kossink.
(Fig. 2.35-38; S3, 4, 6, 13, 14, 16, 20; COCKE, 1967)

Trichomes blue-green, up to 225 µm long, in a thin, hyaline, close-fitting sheath which reaches to the end of the trichome, width at the somewhat bulbous base 6-10 µm, at apex 3-5 µm, no long terminal hair, slightly constricted at transverse walls; cells usually shorter than wide, except at base where sometimes slightly longer, terminal cells often very short, discoidal and short lengths of these released as motile hormogones (Fig. 2.37, 38), immature trichomes (Fig. 2.35) without these; heterocyst basal, rarely two, narrower than basal vegetative cells.

CYLINDROSPERMUM MUSCICOLA Kuetz.
(Fig. 2.39-41; S9, 11, 13, 14, 19; GEITLER, 1932)

Trichomes blue-green, 2.5-4 µm wide, slightly constricted at transverse walls; cells 2.5-5 (-13) µm long, usually about as long as wide; heterocysts terminal, slightly longer than vegetative cells; akinetes adjacent to heterocyst (Fig. 2.41), ellipsoidal to cylindrical, up to 16 µm long and 5 µm wide but mature akinetes probably not observed.

PETERSEN (1928a).

DICHOTHRIX cf. *ORSINIANA* (Kuetz.) Born. and Fla.
(Fig. 2.42-43; S6; GEITLER, 1932)

Trichomes blue-green at base tapering to short hyaline hairs, in bundles held together by close-fitting, hyaline sheaths, width at base 3.5-6.5 µm, at apex tapering to 1.5 µm, slightly constricted at transverse walls at base; heterocysts basal, sub-spherical. Only a single specimen observed.

D. orsiniana has wider basal cells, 6-7.5 µm wide, and yellow-brown mucilage.

ISOCYSTIS PALLIDA Vor.
(Fig. 2.44; S7, 11, 13, 14, 16, 17; KULLBERG, 1971)

Trichomes pale blue-green, sheathless; cells globular and ellipsoidal, 1-2 µm wide, often of different widths along the same trichome.

LYNGBYA AERUGINEO-COERULEA (Kuetz.) Gom.
(Fig. 3.12-14; S2, 3, 6, 11, 16, 20; GEITLER, 1932)

Trichomes greyish blue-green, 3-6.5 µm wide, not constricted at transverse walls, usually with a thin hyaline sheath around single trichomes but growths removed from a drying moist plate enrichment culture had thickened stratified sheaths containing from one to three parallel trichomes (Fig. 3.14); cells 3-9.5 µm long, with or without granules along transverse walls, terminal cell with calyptra in mature trichomes.

The growth form in which up to three trichomes are enclosed in a single sheath resembles *Schizothrix*, however, because the dominant growth form was of single trichomes in individual sheaths this alga has been assigned to *Lyngbya*.

LYNGBYA sp. 4
(Fig. 3.6, 7; S2, 11, 21)

Trichomes blue-green, 4-5 µm wide, slightly attenuated terminally, in a thin hyaline sheath which encloses the terminal cell; cells shorter than wide, 1-2.5 µm long, granular; separation discs formed (Fig. 3.7).

LYNGBYA sp. 6
(Fig. 3.8; S2-4, 7, 9, 11, 16-18, 20, 21)

Trichomes pale blue-green, 0.5-0.8 µm wide in a very thin sheath, transverse walls faint; cells 3-5 µm long.

LYNGBYA sp. 7
(Fig. 3.9; S2-4, 18)

Trichomes pale blue-green, 6-8 µm wide, in a thin hyaline sheath, faintly constricted at transverse walls, readily fragmenting into short lengths up to 50 µm long by the production of bi-concave separation discs.

LYNGBYA sp. 8
(Fig. 3.10; S7, 14, 16)

Trichomes blue-green, 8-11 µm wide, in readily visible hyaline sheath *ca.* 1 µm wide; cells 5-18 µm long with granular contents

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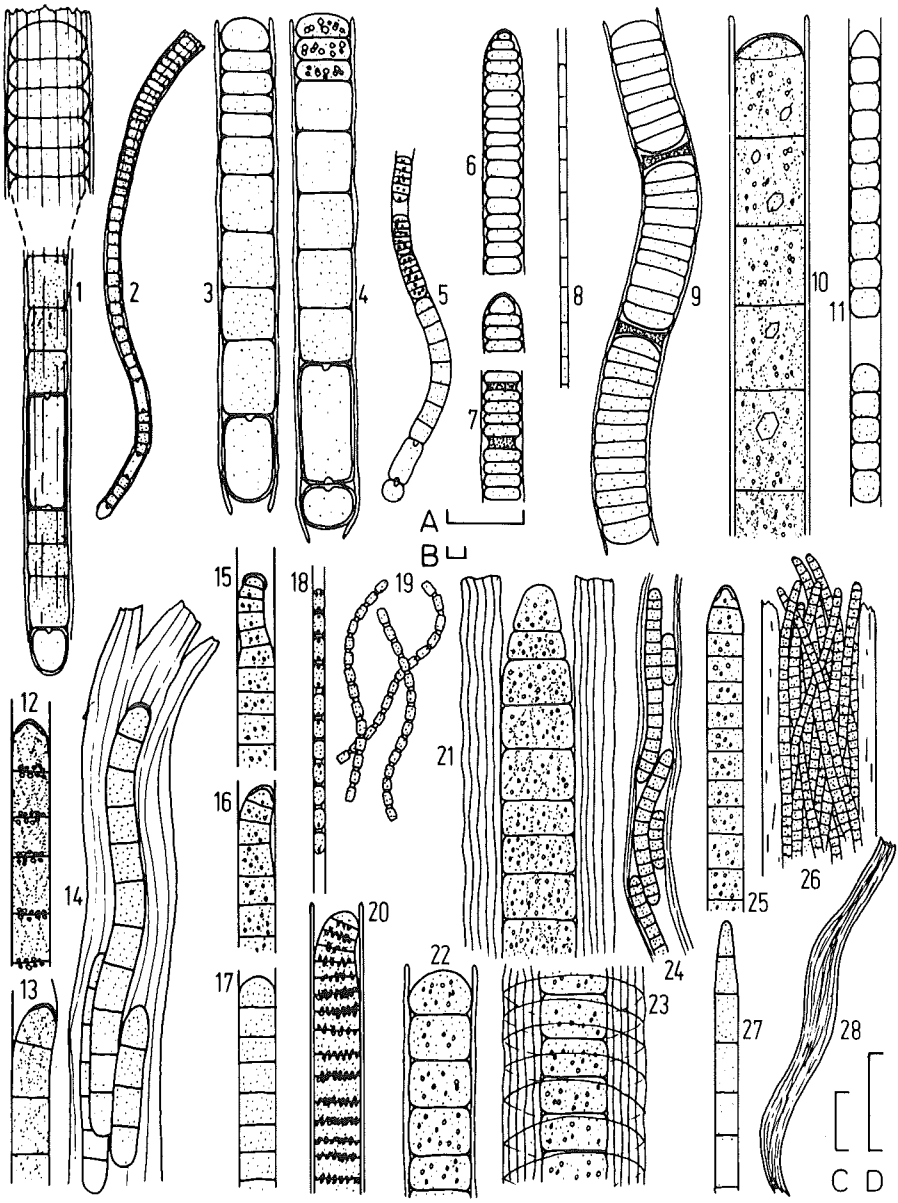
Fig. 3. 1,2, *Microchaete striatula*. 3-5, *M.* cf. *investiens*. 6,7, *Lyngbya* sp. 4. 8, *L.* sp. 6. 9, *L.* sp. 7. 10, *L.* sp. 8. 11, *L.* sp. 9. 12-14, *L. aerugineo-coerulea*. 15-17, *Phormidium autumnale*. 18, 19, *P. frigidum*. 20, *P. uncinatum*. 21-24, *Porphyrosiphon notarisii*. 25,



26, *Microcoleus vaginatus*. 27, 28, *M. chthonoplastes*. Scales A, B and C equal 10 µm, D equals 0.5 mm; A, all figures except: B, 2, 5, 24; C, 26; D, 28.

and readily visible polyhedral bodies; terminal cell rounded and sometimes with calyptra; separation discs formed.

LYNGBYA sp. 9
(Fig. 3.11; S6, 11, 18, 21)

Trichomes blue-green, 3.5-4 µm wide, constricted at transverse walls, in a thin hyaline sheath; cells 3-6 µm long; terminal cell conical.

MICROCHAETE cf. *INVESTIENS* Fremy
(Fig. 3.3-5; S16; GEITLER, 1932)

Trichomes blue-green, up to 180 µm long, in a hyaline sheath up to 3 µm thick; cells 6-8 µm wide, at base longer than wide, up to 13 µm long, at apex shorter than wide and often granular; motile hormogones released (Fig. 3.5); heterocyst basal, usually sub-spherical, a second adjacent, cylindrical heterocyst sometimes present (Fig. 3.4).

M. investiens forms large akinetes which were not observed in the present specimens.

MICROCHAETE STRIATULA Hy.
Syn. *Leptobasis striatula* (Hy.) Elenk.
(Fig. 3.1,2; S 13, 14, 16; GEITLER, 1932)

Trichomes blue-green, width at base 3-3.5 µm, at apex 8-11 µm, constricted at transverse walls at apex but only occasionally at base, in an obvious hyaline sheath down which parallel striations are often visible, especially at apex; cells 3-16 µm long, longer at base than at apex; terminal, subspherical, heterocyst always present, also occasionally intercalary cylindrical heterocysts; motile hormogones released. Immature filaments in which the difference in width between apex and base has not developed often resemble *M.* cf. *investiens*.

MICROCOLEUS CHTHONOPLASTES Thur.
(Fig. 3.27, 28; S11, 21; GEITLER, 1932)

Plant mass consisting of unbranched bundles of trichomes numbering three to over 40 enclosed within a common thick, hyaline sheath, total width up to 70 µm and length up to 6 mm (Fig. 3.28); individual trichomes (Fig. 3.27) blue-green, 2-3.5 µm wide, slightly attenuated at apices, slightly constricted at transverse walls; cells 4.5-9.5 µm long, slightly granular.

MICROCOLEUS VAGINATUS (Vauch.) Gom.
(Fig. 3.25, 26, S21; GEITLER, 1932)

Plant mass similar to *M. chthonoplastes* (Fig. 3.28); individual trichomes (Fig. 3.25) blue-green, 4-5 µm wide, not constricted at transverse walls, slightly attenuated; cells 3-6 µm long with granular contents; terminal cell with calyptra.

NODULARIA HARVEYANA Thur.
(Fig. 4.21, 22; S3; GEITLER, 1932)

Trichomes blue-green, 4-4.5 µm wide, constricted at transverse walls, occasionally attenuated at apex (Fig. 4.22), in a thin hyaline sheath; cells shorter than wide, 1.5-3 µm long, granular; terminal cell usually bluntly rounded; heterocysts at regular intervals along trichomes, as wide or slightly wider than cells, generally slightly longer than cells, 3-4.5 (-6) µm long.
SCHWABE (1974).

NOSTOC sp. 2
(S2-7, 10, 11, 16, 19, 20)

NOSTOC sp. 3
(S7, 8, 13, 16, 23)

NOSTOC sp. 4
(S2, 11, 13, 14, 16, 21, 23)

NOSTOC sp. 5
(S3, 14, 19)

NOSTOC spp.
(S9, 15, 17)

Four morphologically different isolates of *Nostoc* were obtained in culture. It is hoped to provide descriptions of these at a later date after further study.
PETERSEN (1928), SCHWABE (1974) report *Nostoc* spp.

OSCILLATORIA AMOENA Gom.
(Fig. 4.7-9; S15; GEITLER, 1932)

Trichomes grey blue-green, 4.5-6.5 µm wide, mature trichomes attenuated and hooked at apex (Fig. 4.7, 8), immature trichomes bluntly rounded (Fig. 4.9); cells 2-5 (-8) µm long often with granules along transverse walls; terminal cell with a calyptra.

OSCILLATORIA CURVICEPS Ag.
(Fig. 4.6; S11, 21; GEITLER, 1932)

Trichomes blue-green, 6 µm wide, terminally hooked; cells 1-2.5 µm long, granular.

OSCILLATORIA SPLENDIDA Grev.
(Fig. 4.5; S2, 3, 11, 16, 18, 21; GEITLER, 1932)

Trichomes blue-green, 1.5-2.5 µm wide, greatly attenuated at tip with the apex often slightly swollen, terminally hooked; cells (1.5)-3-6 µm long often with a few granules along transverse walls.
PETERSEN (1928b).

OSCILLATORIA SUBTILISSIMA Kuetz.
(Fig. 4.3,4; S11, 14, 16, 19, 21; GEITLER, 1932)

Trichomes blue-green, 3-5 µm wide, slightly attenuated and hooked at apex; cells 1.5-3.5 µm long, slightly granular with some granules arranged along transverse walls.

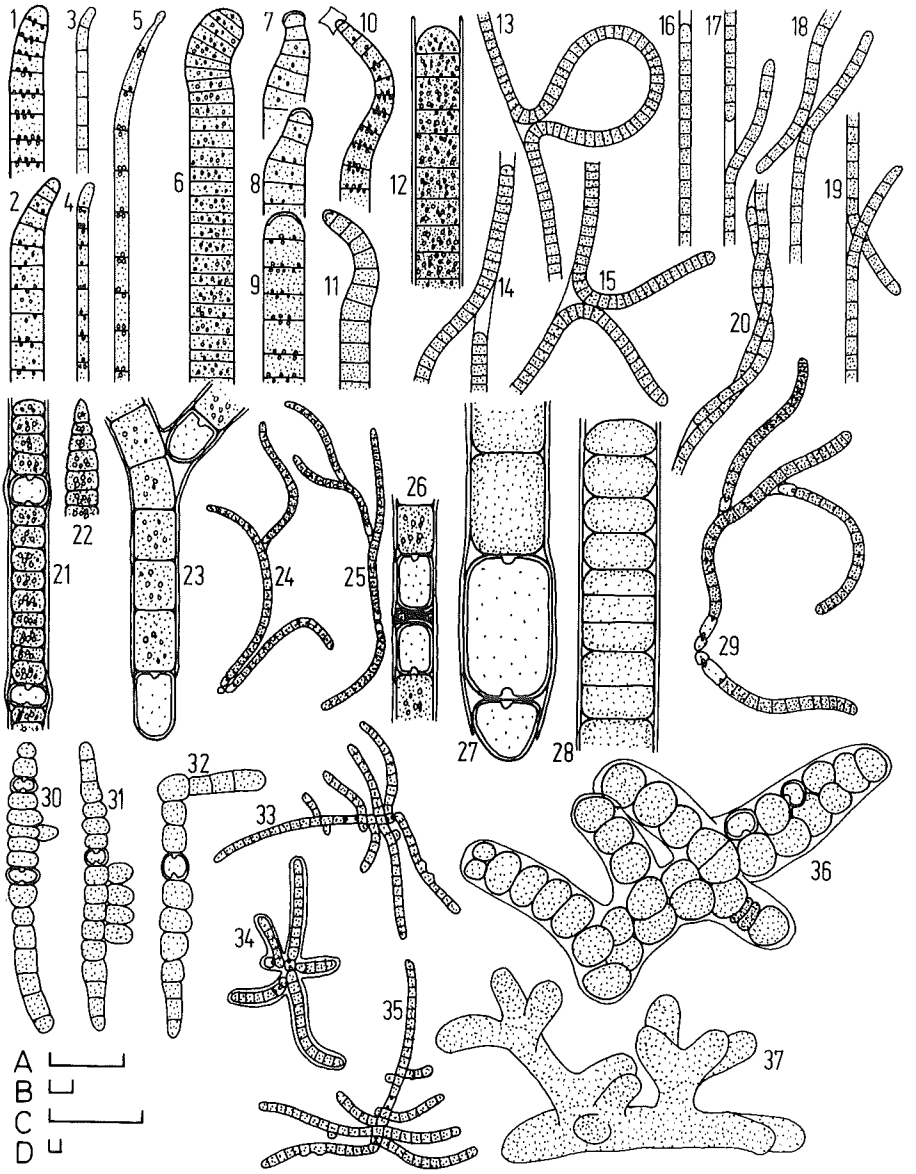


Fig. 4. 1,2 *Oscillatoria* sp. 1. 3,4, *O. subtilissima*. 5, *O. splendida*. 6, *O. curviceps*. 7-9, *O. amoena*. 10, 11, *O.* sp. 6. 12-15, *Plectonema phormidioides*. 16-20, *P.* cf. *notatum*. 21, 22, *Nodularia har-*

OSCILLATORIA sp. 1.
(Fig. 4.1, 2; S2-6, 8, 11, 15, 16, 19, 21)

Trichomes blue-green, 3-5 µm wide, attenuated slightly and hooked at apex; cells 1.5-3.5 µm long, slightly granular with some granules arranged along transverse walls.

