Green and yellow-green terrestrial algae from Surtsey (Iceland) in 1978

By

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INTRODUCTION

The first record of the occurrence of microscopic terrestrial algae on Surtsey was made by Maguire (1968) who cultured five green algae from ash samples. The first extensive survey was conducted in 1968 and reported by Behre and Schwabe (1970) and Schwabe (1970). Follow up studies were made in the years to 1973. Schwabe and Behre (1972) reported on all groups of algae recovered from samples removed up to 1970. Schwabe (1972, 1974) examined the role of blue-green algae between 1968 and 1973 and disputed the claim made by Brock (1973) who regarded these algae to be of minor importance as primary colonizers. Castenholz (1972) examined blue-green algal growths on soil adjacent to steam vents and Henriksson and others (1972) and Henriksson and Rodgers (1978) measured nitrogen fixation by blue-green algae in the juvenile soils. To date the emphasis of studies has been placed on the blue-green algae. The present study is concerned solely with the green and yellow-green algae with could be important contributors of organic material to the soils. This would support the establishment and development of a decomposing microflora and fauna.

Terrestrial algae of the Icelandic mainland have been studied by Petersen (1928a, 1928b). Schwabe (1970) examined some mainland samples as well as those from Surtsey. In 1977 a survey of the terrestrial algae of Glerárdalur, near Akureyri, was conducted by Broady (1978).

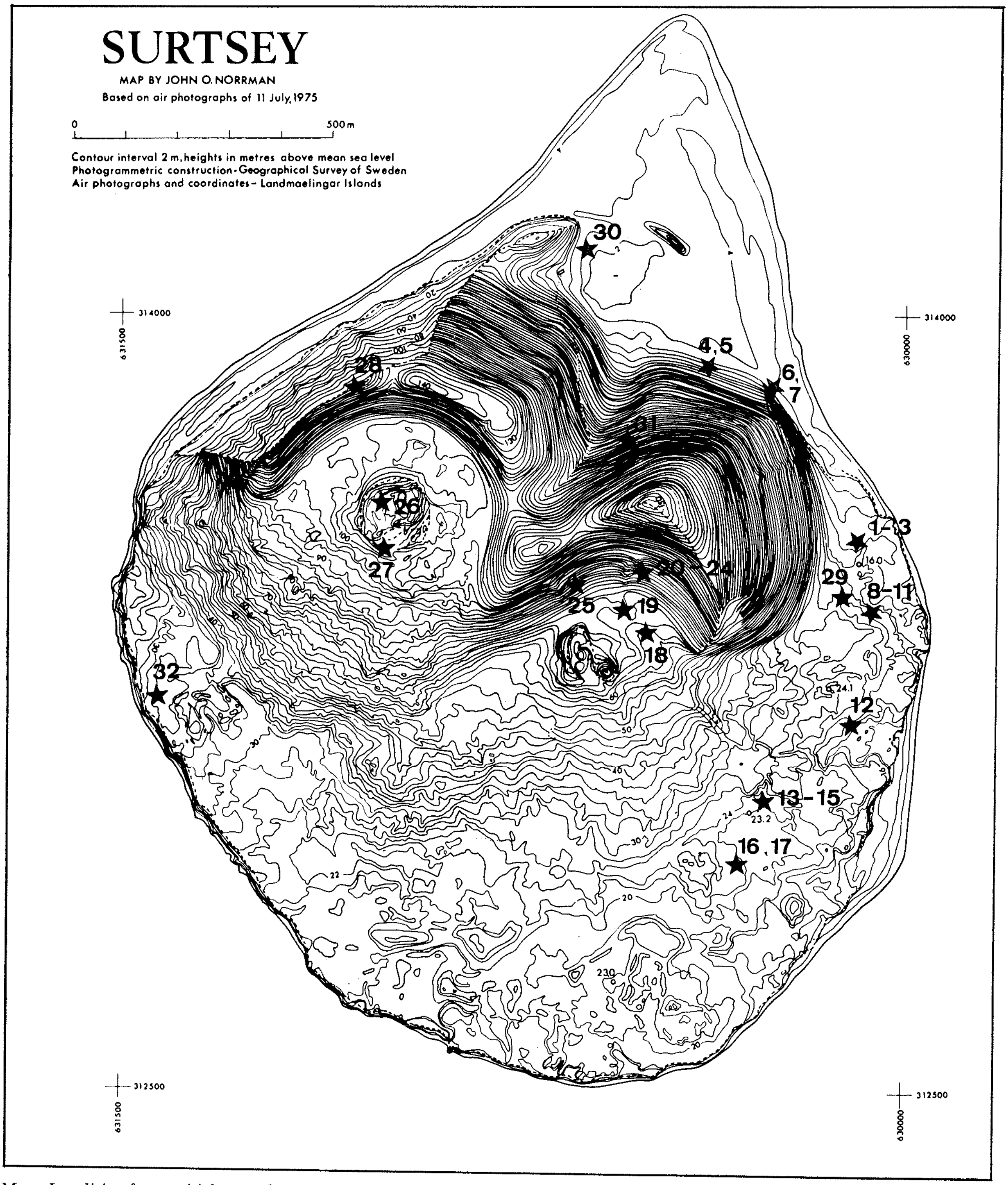
The present work can only be regarded as a preliminary survey as only a single day was spent in the removal of just 32 samples of tephra, lava and vegetation. Presence or absence of the algae was recorded for each sample and little information regarding their abundance was obtained. Difficulties were encountered in identifying several isolates which will require prolonged detailed examination in culture for their characterization. However, it was thought to be worthwhile to provide descriptions and illustrations of difficult forms in order to place their presence on record.