OSCILLATORIA sp. 6.
(Fig. 4.10, 11; S4, 18)

Trichomes blue-green, 3.5-5 µm wide, attenuated and often markedly hooked at apex; cells 1.5-5 µm long, often with granules along transverse walls; terminal cell often attached to the empty remains of a single cell (Fig. 4.10) probably the results of the fragmentation of a longer trichome at the position of a dead cell, other terminal cells with a calyptra.

PHORMIDIUM AUTUMNALE (Ag.) Gom.
(Fig. 3.15-17; S2, 4, 6, 11, 15, 17, 19-21, 24; GEITLER, 1932)

Trichomes blue-green, 3.5-5 µm wide, often with slight terminal hook (Fig. 3.15, 16) though this is lacking in immature trichomes (Fig. 3.17), enclosed in a thin hyaline sheath; cells 2-5 µm long, often granular; terminal cell with calyptra in mature trichomes.
PETERSEN (1928a and 1928b), SCHWABE (1970), BEHRE and SCHWABE (1970).

PHORMIDIUM FRIGIDUM Fritsch
(Fig. 3.18, 19; S3-5, 7, 8, 11, 13, 14, 16-21; GEITLER, 1932)

Trichomes blue-green, 1-2 µm wide, generally short and readily fragmented, either in a thin hyaline sheath (Fig. 3.18) or in entangled masses embedded in mucilage in which individual sheaths not visible (Fig. 3.19), also occurring as free motile trichomes lacking sheath; cells 1.5-3 µm long, apparently joined by short gelatinous pads, often with a single granule at both apices; terminal cell broadly rounded and often with a pair of apical granules.

The trichomes which lack a sheath closely resemble *Pseudanabaena catenata* Lauterb. SCHWABE (1970) records the presence of *Pseudanabaena* cf. *catenata* on Surtsey and BEHRE and SCHWABE (1970) describe what appears to be a similar alga to the present specimens as a life-form of *Schizothrix lardacea* (Ces.) Gom. In the present specimens the *Schizothrix*-like, *Microcoleus*-like and *Plectonema*-like stages described by those authors were not recorded. However, it is possible that the former is also a life-form of *S. lardacea*.

PHORMIDIUM UNCINATUM Gom.
(Fig. 3.20; S20; GEITLER, 1932)

Trichomes blue-green, 5-7 µm wide, slightly attenuated towards apex,

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veyana. 23-26, *Tolypothrix tenuis* f. *terrestris*. 27-29, *T. lanata*. 30-35, *Hapalosiphon hibernicum*. 36, 37, *Stigonema* sp. 1. Scales equal 10 µm; A, all figures except: B, 13-15, 33-35; C, 24, 25, 29; D, 30-32, 36, 37.

often slightly terminally hooked, in a readily visible hyalin sheath although sheathless hormogones are released; cells 2-3.5 µm long, often very granular with granules along transverse walls, apical cell often without granulation.

PLECTONEMA PHROMIDIOIDES Hansg.
(Fig. 4.12-15; S9, 10, 16; GEITLER, 1932)

Trichomes blue-green, 6-7 µm wide, in a thin hyaline sheath, with occasional false-branching (Fig. 4.13-15); cells 3-6 µm long, granular, transverse walls not clear.

PLECTONEMA cf. *NOTATUM* Schmidle
(Fig. 4.16-20; S3-7, 8-11, 13-21; GEITLER, 1932)

Trichomes blue-green, 1-1.5 µm wide, in a thin hyaline sheath. The degree of bending and false-branching of trichomes varies with culture conditions and age of culture. In young moist plate enrichment cultures trichomes were mostly straight or slightly flexuous with rare false-branching. In young BBM agar cultures trichomes were very flexuous and false-branching rare. On an old, drying moist plate enrichment culture trichomes were more twisted and false-branching was frequent, occasionally two trichomes lay side by side within a single sheath (Fig. 4.20). Cells 1.5-3 µm long, occasionally granular.

P. notatum has trichomes 1.7-2 µm wide. *Plectonema* sp. B described by BEHRE and SCWABE (1970) is of similar size to the present specimens.

PORPHYROSIPHON NOTARISII Kuetz.
(Fig. 3.21-24; S11; COCKE, 1967)

Trichomes bright blue-green, 8-11 µm wide, constricted at transverse walls, terminally attenuated in mature specimens (Fig. 3.21), but not in immature ones (Fig. 3.22); sheath up to 13 µm thick, hyaline, clearly stratified and occasionally with ring-like striations (Fig. 3.23), enclosing from one to three parallel trichomes (Fig. 3.24); cells 3-8 µm long, granular.

P. notarisii is usually described as having bright red sheaths, but where the plants are not subjected to strong light the sheaths may be hyaline (DROUET, 1938) as in the icelandic specimens.

TOLYPOTHRIX TENUIS f. *TERRESTRIS* Boye Pet.
(Fig. 4.23-26; S2-6, 11, 14, 16, 19-21; PETERSEN, 1923)

Trichomes blue-green, 4-7.5 µm wide, in a close-fitting, thin hyaline sheath; cells 5-11 µm long; heterocysts 8-12.5 µm long, at bases of false-branches and occasionally intercalary, in the latter case two heterocysts are often on either side of a separation disc (Fig. 4.25, 26) and fragmentation occurs here (Fig. 4.24).

PETERSEN (1928a), SCWABE (1974).

TOLYPOTHRIX LANATA Lemm.
(Fig. 4.27-29; S14, 16; GEITLER, 1932)

Few specimens observed; trichomes blue-green, 9-11 (-16) µm wide

in a thin, close-fitting, hyaline sheath up to 2 μm thick, constricted at transverse walls particularly towards the apices; cells shorter at apices, 4.5-8 μm long (Fig. 4.28), than towards bases of branches, 8-19 μm long; heterocysts single at bases of branches, double at base of whole plant mass with penultimate cylindrical heterocyst (Fig. 4.27), four adjacent intercalary heterocysts (Fig. 4.29) observed on one occasion with fragmentation apparently occurring at the mid-point.

STIGONEMATALES

HAPALOSIPHON HIBERNICUM West and West
(Fig. 4.30-35; S13; GEITLER, 1932)

Trichomes blue-green, 4.5-8 μm wide, in a thin sheath, hyaline in young specimens (Fig. 4.30-32) but reddish-brown in old (Fig. 4.33-35); branches frequent; cells 3.5-6.5 μm long; heterocysts similar size to vegetative cells.
SCHWABE (1974).

STIGONEMA sp. 1
(Fig. 4.36, 37; S10)

Few specimens observed; cells 7-15 μm wide, granular; branches frequent; sheath hyaline; principal axis biseriate with uniseriate branches.

CRYPTOPHYCEAE

CRYPTOMONADALES

CRYPTOMONAS cf. *CYLINDRICA* Ehrenb.
(Fig. 5.1-4; S13, 14; JAVORNICKY, 1967)

Cells narrowly ellipsoidal to cylindrical, 6-9 μm wide by 14-19 μm long, in transverse section spherical or slightly laterally flattened (Fig. 5.3); apex obliquely cut at entrance of gullet with two slightly unequal flagella inserted subapically; two, golden-brown, parietal plate-like chromatophores almost completely line wall (dorsal view, Fig. 5.2), inner surface of chromatophores sometimes lined with large granules (Fig. 5.4); gullet lined with rows of trichocysts (Fig. 5.1); contractile vacuole apical; two large ellipsoidal Maupas corpuscules often present (Fig. 5.1, 4).

DINOPHYCEAE

DINOCOCCALES

GLOEODINIUM MONTANUM Klebs
(Fig. 5.5, 6; S2, 6, 10, 12, 13, 14, 15, 16; SCHILLER, 1937)

Cells usually non-motile, spherical to broadly ellipsoidal, up to 30 µm diameter, enclosed in hyaline mucilage (Fig. 5.5); chromatophores numerous, golden-brown, parietal; reproduction by autospores with the sporangium wall splitting irregularly and the remains often visible; zoospores also formed (Fig. 5.6) but only one specimen observed, this possessed a pyrenoid-like body and numerous discoidal, parietal chromatophores.

CHRYSOPHYCEAE

CHRYSOSACCALES

CHRYSOSACCUS EPILITHICUS Starmach
(Fig. 5.7; S21; STARMACH, 1966)

Only one colony of three cells embedded in homogeneous hyaline mucilage observed; cells naked, subspherical, 8-12.5 µm in diameter, with two or three contractile vacuoles and a single, parietal, lobed, golden-brown chromatophore.

CHRYSOSACCUS SPHAERICUS Bourr.
(Fig. 5.8, 9; S21; BOURELLY, 1957)

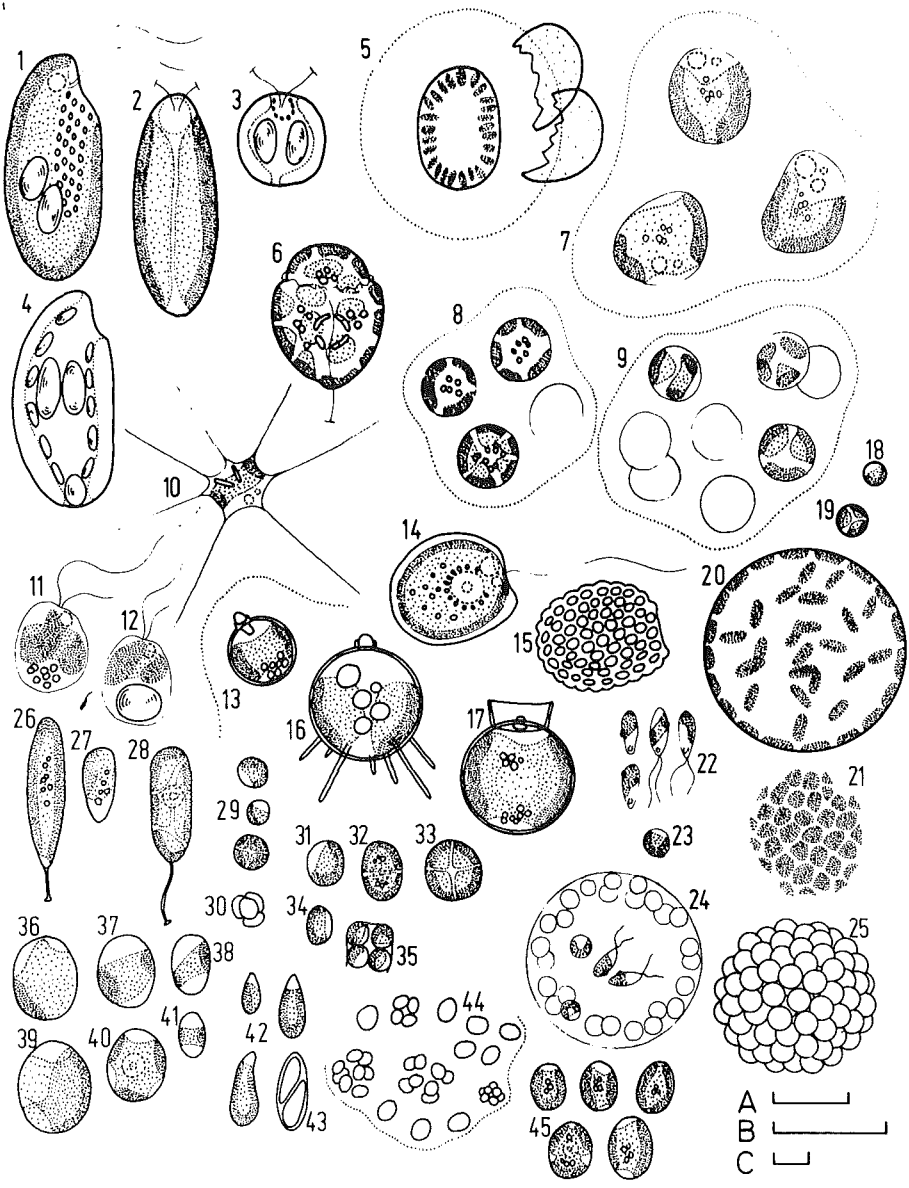
Colonies consisting of four to eight cells embedded in homogeneous hyaline mucilage; cells naked, spherical, 6-8 µm diameter, with disc-like, parietal, golden-brown chromatophores.

RHIZOCHRYSIDALES

RHIZOCHRYSIS sp. 1
(Fig. 5.10; S10, 13, 14; BOURELLY, 1968)

Cells 3.5 µm diameter with fine rhizopodia, a single, golden-brown, band-like chromatophore and one or two indistinct contractile vacuoles.

Fig. 5. 1-4, *Cryptomonas* cf. *cylindrica*. 5,6, *Gloeodinium montanum*. 7, *Chrysosaccus epilithicus*. 8,9, *C. sphaericus*. 10, *Rhizochrysis* sp. 11-13, *Ochromonas* sp. 1. 14, 15, *Chrysococcus* sp. 1. 16, Cyst 2. 17, Cyst 1. 18-25, *Botrydiopsis* sp. 1. 26, 27, *Characiopsis* cf. *minuta*.



28, *C.* cf.*teres*. 29, 30, *Chloridella minuta*. 31-35, *Ellipsoidion oocystoides*. 36-41, *E.* cf. *annulatum*. 42, 43, *Monodus subterraneus*. 44, 45, *Gloeobotrys* cf. *terrestris*. Scales equal 10 µm; A, all figures except: B, 1-4, 10-12, 17; C, 5, 44.