METHODS AND MATERIALS

Sampling. Samples were collected on the 28th July. About 25 gm. of the superficial substratum was scooped or chipped into sterile plastic containers using a sterile spoon fixed within the lid of each container.

Treatment of samples. Samples were treated four days after collection following transport and storage at ambient temperatures. Sample material was examined microscopically in order to obtain a general impression of the types and abundance of algae present. Approximately one gram of material was spread over the surface of agarised (1.5% w/v) Bold's basal medium (BBM) (Chantanachat and Bold, 1962) containing 10% v/v of an unfertilised garden soil extract. Moist plate enrichment cultures (Lund, 1945) were established. The sample was moistened with sterile distilled water and the cultures examined over a period of six weeks. Algae appearing on agarised media were used to innoculate stock cultures on BBM agar slopes.

Examination of algae. Cultures were examined at magnifications up to x1000 using illumination. Photographs were taken using Ilford Pan F film. Lugol's iodine was used to test for the presence of starch and occasionally to clarify the number of nuclei. Indian ink and toluidine blue helped reveal the presence of gelatinous matrices. The latter stain often helped in distinguishing sporangium wall remains. Chloroplast structure



Map. Localities from which samples were removed for analysis of the algal flora.

was elucidated using a dark blue filter. (Kodak Wratten Nr. 48) as suggested by Friedmann (1966).

SAMPLE LOCATIONS

The approximate locations of the 32 sample collections are shown on the map.

1. Green crust-like algal growth thinly coating the underside of a portion of lava.
2. Fine-grained moist ash in small depressions in lava, with a slight moss growth.
3. Well established cushions of moss up to 5 cm in diameter, on ash and dust collected in crevices and hollows in the lava.
4. Coarse-grained tephra around and below bird droppings.
5. Coarse-grained tephra a few metres distant from the droppings sampled in 4 above.

6. Fine-grained tephra in the centre of a well established growth of *Honkenya peploides* one metre wide.
7. Bare tephra a few metres from sample 6 above.
8. Moss from extensive cushion growths in a damp, dimly illuminated cave in the lava field.
9. Scrapings from green crusts of algae on damp lava surfaces in cave, as 8 above.
10. Fine-grained tephra, moist, lodged in crevices and depressions in lava.
11. Green crust of algae coating the bones of a dead bird, adjacent to 10 above.
12. Tephra in depressions in one of the last lava flows, only slight moss development.

13-15. Samples removed from a lava knoll the summit of which was used as a nesting site by black-backed gulls; bird droppings and bones in the immediate vincinty.