CHROMULINALES

CHRYSOCOCCUS sp. 1
(Fig. 5.14, 15; S13, 19; BOURELLY, 1968)

Cells broadly ellipsoidal, 16 µm long by 11 µm wide, enclosed within a sculptured lorica (Fig. 5.15); chromatophore single, parietal, almost filling the cell, with an apical opening containing two contractile vacuoles; also with an apical red stigma and a single long flagellum.

OCHROMONADALES

OCHROMONAS sp. 1
(Fig. 5.11-13; S13; BOURELLY, 1968)

Motile stage (Fig. 5.11, 12) subspherical, 5-8 µm diameter, slightly obliquely flattened apically with two unequal flagella inserted in a slightly lateral position; chromatophore golden-brown, somewhat spiralled; leucosine globules present, sometimes replaced by a single large basal globule; cysts formed and embedded in a homogeneous mucilage (Fig. 5.13).

Unidentified cyst 1
(Fig. 5.17; S13)

Cyst spherical, 9.5 µm diameter, chromatophore golden-brown, collar around apical plug.

Unidentified cyst 2
(Fig. 5.16; S13)

Cyst spherical with a number of long straight basal spines, 15 µm diameter.

XANTHOPHYCEAE

MISCHOCOCCALES

BOTRYDIOPSIS sp. 1
(Fig. 5.18-25; S4, 5, 21; PASCHER, 1939)

Cells spherical, up to 21 µm diameter; smallest cells 3 µm diameter with a single chromatophore (Fig. 5.18); chromatophore numbers increasing with cell diameter, largest cells containing nume-

rous parietal and some internal chromatophores (Fig. 5.20), in surface view these appear as polygonal plates (Fig. 5.21); reproduction by numerous aplanospores, which remain in close aggregates on release from the sporangium (Fig. 5.25), and zoospores (Fig. 5.22) which are only slightly unequally biflagellate, naked, and which rapidly become spherical on quiescence (Fig. 5.23), the single chromatophore contains a variably positioned orange stigma which is usually in the posterior half of the cell; spore release is by gelatinization of the sporangium wall but many often become caught in the mucilage and lose their motility (Fig. 5.24).

PETERSEN (1928a) records *B. arhiza* Borzi and PETERSEN (1928b) *B. minor* Schmidle.

CHARACIOPSIS cf. *MINUTA* Lemm.
(Fig. 5.26, 27; S13, 14; PASCHER, 1939)

Cells 10-25 µm long by 4-5 µm wide with a short stalk; chromatophore parietal; young cells initially without a stalk (Fig. 5.27).

C. minuta possesses cells with more acute apices.

CHARACIOPSIS cf. *TERES* Pa.
(Fig. 5.28; S2, 11; PASCHER, 1939)

Few specimens observed; cells cylindrical, 11-20 µm long by 4.5 µm wide, attached to substratum by thin stalk *ca.* 7.5 µm long with terminal button; several parietal chromatophores.

C. teres has generally larger cells, 19-30 µm long by 8-14 µm wide.

CHLORIDELLA MINUTA Gayral and Mazancourt
(Fig. 5.29, 30; S4, 5, 6, 8, 12, 15, 21; GAYRAL and MAZANCOURT, 1958)

Cells spherical to subspherical, 1.5-5 µm diameter; chromatophore parietal; reproduction by formation of four or eight autospores (Fig. 5.30).

ELLIPSOIDION cf. *ANNULATUM* Pa.
(Fig. 5.36-41; S18; PASCHER, 1939)

Mature cells broadly ellipsoidal, up to 12.5 µm long by 10 µm wide, smallest cells narrowly ellipsoidal to almost cylindrical, 6 µm long by 3 µm wide; chromatophore parietal, plate-like, lobed, or band-like; reproduction by formation of eight autospores.

E. annulatum has contractile vacuoles in young cells and the chromatophore is more regularly band-shaped and equatorial.

ELLIPSOIDION OOCYSTOIDES Pa.
(Fig. 5.31-35, S2, 4-10, 12, 15, 17, 18, 20, 24; PASCHER, 1939)

Cells broadly ellipsoidal to spherical, 4.5-8 µm diameter, with one parietal chromatophore in young cells, usually two, but up to four, in mature cells; reproduction by formation of two, four or eight autospores.

GLOEOBOTRYS cf. *TERRESTRIS* Reisigl
(Fig. 5.44, 45; S4-8, 12, 13, 15, 19, 20, 22; REISIGL, 1964)

Colonies containing cells in groups of four or eight or irregularly arranged throughout homogeneous, hyaline mucilage (Fig. 5.44); cells ellipsoidal, up to 9.5 µm long by 8 µm wide, smallest spores 2 µm in diameter; chromatophore parietal, broadly lobed; reproduction by formation of four or eight spores released by gelatinization of sporangium wall.

G. terrestris has one or two chromatophores. *G. coenococcoides* Fott is similar in the possession of a single chromatophore but has spherical cells and stratified mucilage.

HETEROTHRIX EXILIS Pa. f.
(Fig. 6.1; S2, 6, 20, 24; PASCHER, 1939)

Filaments readily fragmented but usually more than eight cells in length; cells 3-3.5 µm wide, slightly swollen at centre, 6-13 µm long, with one or two, rarely three chromatophores.

SCHWABE and BEHRE (1972).

HETEROTHRIX DEBILIS Pa. f.
(Fig. 6.2; S8; PASCHER, 1939)

Filaments readily fragmented, from nine to more than 20 cells long; cells 6-6.5 µm wide by 4.5-9.5 µm long, with one to four chromatophores.

cf. *HETEROTRICHELLA GRACILIS* Reisigl
(Fig. 6.5-9; S9, 17; REISIGL, 1964)

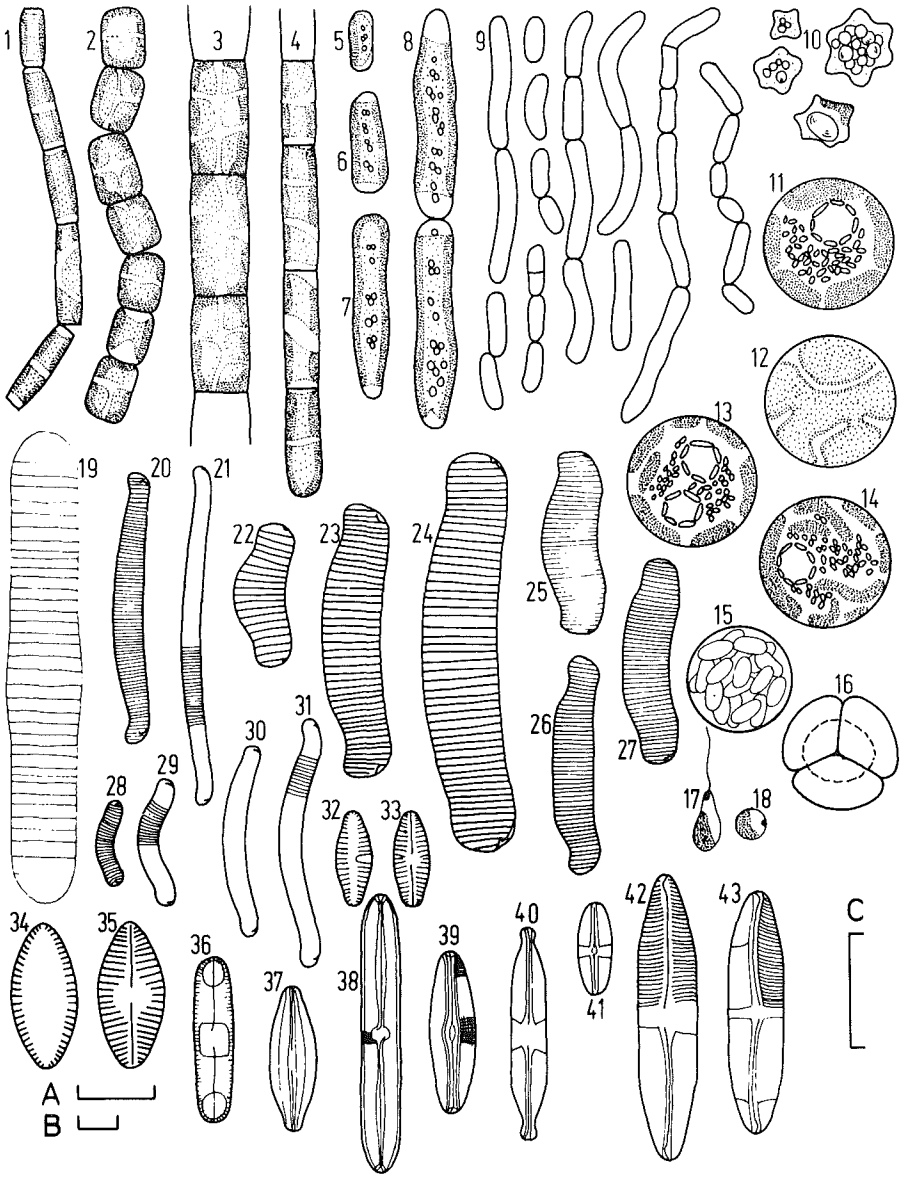
Filaments short, flexuous, redily fragmented, many single cells (Fig. 6.9); cells cylindrical, straight or curved, occasionally slightly attenuated at one apex, 3-5 µm wide by 8-35 µm long; chromatophore parietal stretching the length of the cell and covering one half or more of the wall; nucleus central; many small oil globules often present.

H. gracilis has several similarities to this alga, namely the short fragmenting filaments and the large range in cell length with many curved cells. However, the cells of *H. gracilis* are narrower and more markedly attenuated at one pole.

TRIBONEMA VULGARE Pa.
(Fig. 6.3; S2, 4; PASCHER, 1939)

Filaments long, 8 µm wide, with cells slightly swollen at centre; cells 9-18 µm long containing several parietal, plate-like chromatophores; cells fragmenting into "H"-shaped fragments.

Fig. 6. 1, *Heterothrix exilis* f. 2, *H. debilis* f. 3, *Tribonema vulgaris*. 4, *T. minus*. 5-9, cf. *Heterotrichella gracilis*. 10, *Vischeria punctata*. 11-18, Unidentified species of the Eustigmatophyceae. 19, *Diatoma hiemale* var. *maior* nov. var. 20, *Eunotia exigua* var. *compacta*. 21, *E. gracilis*. 22-24, *E. praerupta*. 25-27, *E. praerupta* cf. var. *muscicola*. 28-31, *E. repens* var. *arcuata*. 32, 33, *Achnanthes lanceolata* f. *rostrata*. 34, 35, *A. montana*. 36, *Diatomella balfouri-*



ana. 37, *Frustulia vitrea.* 38, *Neidium bisulcatum.* 39, *Diploneis oblongella* var. *genuina.* 40, *Stauroneis* cf. *pygmaea.* 41, *S.* sp. 3. 42, 43, *S.* sp. 2. Scales equal 10 µm; A, all figures except: B, 9, 19; C, 34, 35.

TRIBONEMA MINUS Hazen
(Fig. 6.4; S20, 24; PASCHER, 1939)

Filaments long, 4.5 µm wide, with cells barely swollen at centre; cells 11-24 µm long, containing two or three chromatophores; "H"-shaped walls sometimes clearly visible in healthy material.

EUSTIGMATOPHYCEAE

MONODUS SUBTERRANEUS Boye Pet.
(Fig. 5.42, 43; S1-24; PETERSEN, 1932a)

Cells pyriform, sometimes slightly curved, 4-11 µm long by 1.5-4 µm wide; chromatophore parietal, plate-like; reproduction by formation of two or four autospores.

WHITTLE and CASSELTON (1975) put forward strong evidence on the basis of pigment composition for the transfer of *M subterraneus* from the Xanthophyceae to the Eustigmatophyceae.

SCHWABE and BEHRE (1972).

VISCHERIA PUNCTATA Visch.
(Fig. 6.10; S2, 3, 6, 10; PASCHER, 1939)

Cells irregularly star-shaped with a warty wall, 3.5-9.5 µm diameter; all specimens observed had a high oil content and the chromatophore was only occasionally visible.

This alga was transferred from the Xanthophyceae to the Eustigmatophyceae by HIBBERD and LEEDALE (1972).

Unidentified sp.
(Fig. 6.11-18; S2, 5, 9, 10, 13, 20, 21)

Cells spherical up to 24 µm diameter, smallest cells 5 µm diameter; chromatophore yellow-green, parietal, fissured (Fig. 6.12, surface view) and in larger cells with inward projections (Fig. 6.13, 14), no starch revealed on treatment with Lugol's iodine; pyrenoid polygonal, usually single, occasionally two, surrounded by large granules, often adpressed to the inner surface of, though not embedded in, the chromatophore; vegetative division occurring with formation of two or four cells (Fig. 6.16); zoospores (Fig. 6.17) naked, becoming spherical on quiescence (Fig. 6.18), uniflagellate with a single basal chromatophore and an anterior orange stigma independent of the chromatophore, formed in sporangia containing 16 (?) spores (Fig. 6.15); aplanospores also formed.

This alga has been placed in the Eustigmatophyceae because it possesses several of the features by which the class has been distinguished by HIBBERD and LEEDALE (1972), namely: zoospores with a single chromatophore, single flagellum and an anterior stigma remote from the chromatophore; pyrenoid only in vegetative cells, attached to the inner surface of the chromatophore, polygonal and surrounded by large flattened vesicles; vegetative cell coccoid. It is hoped to make more complete observations on cultures before presenting a formal description of this probably new member of the class.

BACILLARIOPHYCEAE

DIATOMALES

DIATOMA HIEMALE var. *MAIOR* nov. var.
(Fig. 6.19; S24)

Only two specimens observed; frustules lightly silicified with septa faintly visible and striae not resolved; valves 125 µm long by 17 µm wide, with a slight central swelling; septa 3.5 in 10 µm.

D. hiemale var. *anceps* (Ehrenb.) A. Cl. has the largest frustules of described varieties, 12-100 µm long by 4-7 µm wide. The present variety has longer and wider valves and lacks the capitate, attenuated apices of *D. hiemale* var. *anceps*. The density of septa lies in the range given for *D. hiemale* (Lyngb.) Heib. by CLEVE-EULER (1953b).

EUNOTIALES

EUNOTIA EXIGUA var. *COMPACTA* Hust.
(Fig. 6.20; S13; HUSTEDT, 1930)

Valves 23-47 µm long by 4 µm wide, with obviously curved dorsal margin, barely curved ventral margin and markedly capitate apices; striae 20 in 10 µm.

PETERSEN (1928b), FOGED (1974) and SCHWABE (1970) all record *E. exigua* but this possesses valves with a greater curvature than the variety.

EUNOTIA GRACILIS (Ehrenb.) Rabenh.
(Fig. 6.21; S14, 16; HUSTEDT, 1959-1962)

Valves 54-90 µm long by 4.5-5 µm wide, slightly curved, with parallel margins; striae 12-13 in 10 µm.

PETERSEN (1928a and 1928b), FOGED (1974).

EUNOTIA PRAERUPTA Ehrenb.
(Fig. 6.22-24; S16, 24; HUSTEDT, 1959-1962)

Valves 19-53 µm long by 7.5-11 µm wide; striae 10-13 in 10 µm.

FOGED (1974).

EUNOTIA PRAERUPTA cf. var. *MUSCICOLA* Boye Pet.
(Fig. 6.25-27; S2; HUSTEDT, 1959-1962).

Valves 24-30 µm long by 5-7 µm wide; striae 15-17 in 10 µm.

This alga appears to lie somewhere in between *E. praerupta* var. *muscicola* and *E. septentrionalis* Oestrup, the former has 6-12 striae in 10 µm and the latter 16-19. The shape of the former is most similar to the present specimens with the ventral edge straight at the poles and then becoming suddenly concave (Fig. 6.25, 27) al-

similar to the present specimens with the ventral edge straight at the poles and then becoming suddenly concave (Fig. 6.25, 27) although this was not obvious in all specimens (Fig. 6.26).

PETERSEN (1928a) records *E. praerupta* var. *muscicola* and FOGED (1974) *E. septentrionalis*.

EUNOTIA REPENS var. *ARCUATA* (Naeg.) A.Cl.
(Fig. 6.28-31; S7, 16, 24; CLEVE-EULER, 1953a)

Valves 8-33 µm long by 2-3 µm wide, curved with parallel margins; striae 25 in 10 µm.

Similar to *E. lunaris* (Ehrenb.) Hust. which, however, has fewer striae, 12-20 in 10 µm. The present specimens had a smaller length range than that given for *E. repens* var. *arcuata* by CLEVE-EULER (1953a) of 20-50 µm.

ACHNANTHALES

ACHNANTHES LANCEOLATA f. *ROSTRATA* (Oestrup) Hust.
(Fig. 6.32, 33; S7; HUSTEDT, 1959-1962)

Valves 12 µm long by 5 µm wide, ellipsoidal with slightly attenuated apices; striae 16 in 10 µm, slightly fewer at centre.

The rostrate apices in the present specimens are not so obvious as those illustrated by HUSTEDT (1959-1962).

FOGED (1974).

ACHNANTHES MONTANA Krasske
(Fig. 6.34, 35; S4; HUSTEDT, 1959-1962)

Valves 13 µm long by 6 µm wide, ellipsoidal; striae 20 in 10 µm.

HUSTEDT (1959-1962) illustrates a clear, axial area on the araphid valve which is narrower than that of the present specimens.

NAVICULALES

CYMBELLA sp. 1
(Fig. 7.35, 36; S24)

Valves 17-22 µm long by 5 µm wide, ellipsoidal with attenuated, rostrate apices; striae radiate 13 in 10 µm; clear, unilateral, central area visible on occasional valves (Fig. 6.36) and a single, large, unilateral punctum always present.

CYMBELLA sp. 2
(Fig. 7.33, 34; S14, 16, 24)

Valves 19-33 µm long by 3-5 µm wide; striae 12-15 in 10 µm.

DIATOMELLA BALFOURIANA Grev.
(Fig. 6.36; S24; HUSTEDT, 1959-1962)

Valves 16-22 µm long by 5 µm wide; striae 20 in 10 µm.
PETERSEN (1928a), FOGED (1974).

DIPLONEIS ELLIPTICA (Kuetz.) Cleve
(Fig. 7.20; S24; HUSTEDT, 1959-1962)

Only one specimen observed; valves 34 µm long by 19 µm wide; striae punctate, *ca.* 24 in 10 µm at centre becoming closer together towards apices.

DIPLONEIS OBLONGELLA var. *GENUINA* A. Cl.
(Fig. 6.39; S3, 4, 16; CLEVE-EULER, 1953a)

Valves 22-24 µm long by 6-7.5 µm wide; striae punctate, *ca.* 24 in 10 µm at centre becoming denser towards apices.

EPITHEMIA SOREX Kuetz.
(Fig. 7.37; S16; CLEVE-EULER, 1932)

Valves 32 µm long by 10 µm wide; septa 8 in 10 µm; striae 15 in 10 µm, clearly punctate.
SCHWABE (1970), FOGED (1974).

FRUSTULIA VITREA Oestrup
(Fig. 6.37; S24; PETERSEN, 1932b)

Valves 19 µm long by 6 µm wide; striae not resolved.

HANTZSCHIA AMPHIOXYS (Ehrenb.) Grun.
(Fig. 7.38; S2-7, 15, 16, 19, 20, 24; HUSTEDT, 1930)

Valves 41-71 µm long by 6-11 µm wide.
PETERSEN (1928a and 1928b), SCHWABE (1970), BEHRE and SCHWABE (1970), FOGED (1974).

HANTZSCHIA AMPHIOXYS f. *CAPITATA* O. Muell.
(Fig. 7.39; S2-4, 19, 24; HUSTEDT, 1930)

Valves 25-59 µm long by 5-8 µm wide.
SCHWABE (1970).

NAVICULA BREKKAENSIS Boye Pet.
(Fig. 7.25-27; S24; HUSTEDT, 1959-1962)

Valves 11-14 µm long by 3-3.5 µm wide; occasional valves with central swelling (Fig. 7.26), others with parallel (Fig. 7.25) or slightly convex margins (Fig. 7.27); striae not resolved.
PETERSEN (1928a).

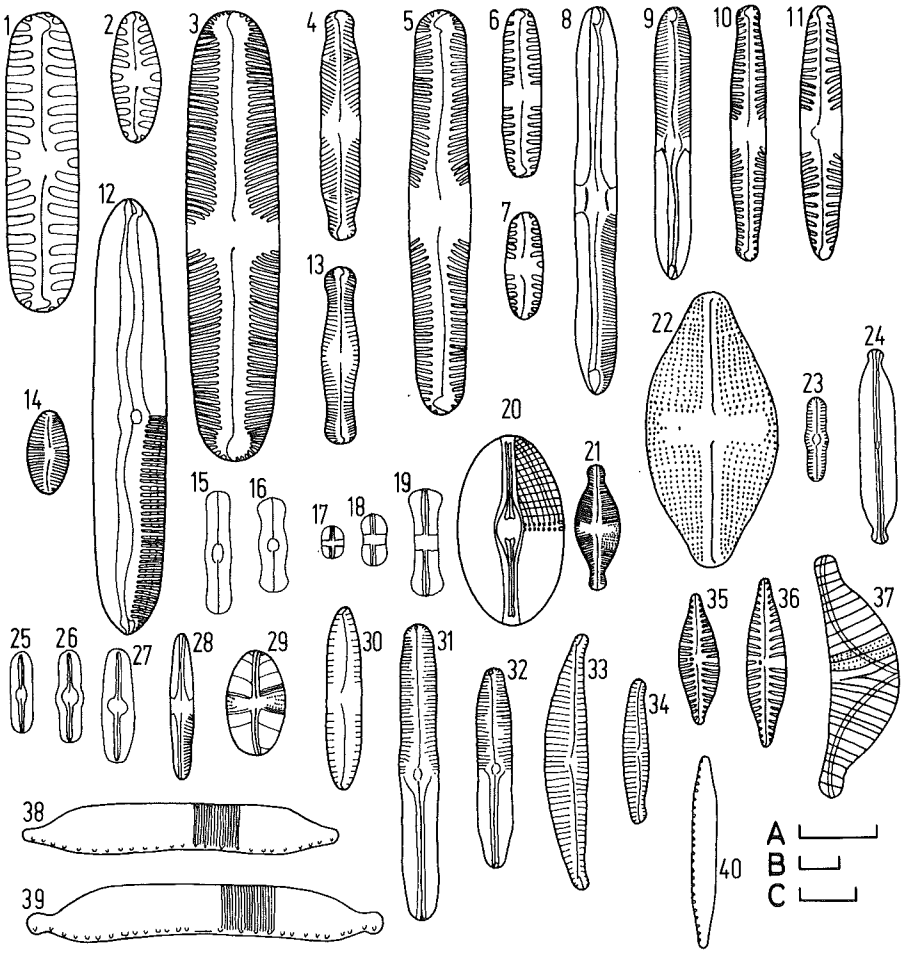


Fig. 7. 1, *Pinnularia borealis*. 2, *P. borealis* f. *lanceolata*. 3, *P. divergens* var. *elliptica*. 4, *P. divergentissima*. 5, *P.* sp. 4. 6, 7, *P. parva* var. *minuta*. 8, 9, *P. stomatophora*. 10, *P. subcapitata* var. *hilseana*. 11, *P. sublanceolata* f. 12, *P. viridis* var. *intermedia* f. 13, *P. globiceps* var. *krookei*. 14, *Navicula* sp. 9. 15, 16, *N. contenta*. 17-19, *N. contenta* cf. var. *cruciata*. 20, *Diploneis elliptica*. 21, *Navicula grimmei*. 22, *N. mutica* var. *cohnii*. 23, *N. seminulum* var.*genuina*. 24, *N. subtilissima*. 25-27, *N. brekkaensis*. 28, *N.* sp. 2. 29, *N.* sp.3. 30, *N.* sp. 4. 31, 32, *N.* sp. 6. 33, 34, *Cymbella* sp. 2. 35, 36, *C.* sp. 1. 37, *Epithemia sorex*. 38, *Hantzschia amphioxys*. 39, *H. amphioxys* f. *capitata*. 40, *Nitzschia frustulum* var. *perpusilla*. Scales equal 10 µm; A, all figures except: B, 3, 8, 12; C, 20.

NAVICULA CONTENTA Grun.
(Fig. 7.15, 16; S7; HUSTEDT, 1959-1962)

Valves 12-16 µm long by 3-3.5 µm wide, with central swelling and capitate apices; striae not resolved; central, clear area ellipsoidal, axial area narrow.
PETERSEN (1928a and 1928b), FOGED (1974).

NAVICULA CONTENTA cf. var. *CRUCIATA* A. Berg.
(Fig. 7.17-19; S3, 4, 24; CLEVE-EULER, 1953b)

Valves 4.5-14 µm long by 3-4.5 µm wide, varying in shape from linear in smallest specimens (Fig. 7.17) to linear with capitate apices in largest specimens (Fig. 7.19); striae not resolved; central area a broad, transverse strip.
N. contenta var. *cruciata* has a similar clear, broad, transverse strip and capitate apices but is centrally swollen as in *N. contenta* Grun. The smallest of the present specimens are close in shape to *N. contenta* var. *elliptica* Krasske but that variety lacks the clear, central, transverse strip.

NAVICULA GRIMMEI Krasske
(Fig. 7.21; S3; CLEVE-EULER, 1953b)

Valves 16-20.5 µm long by 7-8 µm wide; striae *ca.* 23 in 10 µm, punctate.

NAVICULA MUTICA var. *COHNII* (Hilse) Grun.
(Fig. 7.22; S3; CLEVE-EULER, 1953b)

Valves 36 µm long by 17 µm wide; striae 16 in 10 µm.
PETERSEN (1928a), SCHWABE (1970), BEHRE and SCHWABE (1970).

NAVICULA SEMINULUM var. *GENUINA* A. Cl.
(Fig. 7.23; S14; CLEVE-EULER, 1953b)

Valves 11 µm long by 3.5 µm wide; striae *ca.* 24 in 10 µm.
SCHWABE (1970), BEHRE and SCHWABE (1970).

NAVICULA SUBTILISSIMA Cleve
(Fig. 7.24; S16; CLEVE-EULER, 1953b)

Valves 22-25 µm long by 4.5 µm wide; striae not resolved.
PETERSEN (1928a).

NAVICULA sp. 2
(Fig. 7.28; S7)

Valves 14-20.5 µm long by 3-3.5 µm wide; striae radial at centre, convergent at poles, *ca.* 25 in 10 µm; raphe slightly curved.

NAVICULA sp. 3
(Fig. 7.29; S2)

Valves 13-16 µm long by 8 µm wide; striae radial throughout, too dense to count at poles, less dense and shorter at centre where clearly punctate.

NAVICULA sp. 4
(Fig. 7.30; S4)

Valves 16 µm long by 3 µm wide; striae short, absent at centre, parallel, 17 in 10 µm.

NAVICULA sp. 6
(Fig. 7.31, 32; S16, 24)

Valves 26-39 µm long by 4.5-5 µm wide, with faintly undulate margins and faintly rostrate apices; striae slightly radial at centre, otherwise parallel, of unequal lengths throughout, 20-24 in 10 µm, generally shorter at centre producing an ellipsoidal clear area; raphe straight with distinct polar and central nodules.

NAVICULA sp. 9
(Fig. 7.14; S3, 24)

Valves 11 µm long by 5.5 µm wide; striae radiate throughout, *ca.* 25 in 10 µm; raphe curved.

NEIDIUM BISULCATUM (Lagerst.) Cleve
(Fig. 6.38; S14, 16; CLEVE-EULER, 1955)

Valves 50-75 µm long by 9-11 µm wide; striae too fine to count.
PETERSEN (1928a and 1928b), FOGED (1974).

NITZSCHIA FRUSTULUM var. *PERPUSILLA* (Rabenh.) Grun.
(Fig. 7.40; S8, 14, 16, 23; CLEVE-EULER, 1952)

Valves 19-39 µm long by 3 µm wide; striae not resolved; keel punctae 10-12 in 10 µm.
FOGED (1974).

PINNULARIA BOREALIS Ehrenb.
(Fig. 7.1; S2-7, 11-13, 15, 16, 18-24; CLEVE-EULER, 1955)

Valves 22-52 µm long by 8-11 µm wide; costae 5 in 10 µm.
PETERSEN (1928a and 1928b), SCHWABE (1970), BEHRE and SCHWABE (1970), FOGED (1974).

PINNULARIA BOREALIS f. *LANCEOLATA* Boye Pet.
(Fig. 7.2; S14; CLEVE-EULER, 1955)

Valves 17-22 µm long by 6.5-8 µm wide; costae 6-7 in 10µm.
PETERSEN (1928a).

PINNULARIA DIVERGENS var. *ELLIPTICA* Grun.
(Fig. 7.3; S14; CLEVE-EULER, 1955)

Valves 118-160 µm long by 25-31 µm wide; costae 7-8 in 10 µm.
FOGED (1974).

PINNULARIA DIVERGENTISSIMA (Grun.) Cleve
(Fig. 7.4; S14; CLEVE-EULER, 1955)

Valves 30 µm long by 5 µm wide; costae 14 in 10 µm.
FOGED (1974).

PINNULARIA GLOBICEPS var. *KROOKEI* Grun.
(Fig. 7.13; S14; CLEVE-EULER, 1955)

Valves 19-28 µm long by 5 µm wide; costae 16 in 10 µm at centre, more at apices.
PETERSEN (1928a and 1928b).

PINNULARIA PARVA var. *MINUTA* Oestrup
(Fig. 7.6, 7; S2; PETERSEN, 1928)

Valves 14-22 µm long by 4.5-5 µm wide; costae 9-10 in 10 µm; there are either no central costae (Fig. 7.6) or a short unilateral central costa (Fig. 7.7).
PETERSEN (1928a and 1928b)

PINNULARIA STOMATOPHORA Grun.
(Fig. 7.8, 9; S16; CLEVE-EULER, 1955)

Valves 71-101 µm long by 8-11 µm wide; costae 12-14 in 10 µm.
PETERSEN (1928a and 1928b), FOGED (1974).