13. Rich growth of bright green filamentous algae on summit of knoll.
14. Moss from a large cushion 30 cm in diameter on the edge of the knoll.
15. Blackish felts of filamentous Cyanophyta.
16. Moss cushion cm. in diameter; an isolated growth on lava.
17. Fine-grained, moist tephra in depressions in lava, adjacent to 16 above.
18. Coarse-grained, loose tephra, distant from phanerogamic colonisers.
19. Coarse-grained tephra from within a *Honkenya peploides* stand.
20. Fine-grained moist tephra with a slight moss development, warmed by adjacent steam vent.
21. Adjacent and similar to 20 above.
22. Brown algal slime in water film on rock surface within the opening of „the Bell“ fumarole.
23. Macroscopic growths of blue-green algae, adjacent to 22 above, but in a hotter region of the steam vent.
24. Fine-grained tephra with a greenish surface coloration, around „the Bell“ fumarole but hardly warmed by steam emissions.
25. Slight moss growths in a region of steam emission.
26. Moss from extensive growths in the crater of Surtur II.
27. Moss growths warmed by steam, on the southern lip of Surtur II.
28. Loose tephra from the summit of the high ridge above and to the north-west of Surtur II.
29. Loose tephra from around steam bases in the most extensive stand of *Elymus arenarius,* the area spotted by many bird droppings.
30. Lower leaves, dead basal leaves and stems of *Honkenya peploides,* partially below loose tephra or just below the surface.
31. Fine-grained tephra with slight moss growth, from steam-warmed ground above a fumarole.
32. Fine-grained tephra in depressions in lava.

GENERAL NOTES REGARDING ALGAE RECOVERED

In the present study 59 forms of green and yellow-green algae were recovered. Of these over 20 are thought to be new records for Surtsey. However, certain isolates could correspond to the problematic algae noted by previous researchers. For instance, Behre and Schwabe (1972) recorded „*Chlorococcum* and related genera“ in samples removed since 1969. These could have included *Bracteacoccus, Neochloris, Borodinella, Tetracystis* and *Myrmecia,* described here for the first time. Similary, the taxa described here as species of *Chlamydocapsa* and *Palmellopsis* could have been included as palmelloid stages of *Chlamydomonas* in previous studies.

Genera of terrestrial and freshwater algae recovered on Surtsey since 1967 are listed in Table 1. Comparisons between studies have shortcomings because of taxonomic problems and the varying extent of the individual surveys, for instance the differing number and locations of the samples removed by different workers. However, it appears that the number of algae that have reached the island as viable propagules is still increasing. The absence of forms found in previous studies is probably due to an insufficiency in sampling rather than to the absence of those algae. The number of genera recovered in the individual studies has risen from 8 in samples taken in 1967 (Maguire, 1968) to 37 in the present investigation. The total number of genera recovered since studies began now stands at about 52.

Macroscopially visible growths of Chlorophyta were present in only four of the samples. Green, powdery crusts of an unidentified chaetophoralean alga occasionally occurred in small fissures and depressions in the lava surfaces. These growths were only found where the lava surface was shaded and in moist surroundings (samples 1 and 9). Sample 9 was taken from within a small, damp cave in the lava field and it was here that this type of growth showed its greatest luxuriance. The influence of bird life on algal growth was readily apparent. Bones of dead birds, which were not infrequent in the lava field, were foci of enriched algal growth and often had a greenish coating of algae over their surfaces. Sample 11 consisted of a bone with a green crust of predominantly *Chlamydomonas augustae* associated with various other green and blue-green algae and diatoms. A prominent knoll in the lava field was used as a nesting site by a pair of black-backed gulls. In the nutrient-enriched area on the top of the knoll considerable growths of the filamentous *"Hormidium"* stage of *Prasiola crispa* were present (sample 13) together with a felt of *"Phormidium"* and moss cushions. The final sample with macroscopic green growths was taken from the steam moistended soil adjacent to "the Bell" fumarole (sample 24). The faint green coloration was due to the presence of abundant cells of *Chlorella vulgaris* var. *autotrophica.*

The macroscopic felts of blue-green algae, and brown slimes of diatoms in the warm, damp regions around the active steam fumaroles are well known from previous studies. Samples 22 and 23 consisted of such growths removed from within, and adjacent to, "the Bell" fumarole. They revealed an associated flora of green and yellow-green algae of respectively 9 and 10 forms. Samples 20, 21, 25, 26 and 31 were of bryophyte growths adjacent to steam emission and contained a mean number of 10 algae.

In general the greatest number of forms were recovered from well-established bryophyte cushions. Six samples (number 3, 8, 14, 16, 26 and 27) contained from 7 to 16 and a mean of 11 algae. Sample 16 contained 16 algae, the maximum number found in all samples. Where bryophyte growth was at an early stage of development without any cushion formation (samples 2, 12, 20, 21, 25 and 31) fewer algae were recovered, ranging from 6 to 13 and with a mean of 8 per sample.

Tephra completely devoid of bryophytes and phanerogamic colonisers (samples 4, 5, 7, 10, 17, 18, 28 and 32) contained fewer algae, with a mean of 4 and a range of 0 to 8. The four samples recovered from amongst well-established growths of the phanerogams *Honkenya peploides* (samples 6, 19 and 30) and *Elymus arenarius* (sample 29) produced similar numbers of algae to the bare tephra, a mean of 3.5 and a range of 0-7.

Only two samples failed to reveal the presence of any viable algae of any type (samples 4 and 29). Both of these were in areas covered by many bird droppings. It would appear that toxic material in the droppings killed even dormant cells transported into these areas.

It is likely that there was sufficient moisture for algal growth only amongst the bryophyte cushions, in small depressions in the lava where wind-blown tephra had accumulated, and in areas affected by steam emission. The bare unconsolidated tephra, which covers large areas of the island, and the similary loose tephra amongst the phanerogam stands, was probably too freely drained and too unstable for algal growth. The algae recovered from such samples were probably present in low numbers as dormant cells blown in from the limited areas of abundant algal growth or from regions outside the island.

Only five algae were recovered from more than ten samples. *Muriella terrestris* var. A was the most widespread and present in 15 samples. *Klebsormidium flaccidum, Chlorella vulgaris* var. *autotrophica, Bracteacoccus minor* and *Chlorella zofingensis* var. A were found in respectively 14, 13, 11 and 11 samples. Four algae occurred in 6 to 10 samples, namely *Chlamydomonas pseudintermedia, Oocystis minuta* var., *Borodinella polytetras* and an unidentified member of the Eustigmatophyceae, with respectively 9, 7, 7 and 7 occurrences. The large majority of algae were only occasionally recovered, in less than 6 samples, and 22 of these were present in only a single sample.

SYSTEMATICS

CHLOROPHYCEAE

The classification of Bold and Wynne (1978) is followed to the ordinal level. Genera are listed alphabetically within each order.

Volvocales

Chlamydomonas augustae Skuja
Fig. 1, 2
Ettl, 1976, p. 403, Taf. 63a
Samples; 2, 10, 11, 14, 32.

Cells ellipsoidal, 13-22 μm long by 7-17 μm wide; chloroplast axial with radiating arms spreading to form plates at cell wall (Fig. 2); pyrenoid slightly posterior, surrounded by small starch grain. 2, 4, 8 and 16 zoospores formed.

Previous records: Surtsey, Behre and Schwabe (1970).

Chlamydomonas foraminata Behre and Schwabe
Behre and Schwabe, 1970, p. 68-69, Taf I
Fig. 1-6
Samples; 22, 27.

Previous records: Surtsey, Behre and Schwabe (1970).

Chlamydomonas perpusilla Gerloff
Fig. 5, 6
Ettl, 1976, p. 516, Taf. 100, Fig. 3
Samples; 25.

Cells narrowly ellipsoidal straight or curved, 8-12 μm long by 2.5 - 3 μm wide; chloroplast a parietal plate; pyrenoid lateral, surrounded by small starch grains; stigma slightly anterior to pyrenoid; nucleus posterior.

Previous records; Surtsey, *C.* sp. ad *perpusilla* (Korsh.) Gerloff, Behre and Schwabe (1970).

Chlamydomonas cf. *perpusilla* Gerloff
Fig. 8-10
Samples; 17.

Cells narrowly ellipsoidal, straight or slightly curved, 5-13 μm long by 2.5-5 μm wide; chloroplast a lobed parietal plate; pyrenoid lateral surrounded by an apparently complete starch sheath; nucleus posterior; stigma anterior.