PINNULARIA SUBCAPITATA var. *HILSEANA* (Jan.) O.M.
(Fig. 7.10; S4, 7, 14, 16, 24; CLEVE-EULER, 1955)

Valves 28-38 µm long by 4-5 µm wide; costae 10-13 in 10 µm.

PINNULARIA SUBLANCEOLATA (Boye Pet.) A. Cl. f.
Syn. *Pinnularia subcapitata* var. *sublanceolata* Boye Pet.
(Fig. 7.11; S2, 4, 16; CLEVE-EULER, 1955)

Valves 22-38 µm long by 3.5-5 µm wide; costae 8-12 in 10 µm.
P. sublanceolata has slightly more costae, 11-14 in 10 µm, faintly attenuated poles and is only 17-22 µm long.

PINNULARIA VIRIDIS var. *INTERMEDIA* Cleve f.
(Fig. 7.12; S14, 16, 24; CLEVE-EULER, 1955)

Valves 66-159 µm long by 10-20 µm wide; costae 8-10 in 10 µm.
The apices of the present specimens are somewhat less broadly rounded than those of *P. viridis* var. *intermedia*.
FOGED (1974).

PINNULARIA sp. 4
(Fig. 7.5; S16)

Valves 38-53 µm long by 5-8 µm wide, linear with the centre slightly swollen; costae 12 in 10 µm.

STAURONEIS cf. *PYGMAEA* Krieger
(Fig. 6.40; S4; CLEVE-EULER, 1953b)

Valves 28 µm long by 4.5 µm wide; striae not resolved.
S. pygmaea is shorter, 20-24 µm long, and the clear, central, transverse strip of the present specimens is wider than that illustrated by CLEVE-EULER (1953b).

STAURONEIS sp. 2
(Fig. 6.42, 43; S2-4, 16, 24)

Valves 19-38 µm long by 5-8 µm wide; striae *ca.* 20 in 10 µm; clear, central, transverse area of variable width.

STAURONEIS sp. 3
(Fig. 6.41; S24)

Valves 8-12.5 µm long by 3.5-4.5 µm wide; striae not resolved; central nodule clear.

EUGLENOPHYCEAE

EUGLENALES

EUGLENA MUTABILIS Schmitz f.
(Fig. 8.1-4; S2-4, 11, 13, 16, 18, 21; ETTL, 1960)

Cells *ca.* 27 µm long by 2-4 µm wide, highly metabolic lacking flagella and moving by creeping over the substratum, with two or three chromatophores, each with a naked pyrenoid.
The specimens observed were considerably smaller than those recorded by BEHRE and SCHWABE (1970) which were 50-60 µm long by 6-8 µm wide.

CHLOROPHYCEAE

VOLVOCALES

CARTERIA sp. 1
(Fig. 8.5; S13, 14, 19)

Cells broadly ellipsoidal, 12.5-16 µm long by 7-12 µm wide, with a small apical papilla; chromatophore thick, parietal with a la-

teral pyrenoid.

CARTERIA sp. 2
(Fig. 8.6; S15)

Cells broadly ellipsoidal, 16-21 µm long by 11-16 µm wide, lacking an apical papilla; chromatophore cup-shaped, massive, with a large pyrenoid embedded in the basal portion; no stigma observed.

CHLAMYDOMONAS cf. *PSEUDINTERMEDIA* Behre and Schwabe
(Fig. 8.11, 12; S8; BEHRE and SCHWABE, 1970)

Cells oval to ellipsoidal, 12.5-19 µm long by 6-14 µm wide, with two contractile vacuoles; chromatophore cup-shaped, fissured (Fig. 8.12, surface view) containing a basal pyrenoid and an orange stigma situated some distance from the apical pole; apical papilla wide and flat; palmella-stage formed in which cells embedded in stratified mucilage.

The specimens differed from *C. pseudintermedia*, which was recovered from Surtsey by BEHRE and SCHWABE (1970), in the possession of a palmella-stage and a more flattened apical papilla.

CHLAMYDOMONAS cf. *PSEUDOMUTABILIS* Ettl
(Fig. 8.7, 8; S14, 19; ETTL, 1976)

Cells cylindrical to ellipsoidal, 17-22 µm long by 7.5-9.5 µm wide, occasionally slightly curved or oval, with two contractile vacuoles and a small, hemispherical, apical papilla; chromatophore parietal with a central, transverse portion containing a pyrenoid, the basal portion is often somewhat fissured; stigma orang-red usually in the lower part of the anterior half of the cell; nucleus usually behind the pyrenoid, rarely in the anterior half of the cell; palmella-stage formed (Fig. 8.8).

C. pseudomutabilis lacks fissures in the basal portion of the chromatophore and does not produce a palmella-stage.

CHLAMYDOMONAS sp. 2
(Fig. 8.9, 10; S14, 16, 23)

Cells ellipsoidal to slightly oval, 8-16 µm long by 5-11 µm wide, with a small hemispherical apical papilla and two contractile vacuoles; chromatophore with a stellate, central portion the arms of which merge with the fissured, parietal portion (Fig. 9.10, surface view); pyrenoid almost central often being more in the posterior portion of the cell; stigma anterior. On agar cultures a quite stable palmella-stage is formed which does not readily form motil cells on transfer to liquid cultures.

CHLAMYDOMONAS sp. 4
(Fig. 8.13, 14; S3, 16, 23)

Cells only observed in palmella-stage, ellipsoidal to oval, 8-16 µm long by 4.5-9.5 µm wide, with a small, hemispherical, apical papilla and two contractile vacuoles; chromatophore parietal, fis-

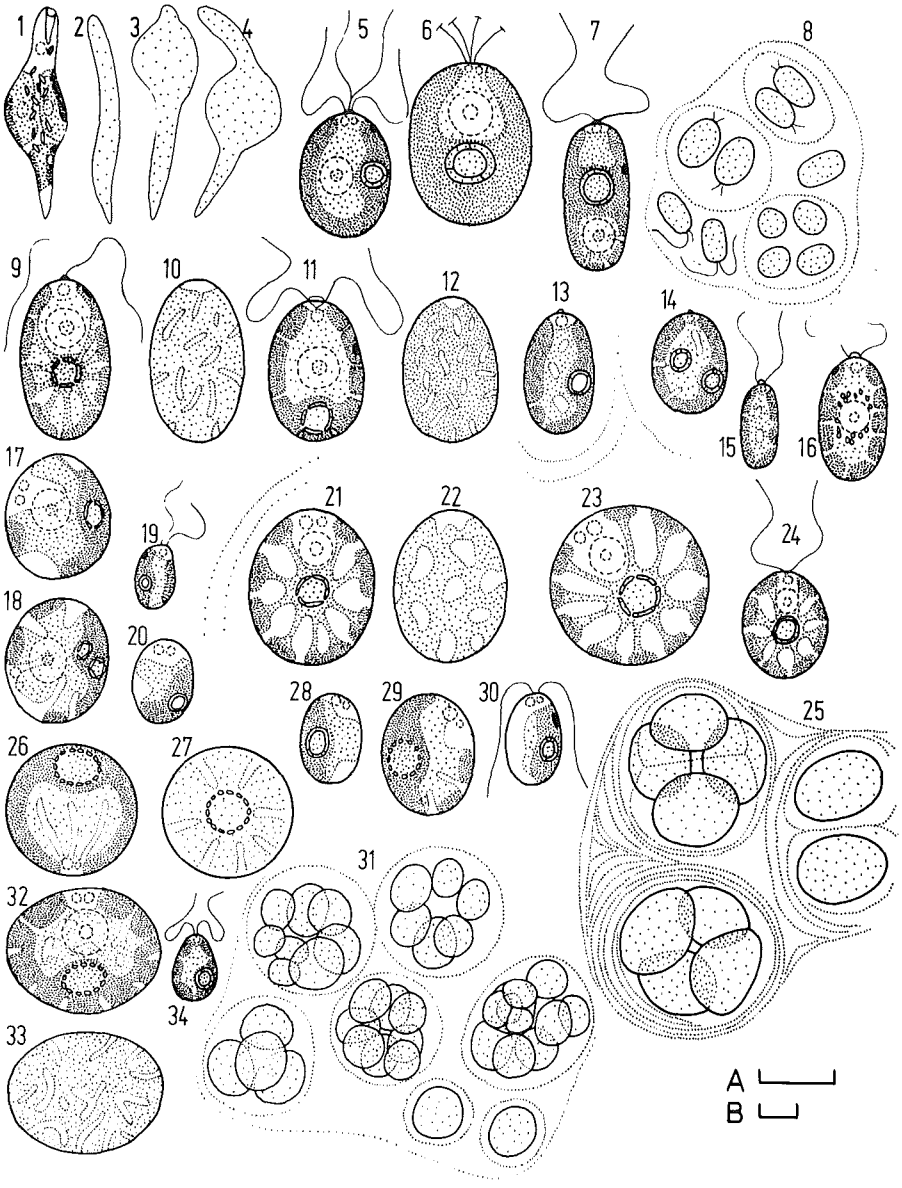


Fig. 8. 1-4, *Euglena mutabilis* f. 5, *Carteria* sp. 1. 6, *C.* sp. 2. 7, 8, *Chlamydomonas* cf. *pseudomutabilis*. 9, 10, *C.* sp. 2. 11, 12, *C.* cf. *pseudintermedia*. 13, 14, *C.* sp. 4. 15, 16, *Chloromonas* cf. *clath-*

sured, containing usually a single but up to three pyrenoids; no stigma observed.

CHLOROMONAS cf. *CLATHRATA* Korsch.
(Fig. 8.15, 16; S5, 7, 8, 10, 13, 15, 19, 23, 24; ETTL, 1970)

Cells ellipsoidal, 11-21 µm long by 4-16 um wide, with a hemispherical, apical papilla and two contractile vacuoles; chromatophore parietal, fissured, with an anterior orange stigma; oil droplets often present.

C. clathrata Korsch. has generally larger cells 14-26 µm long by 11-18 µm wide.

Unidentified sp.
(Not illustrated; S11, 21)

Cultures of an unusual quadriflagellate unicell with a complex vacuolar apparatus, metabolic cells and the capacity to form a palmella-stage and long, branched pseudocilia have been obtained. It is hoped to present a detailed description of this alga after examination of cultures.

TETRASPORALES

ASTEROCOCCUS sp. 1
(Fig. 8.21-25; S14; NOVÁKOVÁ, 1964)

Cells ellipsoidal, sub-ellipsoidal to spherical, 9.5-24 µm long by 8-21 um wide, embedded in groups of two, four and eight in firmly mucilaginous colonies which are frequently clearly stratified (Fig. 8.25); two contractile vacuoles are present but the cells lack a stigma and apical papilla; chromatophore consisting of a central stellate portion, the arms of which fuse with a fissured parietal portion (Fig. 8.22, surface view), containing a central pyrenoid which is surroun ded by large starch plates; nucleus situated immediately below the pair of contractile vacuoles (Fig. 8.21); reproduction usually by the formation of two, four or eight autospores released by gelatinization of the sporangium wall; in liquid media biflagellate motile cells are released from the colonies, these still lack an apical papilla and a stigma and are probably adult cells which have formed flagella.

No species of *Asterococcus* have been described which possess a parietal reticulate portion of the chromatophore, the radiating arms usually terminate as parietal plates (NOVÁKOVÁ, 1964). However, the present specimen does possess the other characters of this genus. It is hoped to provide a formal description after thorough examination of material in culture.

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rata. 17-20, *Hypnomonas* cf. *schizochlamys*. 21-25, *Asterococcus* sp. 26-31, *Chlamydocapsa lobata* f. 32-34, *C.* sp. 2. Scales equal 10 µm; A, all figures except: B, 8, 31.

CHLAMYDOCAPSA LOBATA mh. f.
(Fig. 8.26-31; S6-8, 12, 13, 16, 19; BROADY, 1977a)

Adult cells spherical, up to 16 µm diameter, young cells ellipsoidal and sub-sphaerical, from 7.5 µm long by 4.5 µm wide, embedded in faintly stratified, mucilaginous colonies (Fig. 8.31) in groups of two, four, eight and 16 or irregularly arranged; chromatophore parietal, deeply lobed, containing a prominent pyrenoid aurrounded by small starch grains in a thickened portion opposite which are two permanent contractile vacuoles (Fig. 8.26), in younger cells these tend to lie to one side (Fig. 8.28, 29); reproduction by formation of two, four, eight or 16 autospores or similar numbers of biflagellate, tunicate zoospores (Fig. 8.30) which possess a lateral chromatophore and a bar-shaped stigma.

The zoospores of *C. lobata* possess a small apical papilla, not observed in the present specimens, and a smaller stigma.

CHLAMYDOCAPSA sp. 2
(Fig. 8.32-34; S22)

Cells arranged in groups of four, eight and 16 in faintly stratified, mucilaginous colonies, the stratifications are limited to single lines around cell groups; adult cells broadly ellipsoidal, oval, sub-spherical or spherical, up to 22 µm by 19 µm, young cells ellipsoidal or slightly oval, from 8 µm by 5 µm; chromatophore parietal, thick, covering most of wall except for apical opening containing two contractile vacuoles, deeply fissured although these often do not pass completely trhough the chromatophore, surrounded by numerous small starch grains; reproduction by formation of four, eight or 16 autospores or zoospores; zoospores (Fig. 8.34) often oval, but also ellipsoidal, with a faint spot-like stigma.

Unfortunately a culture of this alga was lost and a more complete description cannot be made. It is very similar to the previous alga in its major features.

HYPNOMONAS cf. *SCHIZOCHLAMYS* Korsch.
(Fig. 8.17-20; S13; KORSCHIKOFF, 1953)

Cells spherical to ellipsoidal, up to 16 µm diameter; chromatophore single, pareital, deeply lobed containing a prominent pyrenoid or two pyrenoids (Fig. 8.18); a pair of permanent contractile vacuoles present between chromatophore lobes; reproduction by four or eight autospores and two, four, eight or 16 zoospores; zoospores tunicate, biflagellate, 8 µm long by 3.5 µm wide, often slightly curved.

The zoospores of *H. schizochlamys* are oval with a small apical papilla.

CHLOROCOCCALES

CHARACIUM sp. 1
(Fig. 9.1, 2; S21; BOURRELLY, 1966)

Cells *ca.* ellipsoidal with a short stalk and terminal button-like

holdfast, 9-13 µm long by 3-5 µm wide; chromatophore single, parietal, with a distinct pyrenoid.

CHLORELLA VULGARIS Beij. var. 1
(Fig. 9.33-37; S5, 8, 9, 11; FOTT and NOVÁKOVÁ, 1969)

Adult cells spherical (Fig. 9.33-35), up to 6 µm diameter, young cells ellipsoidal and sub-spherical (Fig. 9.36), from 3.5µm by 2 µm; chromatophore parietal, cup-shaped, sometimes broadly lobed with a single prominent pyrenoid; reproduction by two, four (Fig. 9.37) or eight autospores, released by rupture of the sporangium wall.

BEHRE and SCHWABE (1970) record *C. vulgaris* (?).