Chlamydomonas pseudintermedia Behre and Schwabe
Fig. 143
Behre and Schwabe, 1970, p. 70-71, Taf. I, Fig. 8-12.
Samples; 2, 3, 8, 10, 12, 21, 22, 25, 27.

Previous records: Surtsey, Behre and Schwabe (1970).

Chlamydomonas sp. A
Fig. 3, 4
Samples; 17, 27, 31.

Cells ellipsoidal, 5 - 8.5 μm long by 2.5 - 6 μm wide; chloroplast a perforated, parietal cup; pyrenoid lateral and somewhat posterior, surrounded by large starch plates; stigma anterior; nucleus anterior. 4, 8 and 16 gametes formed, these copulating immediately on relase; palmelloid stage formed.

The lateral pyrenoid and perforate chloroplast place this isolate in the *Chlamydella - perforata* group described by Ettl (1976).

Chlamydomonas sp. B
Fig. 7, 142
Samples; 25.

Cells broadly ellipsoidal, 12-15 μm long by 6-9 μm wide; chloroplast a perforate, parietal cup; pyrenoid lateral, surrounded by large starch plates; stigma slightly anterior of pyrenoid; nucleus approximately central. Palmelloid stage readily formed.

Similar to *C.* sp. A in the *Chlamydella - perforata* group of Ettl (1976).

Tetrasporales

Chlamydocapsa sp. A
Fig. 12-14, 140, 141
Samples; 12, 21, 24, 27.

Colonies mucilaginous with cells arranged in groups of 2,4 and 8 throughout (Fig. 140, 141); mucilage faintly stratified around cells and cell groups. Cells broadly ellipsoidal, 8-12 μm long by 5-10.5 μm wide; chloroplast a lobed, perforate, parietal plate (Fig. 12, 13); pyrenoid surrounded by large starch grains. 2, 4 and 8 zoospores formed, with posterior nucleus, anterior stigma (Fig. 14).

Following the scheme proposed by Fott (1972) the presence of lamellations in the mucilage places this alga in *Chlamydocapsa* rather than *Palmellopsis* in which lamellations are absent.

Previous records; Glerárdalur; Broady (1978) described two *Chlamydocapsa* isolates.

Chlamydocapsa sp. B
Fig. 17-19, 135, 136
Samples; 21, 24, 31.

Colonies mucilaginous with cells in groups of 2, 4, 8 and 16 surrounded by faint remains of dilated sporangium wall. Adult cells generally broadly ellipsoidal (Fig. 17), to 13 by 8.5 μm, some approaching spherical (Fig. 136); chloroplast axial with broad radiating arms joining to form a perforate parietal portion (Fig. 19); pyrenoid surrounded by numerous small starch grains. 2, 4, 8 and 16 (Fig. 135) zoospores released by gelatinization of sporangium wall; zoospores (Fig. 18) with an anterior nucleus and stigma.

Palmellopsis sp.
Fig. 15, 16, 137-139
Samples; 3, 21, 23, 24, 27.

Colonies mucilaginous with cells in groups of 2, 4, 8, 16 and 32; mucilage without distinct lamellations. Adult cells broadly ellipsoidal (Fig. 15), up to 19 by 17.5 μm; chloroplast an extensive, perforate cup (Fig. 138, 139); pyrenoid surrounded by numerous starch grains which are often arranged in rows (Fig. 16). 2, 4, 8, 16 and 32 zoospores released by gelatinization of sporangium wall, these are often released without the formation of flagella, as aplanospores, and remain in close groups (Fig. 137); zoospores with posterior nucleus and anterior stigma.

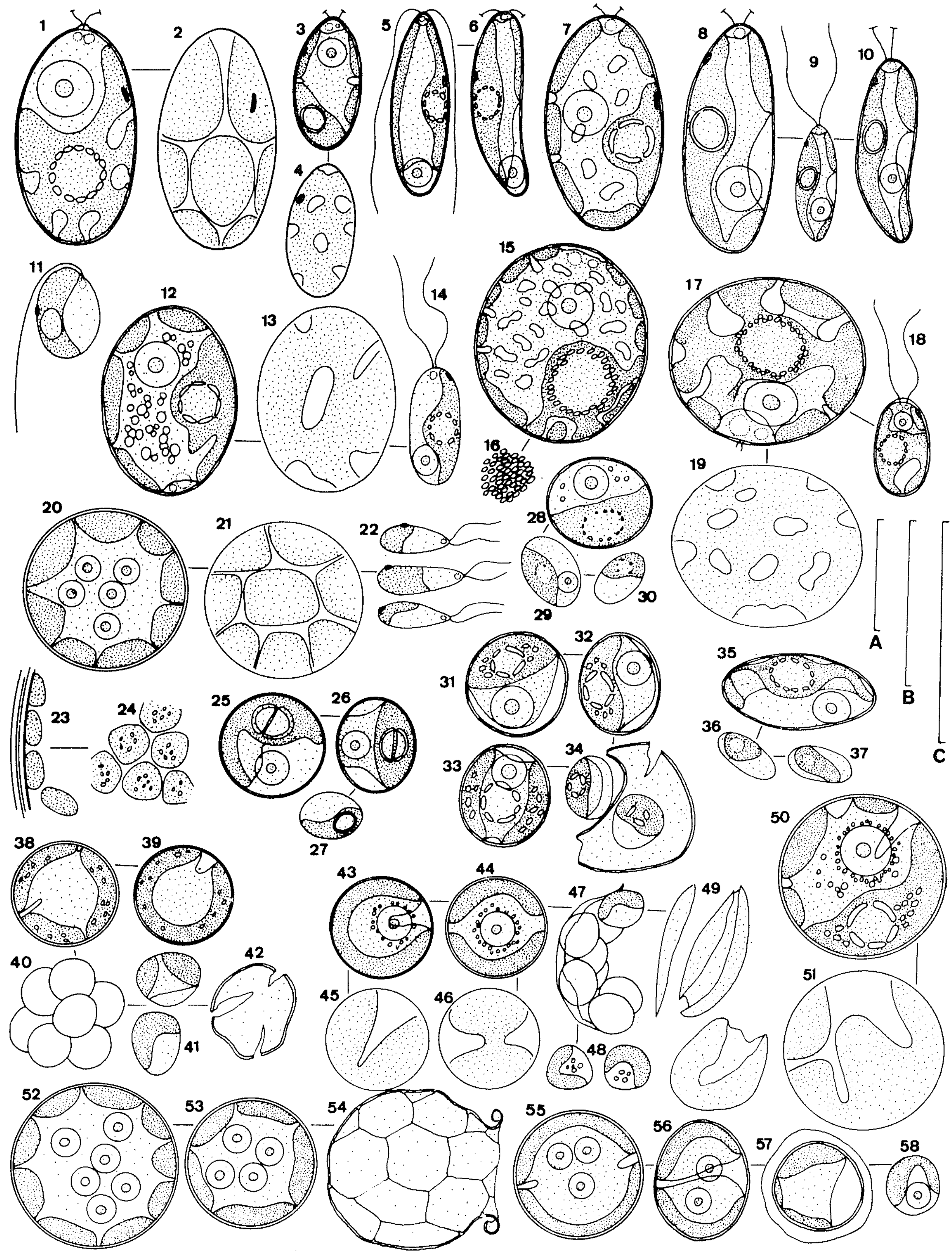


Fig. 1, 2, *Chlamydomonas augustae;* 3, 4, *C.* sp. A; 5, 6, *C. perpusilla;* 7, *C.* sp. B; 8-10, *C.* cf. *perpusilla;* 11, *Pedinomonas minor;* 12-14, *Chlamydocapsa* sp. A; 15, 16, *Palmellopsis* sp.; 17-19, *Chlamydocapsa* sp. B; 20-22, *Bracteacoccus minor;* 23, 24, *B. giganteus;* 25-27, *Chlorella vulgaris* var. *autotrophica;* 28-30, *C.* sp. B; 31-34, *C.* sp. A; 35-37, *C. saccharophila* var. *ellipsoidea;* 38-42, *C. zofingensis* var. A; 43-49, *C. zofingensis* var. B; 50, 51, *C.* sp. C(?); 52-54, *Muriella terrestris* var. A; 55-58, *M. terrestris* var. B. The scales represent 10 μm. A; Fig. 12, 13, 15-19, 20-22. B; Fig. 1-10, 14, 25-58. C; Fig. 11.