CHLORELLA VULGARIS Beij. var. 2
(Fig. 9.38-42; S11; FOTT and NOVÁKOVÁ, 1969)

Adult cells spherical (Fig. 9.38, 39) up to 9.5 µm diameter, though mostly 6-8 µm, young cells ellipsoidal; chromatophore cup-shaped with prominent pyrenoid; reproduction by two or four autospores (Fig. 9.40, 41).

CHLORELLA cf. *ZOFINGENSIS* Doenz.
(Fig. 9.43-47; S5; FOTT and NOVÁKOVÁ, 1969)

Adult cells spherical (Fig. 9.43-45), up to 9.5 µm diameter, young cells broadly ellipsoidal to spherical from 2 µm diameter; chromatophore thick, cup-shaped, occupying much of cell, lacking a pyrenoid; two, four, eight or 16 autospores formed and tending to remain aggregated after release from the ruptured sporangium (Fig. 9.47); oil droplets often present; few starch grains detected in chromatophore after treatment with Lugol´s iodine.

FOTT and NOVÁKOVÁ(1969) did not detect starch in their isolate of *C.zofingensis*, 4-64 spores were formed and the chromatophore was somewhat lobed.

DICTYOSPHAERIUM MINUTUM Boye Pet.
(Fig. 10.13-15; S24; PETERSEN, 1932b)

Cells ellipsoidal, 5 µm by 3.5 µm; chromatophore cup-shaped with a pyrenoid; reproduction by formation of four autospores which temporarily remain adhering to the points of the cruciform remains of the sporangium wall (Fig. 10.15, lateral view of remains of sporangium wall).

SCHWABE and BEHRE (1972).

FERNANDINELLA ALPINA Chod.
(Fig. 9.25, 26; S15, 20; PETERSEN, 1932b)

Cells pyriform, 6-8 µm diameter, often remaining in small aggregates of 4-10 cells; chromatophore parietal, cup-shaped with a pyrenoid; reproduction by formation of four, naked, quadriflagellate zoospores.

PETERSEN (1928a and 1928b).

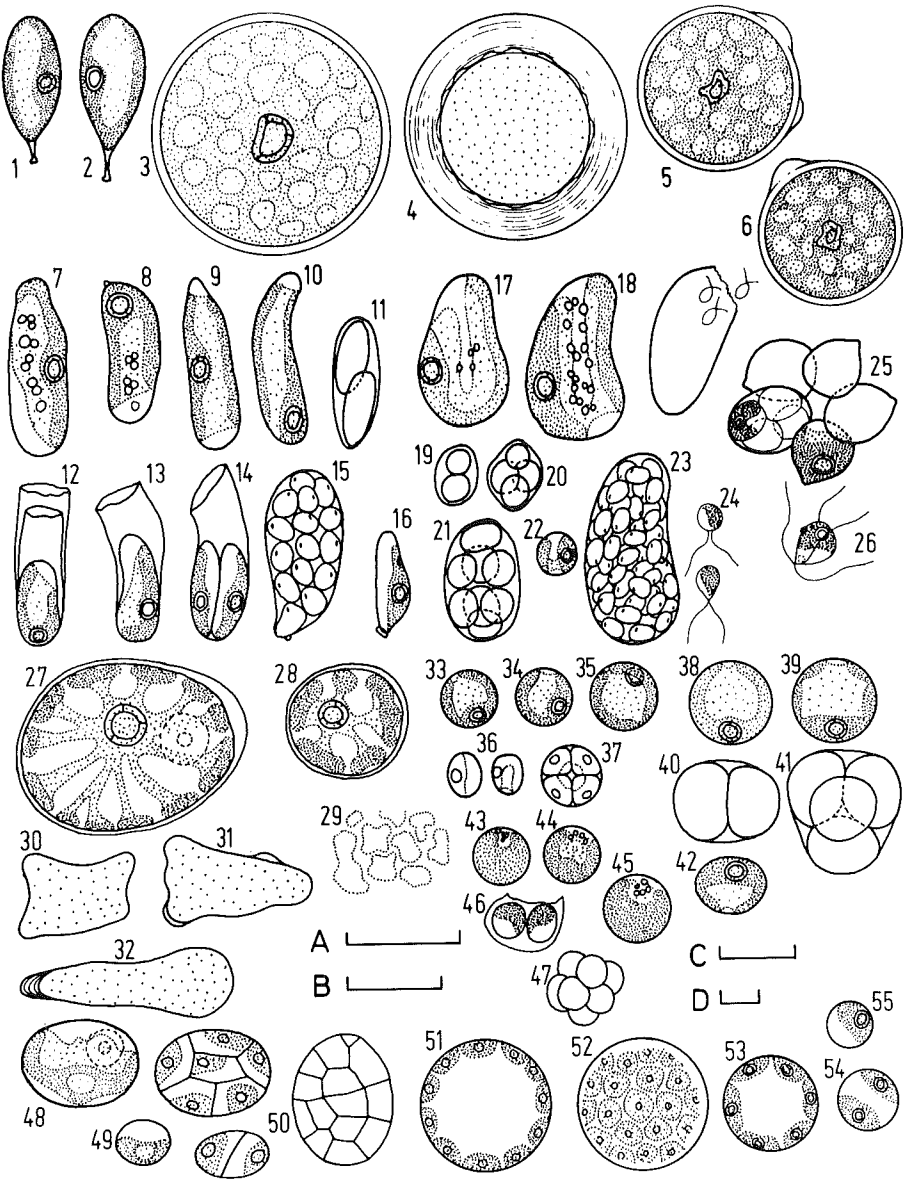

Fig. 9. 1, 2, *Characium* sp. 1. 3-6, cf. *Spongiococcum* sp. 7-16, *Rhopalocystis* cf. *oleifera*. 17-24, cf. *Rhopalocystis cucumis*. 25, 26, *Fernandinella alpina*. 27-32, *Kentrosphaera bristolae*. 33-37, *Chlorella*

cf. *JAAGIOCHLORELLA GEOMETRICA* Reisigl
(Fig. 9.48-50; S17, 18, 24; REISIGL, 1964)

Cells broadly ellipsoidal, up to 17.5 µm long by 14 µm wide, youngest cells from 4.5 µm by 3 µm; chromatophore cup-shaped, lobed, sub-parietal in its basal portion (Fig. 9.48) with a faint pyrenoid lacking a starch sheath, but many starch grains throughout chromatophore; reproduction by formation of two to many (*ca.* 30) aplanospores which are closely packed in the sporangia and assume polygonal shapes (Fig. 9.50).

The polygonal spores in the sporangia and the sub-parietal chromatophore are similar characters to those of *J. geometrica* but the cells of that species are spherical and small, only *ca.* 4 µm diameter.

KENTROSPHAERA BRISTOLAE G. M. Sm.
(Fig. 9.27-32; S20; SMITH, 1933)

Cells spherical, ellipsoidal and irregularly shaped, 16-140 µm but mostly 30-60 µm long, often with an apical wall thickening which is often faintly lamellate, occasionally more thickenings (Fig. 9.31); chromatophore axial with numerous radiating lobes which spread to form irregular plates against the cell wall (Fig. 9.29, surface view) pyrenoid usually single, central, with a thick starch sheath, occasionally two or three pyrenoids present; spore formation not observed.

MURIELLA cf. *TERRESTRIS* Boye Pet.
(Fig. 10.1-8; S9; PETERSEN, 1932a)

Cells spherical to sub-spherical, up to 14.5 µm diameter but mostly 8-11 µm, occasionally with small papilla-like wall thickenings (Fig. 10.1), smallest cells 5 µm diameter; chromatophore single in recently released aplanospores (Fig. 10.6), several in largest cells (Fig. 10.3-5); pyrenoids absent; starch grains scattered throughout chromatophores; reproduction by formation of two, four, eight and 16 aplanospores released by rupture of sporangium wall.

M. terrestris has smaller cells, 3-7 µm diameter, and does not possess the small papillae seen in the present specimens.

SCHWABE (1970), BEHRE and SCHWABE (1970) record *M. terrestris*.

cf. *OOCYSTIS* sp.
(Fig. 10.9-12; S13; BOURRELLY, 1966)

Cells ellipsoidal but often with a greater curvature on one side (Fig. 10.10), 9-14 µm long by 3.5-8 µm wide, with slightly thickened apical walls; chromatophore parietal, often lobed, containing from one to three pyrenoids; reproduction by formation of two, four or eight autospores released by rupture of the sporangium

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vulgaris var. 1. 38-42, *C. vulgaris* var. 2. 43-47, *C.* cf. *zofingensis*. 48-50, cf. *Jaagiochlorella geometrica*. 51-55, *Planktosphaerella terrestris*. Scales equal 10 µm; A, 1, 2, 7-24, 33-47; B, 27-29, 51-55; C, 3, 4, 25, 26, 48-50, D, 5, 6, 30-32.

wall (Fig. 10.12).

Oocystis spp. are often characterized by the autospores remaining within a greatly expanded sporangium wall before their eventual release, this was not observed in the present specimens. However, cell shape, the thickened apices, and reproduction by autospores are characteristic of that genus.

PLANKTOSPHAERELLA TERRESTRIS Reisigl
(Fig. 9.51-55; S5-7, 22; REISIGL, 1964)

Cells spherical up to 13 µm diameter, smallest released spores from 3 µm diameter; chromatophores parietal, each with a single pyrenoid, numerous in adult cells (Fig. 9.51, 52), single in smallest spores (Fig. 9.55); reproduction by formation of two, four, eight, 16 or 32 autospores.

cf. *RHOPALOCYSTIS CUCUMIS* Reisigl
(Fig. 9.17-24; S21; REISIGL, 1964)

Cells *ca.* pyriform, 13-18 µm long by 6.5-11 µm wide, often slightly curved at the narrow apex (Fig. 9.18); chromatophore parietal, often appearing bilobed, with a single pyrenoid; oil globules often present; reproduction by spherical aplanospores (Fig. 9.19-22), from two to 32 per sporangium, or by zoospores (Fig. 9.23, 24), sporangia containing numerous spores; zoospores equally biflagellate, spherical to pyriform, *ca.* 4.5 µm in diameter, released through an apical rupture.

R. cucumis has similarly shaped cells and reproduction. The cells, however, are up to 30 µm long. BOURRELLY (1966) states that after zoosporulation in *Rhopalocystis* a portion of the sporangium remains in the base of the otherwise emptied cell. REISIGL (1964) does not describe this for *R. cucumis* nor was it observed in the present specimen. There would appear to be some taxonomic confusion here (cf. the species described below).

RHOPALOCYSTIS cf. *OLEIFERA* Schuss.
(Fig. 9.7-16; S2, 4-7, 14, 16, 19, 20; SCHUSSNIG, 1955)

Cells pyriform to *ca.* cylindrical, often slightly curved, 6-17 µm long by 2-8 µm wide (Fig. 9.7-10), occasionally a small, apical papilla is visible (Fig. 9.8 and Fig. 9.16, on a recently settled zoospore); chromatophore parietal with a prominent pyrenoid; reproduction by autospores, only one sporangium observed with two spores (Fig. 9.11), and zoospores which are formed in large numbers (Fig. 9.15); after zoosporulation a portion of the mother cell, or occasionally two separate portions, remains in the base of the sporangium wall (Fig. 9.12-14), this then regrows, if zoosporulation again occurs then the basal remaining portion is surrounded by two ald sporangium walls (Fig. 9.12).

This alga has the characters of *Rhopalocystis* described by BOURRELLY (1966). *R. oleifera* is the only species described in which a portion of the mother cell remains in the base of the old sporangium wall. However, the cells of *R. oleifera* are up to 30 µm long by 12-14 µm wide.

SCOTIELLA cf. *OOCYSTIFORMIS* Lund
(Fig. 10.16-22; S2, 3, 6, 7, 9-11, 13, 20-22, 24; LUND, 1957)

Cells ellipsoidal to broadly fusiform, 9-22 µm long by 5-16 µm wide; in cultures the cell wall thickenings are often not visible (Fig. 10.16) or only faintly visible as small polar thickenings (Fig. 10.18), occasional cells have more readily visible ridges (Fig. 10.20) which in apical view are slightly spiralled (Fig. 10.21); chromatophore parietal, single in young cells, occasionally fissured (Fig. 10.17) and in older cultures fragmenting into numerous portions (Fig. 10.19); pyrenoid single, prominent; reproduction by four or eight autospores (Fig. 10.22).

S. oocystiformis has similarly sized cells with ridges which are often not detectable. However, two to sixteen autospores are formed and in apical view the cells have 8-10 angles. Further observations of cultures are necessary before the present alga can be confidently assigned to this species.

SPHAEROCYSTIS cf. *SIGNIENSIS* mh.
(Fig. 10.31-33; S8; BROADY, 1976)

Cells in groups of two and four or irregularly arranged throughout homogeneous, mucilaginous colonies (Fig. 10.31); adult cells spherical, 7.5-9.5 µm diameter, chromatophore cup-shaped and lobed with a basal pyrenoid surrounded by large starch grains; oil droplets often present; reproduction by ellipsoidal to subsphaerical autospores, two or four released by rupture (Fig. 10.33) or gelatinization of sporangium wall.

S. signiensis has a larger size range with adult cells up to 15 µm diameter, the colonial mucilage is sometimes faintly stratified and the pyrenoid is surrounded by small starch grains.

SPHAEROCYSTIS sp. 1
(Fig. 10.23-26; S5)

Cells in groups of four and eight or irregularly arranged throughout homogeneous, mucilaginous colonies; adult cells broadly ellipsoidal (Fig. 10.24, 25), up to 11 µm long by 9.5 µm wide, with a lobed, parietal chromatophore containing and indistinct pyrenoid lacking a starch sheath; starch grains revealed in the chromatophore using Lugol´s iodine; oil globules often present; reproduction by ellipsoidal autospores from 6.5 µm long by 5 µm wide (Fig. 10.26), released by partial gelatinization and rupture of sporangium wall.

This alga is in many respects similar to the three species of *Sphaerocystis* described by BROADY (1976) but cannot be assigned to any of these.

SPHAEROCYSTIS sp. 2
(Fig. 10.27-30; S2, 6, 7, 9, 10, 16, 20)

Cells in groups of four and eight and irregularly arranged throughout homogeneous, mucilaginous colonies; adult cells broadly ellipsoidal and spherical, up to 9.5 µm long by 6.5 µm wide, with a cup-shaped chromatophore occupying about half the wall and containing a basal pyrenoid surrounded by small starch grains; oil globules

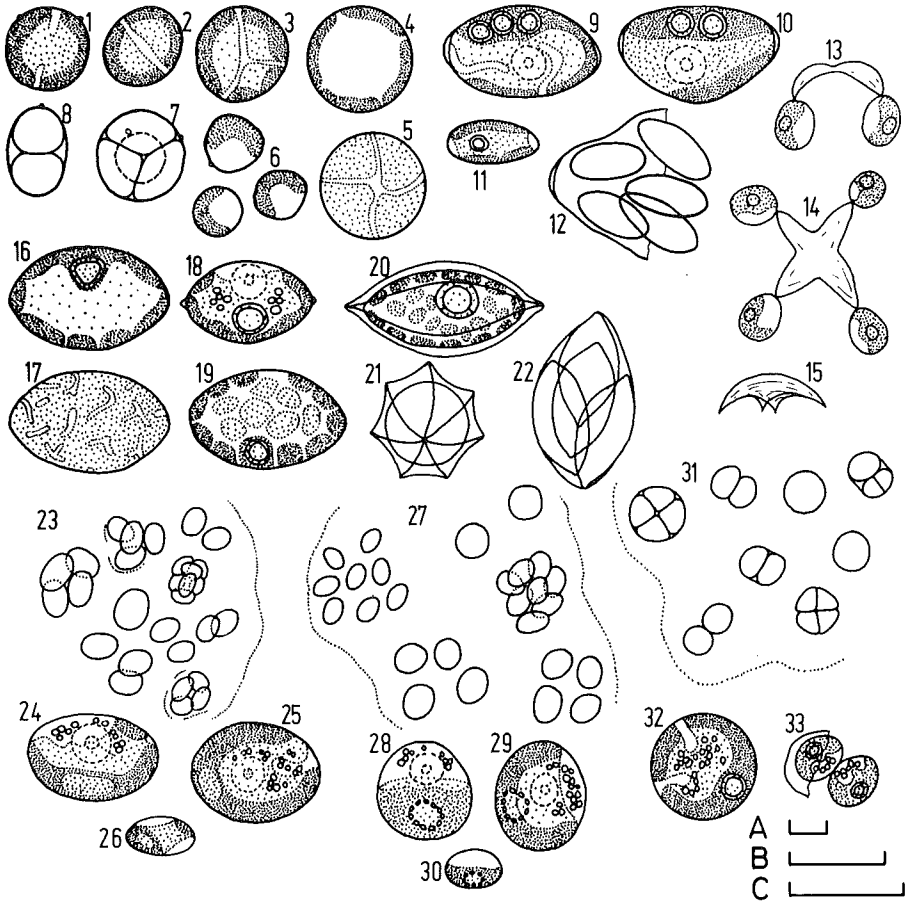


Fig. 10. 1-8, *Muriella* cf. *terrestris*. 9-12, cf. *Oocystis* sp. 13-15, *Dictyosphaerium minutum*. 16-22, *Scotiella* cf. *oocystiformis*. 23-26, *Sphaerocystis* sp. 1. 27-30, *S.* sp. 2. 31-33, *S.* cf. *signiensis*. Scales equal 10 µm; A, 23, 27, 31; B, 16-22; C, 1-15, 24-26, 28-30, 32, 33.

often present; reproduction by ellipsoidal autospores, 5 µm long by 3.5 µm wide, four or eight released by gelatinization of the sporangium wall although wall remains are sometimes visible.

This alga is similar to the above two taxa and to the three species described by BROADY (1976) although slight differences prevent it being assigned to any of the latter.

cf. *SPONGIOCOCCUM* sp.
(Fig. 9.3-6; S28; BOURRELLY, 1966)

Cells spherical, up to 47 µm diameter, with a thickened wall 1.5-6.5 µm wide, often with irregular wall thickenings (Fig. 9.5, 6) or occasionally with a regularly much thickened wall (Fig. 9.4); chromatophore sponge-like with an irregularly shaped central pyrenoid possessing a thick starch sheath; aplanospore production observed in a sporangium 84 µm diameter with spores varying in diameter from 11 to 50 µm.

In the absence of cultures in which life-history could be studies it is impossible to assign this alga to either of the two similar genera *Spongiococcum* and *Spongiochloris* which can only be separated on the basis of the presence or absence of a cell wall around the zoospores.

Unidentified spp.

Eleven free-living, spherical members of the Chlorococcales have been isolated into culture and recognized as different taxa. They include species of *Chlorococcum* and other as yet undetermined genera. It is hoped to present descriptions of these after examination of their morphologies and life-histories.

ULOTHRICALES

CHLORHORMIDIUM DISSECTUM (Chod.) Fott f.
Syn. *Hormidium dissectum* (Gay) Chod.
(Fig. 11.1-4; S2, 5, 6, 9, 10, 12, 15, 18; PRINZ, 1964)

Filaments short, readily fragmented, from two to 14 cells in length (Fig. 11.3, 4); cells 6 µm wide by 8-22 µm long.

The width range of *C. dissectum* is 7-9 µm, slightly more than the present specimens.

CHLORHORMIDIUM FLACCIDUM (A. Br.) Fott
Syn. *Hormidium flaccidum* A. Br.
(Fig. 11.5, 6; S2, 15, 17, 20, 21; PRINZ, 1964)

Filaments long, 7.5-9.5 µm wide; cells 12-27 µm long.
PETERSEN (1928b), SCHWABE and BEHRE (1972).

CHLORHORMIDIUM SUBTILE (Herr.) Fott
Syn. *Hormidium subtile* (Kuetz.) Heer.
(Fig. 11.7, 8; S15, 24; PRINZ, 1964)

Filaments from two to more than 40 cells long, width 3-4µm; cells 6-14.5 µm long; small grains of starch around the pyrenoid; oil globules often present.

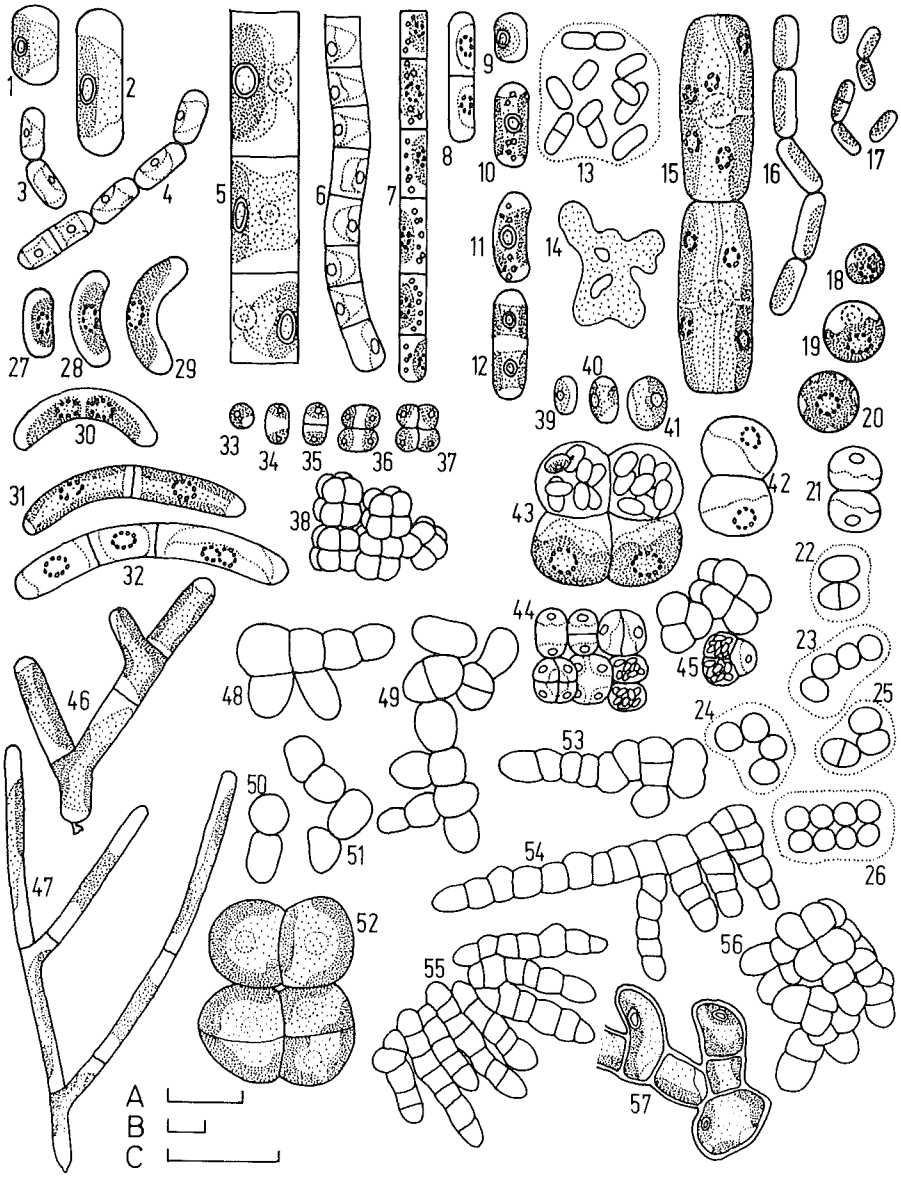


Fig. 11. 1-4, *Chlorhormidium dissectum*. 5, 6, *C. flaccidum*. 7, 8, *C. subtile*. 9-14, *Fottea pyrenoidosa* var. *minor* nov. var. 15, *Heterotrichopsis* cf. *viridis*. 16, *Stichococcus bacillaris*. 17, *S.* cf. *minutus*. 18-

FOTTEA PYRENOIDOSA var. *MINOR* nov. var.
(Fig. 11.9-14; S19)

Irregular colonies (Fig. 11.14, from a young agar culture) containing cells distributed irregularly throughout homogeneous mucilage (Fig. 11.13); cells sylindrical, straight or occasionally slightly curved (Fig. 11.11), 4.5 µm wide by 6-11 µm long; chromatophore single, occasionally two in dividing cells (Fig. 11.12), parietal, plate-like, occupying more than half the wall and containing a single prominent pyrenoid, rarely two; oil globules often present; transverse cell division produces two daughter cells which remain temporarily united.

F. pyrenoidosa Broady (1976) differs in its larger size with cells 6 µm wide by 6-18 µm long, and in its possession of cells which are usually slightly curved.

HETEROTRICHOPSIS cf. *VIRIDIS* Iyengar and Kanthamma
(Fig. 11.15; S2, 11; IYENGAR and KATHAMMA, 1941)

Cells single or in pairs, cylindrical, barely swollen centrally and occasionally slightly curved, 10-11 µm wide by 25-45 µm long, containing two to four plate-like, parietal chromatophores each with one or two pyrenoids surrounded by large starch grains; nucleus central; transverse cell division occurs with the formation of two daughter cells.

H. viridis has smaller cells, 6-8 µm wide by 16-33 µm long and also forms aplanospores, the structure of the vegetative cells is otherwise similar to the present specimens.

STICHOCOCCUS BACILLARIS Naeg. sens. ampl.
(S1, 2, 4, 6-8, 10, 12, 13, 15, 16, 19, 20, 22; PRINZ, 1964)
PETERSEN (1928a), BEHRE and SCHWABE (1970)

STICHOCOCCUS BACILLARIS Naeg. sens. strict.
(Fig. 11.16; S24; PRINZ, 1964)

Filaments of up to 22 loosely connected cells; cells 3-3.5 µm wide by 5-11 µm long; chromatophore single, parietal.

STICHOCOCCUS cf. *MINUTUS* Grintzesco and Peterfi
(Fig. 11.17; S24; PRINZ, 1964)

Filaments rarely as many as four cells long, cells usually single or in pairs; cells 1.5-2.5 µm wide by 3-6.5 µm long, chromatophore single, parietal.

S. minutus has cells 2.5-3 µm wide.

26, cf. *Pseudendocloniopsis* sp. 27-32, Unidentified species of the Ulothricaceae. 33-38, *Chlorosarcinopsis* sp. 1. 39-45, *C.* sp. 2. 46, *Microthamnion kuetzingianum.* 47, *M. strictissimum* f. 48-52, cf. *Gongrosira terricola.* 53-57, cf. *Desmococcus* sp. Scales A and B equal 10 µm, C equals 1 mm; A, all figures except: B, 3, 4, 6, 13, 21-26, 44, 45, 48-51, 53-56; C, 14.

Unidentified genus of the Ulothricaceae
(Fig. 11.27-32; S12)

Cells usually single, though occasionally in short filaments of two or three cells (Fig. 11.31, 32), cylindrical, more or less lunate, 4-5 µm wide by 9.5-24 µm long; chromatophore single, with a central pyrenoid surrounded by small starch grains; transverse cell division.

The cells resemble those of *Fottea pyrenoidosa* mh. in general shape but lack that alga's mucilaginous envelopes. *Chodatia* Kol, a doubtful member of the Chlorophyta (BOURRELLY, 1966), is similar in shape and lacks mucilage. However, it also lacks a pyrenoid. Unfortunately no cultures of this alga were obtained and it must remain undetermined.

CHAETOPHORALES

CHLOROSARCINOPSIS sp. 1
(Fig. 11.33-38; S6, 15, 19; BOURRELLY, 1966)

Cells single, in pairs, fours, cubical aggregates of eight cells or larger, readily fragmented cubical aggregates (Fig. 11.38); cells 3-5 µm diameter with a cup-shaped chromatophore containing a small pyrenoid; transverse cell division (Fig. 11.33-37).

Further observation of cultured material is required.

CHLOROSARCINOPSIS sp. 2
(Fig. 11.39-45; S1, 9, 17, 22; BOURRELLY, 1966)

Cells up to 11 µm diameter, single, in pairs, cubical or tetrahedral packets (Fig. 11.45) and larger, readily fragmented cubical aggregates (Fig. 11.44); chromatophore cup-shaped with a somewhat irregular border, containing a pyrenoid surrounded by small starch grains (Fig. 11.43); aplanospore formation with two, four, eight or larger numbers of ellipsoidal to short cylindrical spores (Fig. 11.39, 40), from 4.5 µm long by 2 µm wide, being formed in single cells and cells in aggregates (Fig. 11.43-45).

Further observation of cultured material is required.

cf. *DESMOCOCCUS* sp.
(Fig. 11.53-57; S20, 22; BOURRELLY, 1966)

Colonies on agar consisting of a central mass of cells in more or less cubical aggregates (Fig. 11.56) with a peripheral growth of richly branching filaments (Fig. 11.53-55); cells 5-7 µm wide and up to 10 µm long, with a parietal chromatophore and a faint pyrenoid (Fig. 11.57), often packed with oil globules.

Spore formation was not observed and hence it is not possible to confidently assign this alga to a genus. On vegetative characteristics it appears close to *Desmococcus* Brand.

cf. *GONGROSIRA TERRICOLA* Bristol
(Fig. 11.48-52; S12, 14; LUND, 1947)

Thalli small, consisting of a few loosely joined cells, often branched or in small cubical packets; cells 11-16 µm in diameter with a parietal chromatophore containing a faint pyrenoid (Fig. 11.52).

The features of the vegetative cells are similar to those of *G. terricola* described by LUND (1947). However, in the absence of spore formation no confident identification can be made.

MICROTHAMNION KUETZINGIANUM Naeg.
(Fig. 11.46; S2, 7, 11-13, 16-19; PRINZ, 1964)

Thalli consisting of richly branched filaments; cells 3-5 µm wide and up to 15 µm long; chromatophore parietal lacking a pyrenoid; small holdfast often distinguishable on basal cell of small thalli, as shown in figure.

PETERSEN (1928a and 1928b).

MICROTHAMNION STRICTISSIMUM Rabenh. f.
(Fig. 11.47; S7, 13, 17, 18; PRINZ, 1964)

Thalli of generally similar form to the above species; cells 1.5-2.0 µm wide by 14-33 µm long.

This species has a somewhat narrower width range than that given for *M. strictissimum* by PRINZ (1964) of 3-4 µm. However, both species have similar long cells.

cf. *PSEUDENDOCLONIOPSIS* sp.
(Fig. 11.18-26; S21; BOURRELLY, 1966)

Cells spherical to ellipsoidal, 5-8 µm in diameter, embedded in soft, homogeneous mucilage; chromatophore parietal, cup-shaped with a lobed border and a basal pyrenoid surrounded by small starch grains (Fig. 11.18-20); vegetative cell division results in groups of two, four or eight cells being formed, the four cell groups may open out to form short chains of loosely adhering cells (Fig. 11.23, 24); colonies from agar plate cultures when transferred to aqueous microscopic preparations split into separate aggregates of two to eight cells when pressure is applied to the coverglass, a thin mucilage layer around each group is revealed by indian ink.

BOURRELLY (1966) provides a similar description for vegetative cells of *Pseudendocloniopsis* Vischer, however, spore formation as described by him was not observed in the present specimens.

ZYGOPHYCEAE

ZYGNEMATALES

ACTINOTAENIUM CUCURBITA (Breb.) Teil.
(Fig. 12.6; S14, 16; TEILING, 1954)

Cells in frontal view 41-64 µm long by 19-27 µm wide.

ACTINOTAENIUM CUCURBITA var. *ATTENUATUM* Teil f.
(Fig. 12.7; S2, 4, 6, 18, 19, 21; TEILING, 1954)

Cells in frontal view 27-38 µm long by 11-16 µm wide.
A. cucurbita var. *attenuatum* possesses somewhat wider cells 15-23 µm wide.

cf. *ACTINOTAENIUM PINICOLUM* Rosa
(Fig. 12.8-13; S15; ROSA, 1959)

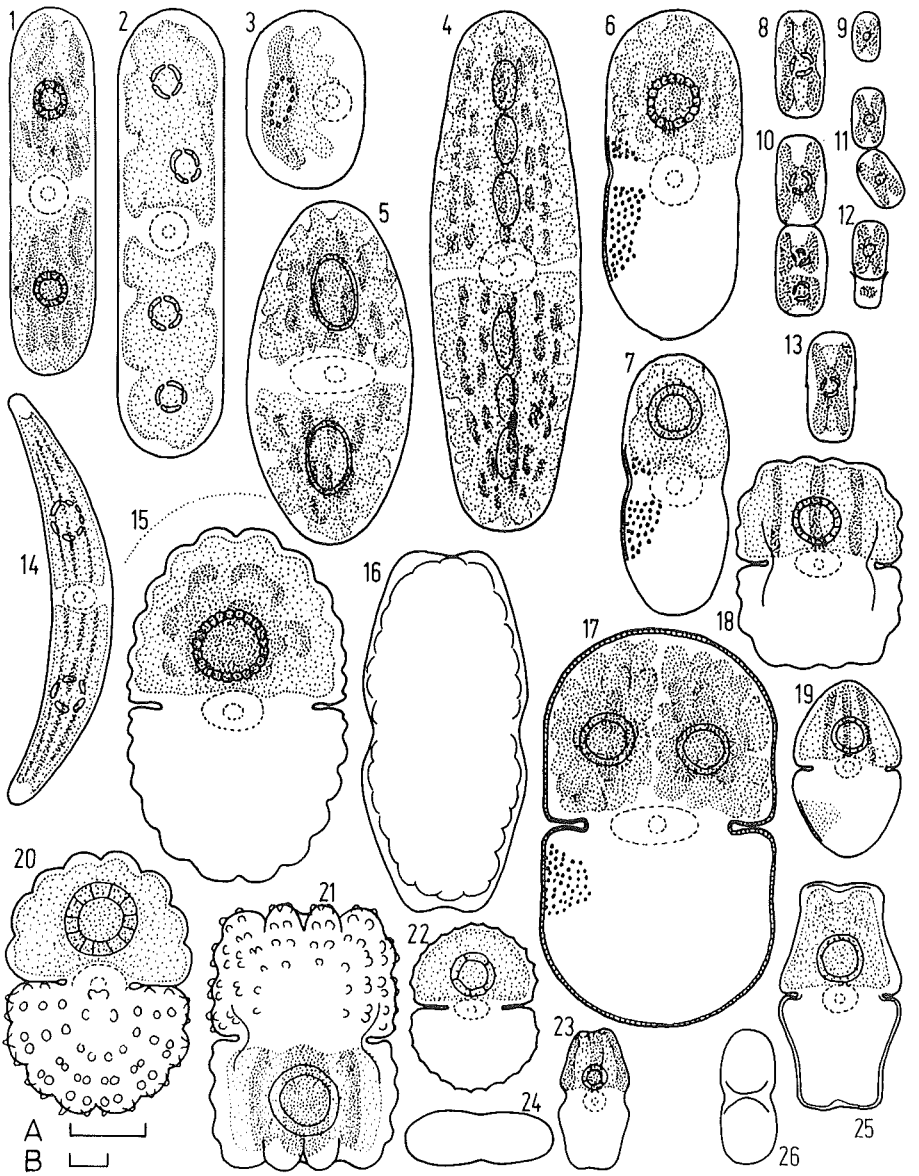
Cells cylindrical, 6.5-14 µm long by 3.5-6.5 µm wide, single or in temprary pairs after cell division; chromatophore single, axial, or occasionally double in dividing cells (Fig. 12.10), with a central pyrenoid surrounded by starch grains; wall appears to be composed of two halves although this is only apparent in occasional cells which may have a slight central bulge (Fig. 12.13) or a slight depression. A cell was observed in which division appeared to have been abortive (Fig. 12.12) and one half of one of the pair of new cells had failed to form, the remaining half of the original mother cell adhered to the single completely-formed daughter cell.

Unfortunately only a few specimens of this curious algae were observed in mixed cultures. It appears to be a member of the Desmidiaceae due to the cell wall being composed of two halves and the possession of an axial chromatophore. However, there is no marked median constriction and zygote formation was not observed. *A. pinicolum* has a similar chromatophore and similarly shaped cells although a faint median constriction is generally visible and the apices are less broadly rounded, the wall is punctate and the cells considerably larger being 25-29 µm long by 7.5-9 µm wide.

CLOSTERIUM PUSILLUM var. *MAJOR* Racib.
(Fig. 12.14; S14; WEST and WEST, 1904)

Only two specimens observed, 102-110 µm long by 15-16 µm wide.
WEST and WEST (1904) describe a smaller size range, 102-110 µm long by 15-16 µm wide.

Fig. 12. 1, *Cylindrocystis brebissonii*. 2, *Mesotaenium endlicherianum* var. *grande*. 3, *M. macrococcum*. 4, *Netrium digitus*. 5, *N. digitus* var. *curtum*. 6, *Actinotaenium cucurbita*. 7, *A. cucurbita* var. *attenuatum*. 8-13, cf. *A. pinicolum*. 14, *Closterium pusillum* var. *major*. 15, 16,



Cosmarium petsamoense. 17, *C.* cf. *pseudonitidulum*. 18, *C.* sp. 6. 19, *C. granatum* f. 20, *C.* sp. 11. 21, *C.* 12. 22, *C. undulatum* var. *minutum*. 23, 24, *C.* sp. 8. 25, 26, *C.* sp. 9. Scales equal 10 µm; A, all figures except: B, 4, 5, 14, 19, 26.

COSMARIUM GRANATUM Breb. f.
(Fig. 12.19; S16; KRIEGER and GERLOFF, 1962-1969)

Cells in frontal view 43-47 µm long by 27-30 µm wide.
C. granatum Breb. has a deeper median suture.

COSMARIUM PETSAMOENSE Cedercreutz
(Fig. 12.15, 16; S2, 3, 6, 11, 14, 16, 19, 20; GRÖNBLAD, 1933)

Cells in frontal view 39-47 µm long by 25-30 µm wide (Fig. 12.15), in profile 22 µm at widest point (Fig. 12.16); embedded in mucilaginous colonies.

COSMARIUM cf. *PSEUDONITIDULUM* Nordst.
(Fig. 12.17; S14; KRIEGER and GERLOFF, 1962-1969)

Cells in frontal view 50-61 µm long by 27-31 µm wide, each half-cell containing two chromatophores.
C. pseudonitidulum has slightly larger cells, 37-54 µm long, and they are slightly attenuated towards the apices.

COSMARIUM UNDULATUM var. *MINUTUM* Wittrock
(Fig. 12.22; S14; KRIEGER and GERLOFF, 1962-1969)

Cells in frontal view 22-28 µm long by 17-23 µm wide.

COSMARIUM sp. 6
(Fig. 12.18; S2)

Cells in frontal view 28 µm long by 22 µm wide, with a single ribbed chromatophore in each half-cell.

COSMARIUM sp. 8
(Fig. 12.23, 24; S11, 21)

Cells in frontal view 16-23 µm long by 9-11 µm wide (Fig. 12.23); profile view without an apical depression (Fig. 12.24).

COSMARIUM sp. 9
(Fig. 12.25, 26; S2, 3, 16, 20, 21)

Cells in frontal view 26-34 µm long by 15-16 µm wide, wall slightly thickened at apices, without a deep constriction in profile (Fig. 12.26).

COSMARIUM sp. 11
(Fig. 12.20; S16)

Cells in frontal view 34-37 µm long by 24-26 µm wide, with a sculptured wall.

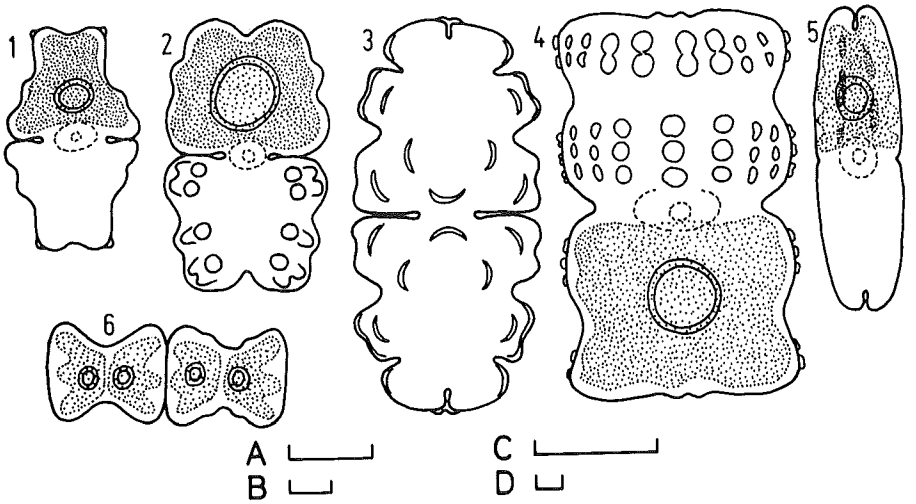


Fig. 13. 1, *Euastrum dubium* f. 2, *E.* sp. 2. 3, *E. oblongum*. 4, *E.* sp. 4. 5, *Tetmemorus laevis*. 6, *Spondylosium* cf. *planum*. Scales equal 10 µm; A, 1, 2, 4; B, 5; C, 6; D, 3.

COSMARIUM sp. 12
(Fig. 12.21; S2, 20)

Cells in frontal view 31-36 µm long by 24-25 µm wide, with a sculptured wall, often occurring in short chains.

CYLINDROCYSTIS BREBISSONII (Ralfs) De Bary
(Fig. 12.1; S2-4, 11-13, 16-19, 21; KRIEGER, 1937)

Cells cylindrical, 41-53 µm long by 11-19 µm wide.

EUASTRUM DUBIUM Naeg. f.
(Fig. 13,1; S16; KRIEGER, 1937)

Cells in frontal view 27-28 µm long by 16-17.5 µm wide. *E. dubium* has slightly wider cells, 17-26 µm wide.

EUASTRUM OBLONGUM (Grev.) Ralfs
(Fig. 13.3; S14; KRIEGER, 1937)

Cells in frontal view 149-162 µm long by 69-72 µm wide; chromatophores not clearly observed.

EUASTRUM sp. 2
(Fig. 13.2; S14, 16)

Cells in frontal view 33-38 µm long by 20-23 µm wide, with a sculptured wall.

EUASTRUM sp. 4
(Fig. 13.4; S2)

Only one specimen observed; cell in frontal view 47 µm long by 28 µm wide with a sculptured wall.

MESOTAENIUM ENDLICHERIANUM var.*GRANDE* Nordst.
(Fig. 12.2; S16; KRIEGER, 1937)

Few specimens observed; cells cylindrical, 61-62 µm long by 14-15 µm wide, with two axial chromatophores each containing two pyrenoids.

The violet cell sap described by KRIEGER (1937) as often present was not observed.

MESOTAENIUM MACROCOCCUM West and West
(Fig. 12.3; S12, 21; WEST and WEST, 1904)

Few specimens observed; cells generally short, cylindrical, 27-28 µm long by 16-17 µm wide, dividing cells up to 55 µm long; chromatophore with a lobed margin.

SCHWABE and BEHRE (1972).

NETRIUM DIGITUS (Ehrenb.) Itzigs. and Rothe
(Fig. 12.4; S14; KRIEGER, 1937)

Cells 113-138 µm long by 38-40 µm wide.

NETRIUM DIGITUS var. *CURTUM* (Borge) Krieger f.
(Fig. 12.5; S14; KRIEGER, 1937)

Only two specimens observed; cells 64-91 µm long by 26-45 µm wide.

The present specimens were smaller than the specimen described by KRIEGER (1937) which was 113 µm long by 46 µm wide.

SPONDYLOSIUM cf. *PLANUM* (Wolle) West and West
(Fig. 13.6; S11, 16, 21; CROASDALE, 1957)

Cells *ca.* 9 µm long by 8 µm wide, forming short chains of up to four cells; the lateral walls often have a small undulation as in the second cell illustrated.

CROASDALE (1957) describes the cells of *S. planum* as 12.5 µm long by 13 µm wide and does not illustrate any cell wall undulations.

STAURASTRUM sp.
(not illustrated; S18)

Only one poor specimen observed; cell with four radiating arms in apical view; wall punctate; in profile 33 µm long by 23 µm wide.

TETMEMORUS LAEVIS (Kuetz.) Ralfs
(Fig. 13.5; S14; KRIEGER, 1937)

Only two specimens observed; cells in frontal view 74-76 µm long by 20 µm wide.

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Höfundur dvaldi á Akureyri sumarið 1977 og safnaði þá sýnum af yfirborði jarðvegs og mosagróðri í 500-1300 m hæð yfir sjó í fjöllunum við Glerárdal(mynd 1). Sýnin voru fyrst skoðuð eins og þau komu fyrir en síðan tekin af þeim deilisýni til ræktunar jarðvegsþörunga. Hvorki voru tekin sýni af klettum(steinum) né úr varanlegu vatni,en sum voru tekin í mjög blautu landi.

Ræktun þörunganna og smásjárskoðun (greining) fór að mestu fram í rannsóknastofu Náttúrugripasafnsins á Akureyri þetta sama sumar.

Við rannsóknina fundust um 200 gerðir (taxa) af jarðvegsþörungum og er 184 þeirra lýst í greininni. Af þeim eru um 100 gerðir greindar til tegundar en hinar yfirleitt til ættkvíslar.Lýst er tveimur nýjum afbrigðum.

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