Chlorococcales

Bracteacoccus sf. *giganteus* Bischoff and Bold
Fig. 23, 24, 151, 152
Bischoff and Bold, 1963, p. 44-46, Fig. 70-72, 131-136
Samples; 14, 17, 18, 26.

Cells spherical, to 60 μm diameter; wall 1-2 μm thick (Fig. 23); chloroplasts parietal and internal, disc-like (Fig. 24, 151). Reproduction by numerous zoospores and aplanospores; aplanospores spherical 3.5 μm diameter; zoospore morphology not clearly observed.

Bracteacoccus minor (Chodat) Petrova
Fig. 20-22, 153, 154
Starr, 1955, p. 63-64, Fig. 153, 154
Samples; 2, 8, 9, 16-19, 25, 26, 30, 32.

Cells spherical to 15 μm diameter; chloroplasts parietal, discoid (Fig. 20, 21, 154). Zoospores and aplanospores produced in thin-walled sporangia up to 21 μm diameter and containing numerous spores; zoospores naked, stigma variably positioned (Fig. 22); aplanospores spherical, 3.5 μm diameter (Fig. 153).

Characium sp.
Fig. 147-150
Samples; 19, 22.

Adult cells approximately ellipsoidal (Fig. 148), up to 15.5 μm long by 8.5 μm wide, possessing a holdfast with a terminal button-like swelling; chloroplast parietal containing a distinct pyrenoid surrounded by two large starch plates. Reproduction by autospores (Fig. 149, 150), released by rupture of sporangium wall; zoosporangia observed but not the released zoospores.

Previous records: Glerárdalur; Broady (1978) recovered an unidentified *Characium* sp.

Chlorococcum sp.
Fig. 83-85, 144
Samples; 20, 21.

Adult cells broadly ellipsoidal (Fig. 85-144) occasionally spherical (Fig. 84), to 16 μm diameter; chloroplast cup-shaped, perforated and fissured; pyrenoid in basal thickened portion of chloroplast, surrounded by distinct starch plates; two contractile vacuoles situated opposite the pyrenoid and adjacent to the large nucleus. Sporangia contain 2, 4, 8 and 16 zoospores and aplanospores; zoospores 7-9 μm long by 3.5 - 5 μm wide, with a posterior nucleus and anterior stigma (Fig. 83).

Previous records: Surtsey, *Chlorococcum* spp. recovered by Maguire (1968), Schwabe and Behre (1972). Glerárdalur, unidentified *Chlorococcum* spp., Broady (1978).

Neochloris bilobata Vinatzer var.
Fig. 86-89, 145, 146
Vinatzer, 1975, p. 221-223, Abb. 5
Samples; 20, 31.

Cells spherical, to 25 μm, exceptionally 37 μm diameter; chloroplast bi-lobed (Fig. 86-88); pyrenoid large, between the chloroplast lobes, surrounded by numerous small starch grains; nucleus distinct. Numerous zoospores and aplanospores formed in thin-walled sporangia (Fig. 145); zoospores pyriform, naked, with a posterior stigma (Fig. 89).

Vinatzer (1975) described zoospores with an anterior stigma.

Chlorellales

Chorella saccharophila var. *ellipsoidea* (Gerneck) Fott and Nováková
Fig. 35-37, 163-165
Fott and Nováková, 1969, p. 39-41, Plates XI, XII
Samples; 9, 17.

Adult cells narrowly ellipsoidal (Fig. 35, 165), to 10.5 μm by 4.5 μm; chloroplast approximately saucer-shaped, often only partially adherent to the inner wall; pyrenoid surrounded by small starch grains. Sporangia containing 2 to 16 spores, one of the products of protoplast divison is usually larger than the remainder (Fig. 163, 164); spores narowly ellipsoidal (Fig. 36, 37), from 3.5 by 2 μm, released by rupture of the sporangium wall.

Previous records: Surtsey, *C. saccharophila*, Schwabe and Behre (1972).

Chlorella vulgaris var. *autotrophica* (Shihira and Krauss) Fott and Nováková
Fig. 25-27, 155, 156
Fott and Nováková, 1969, p. 25-26, Plate III f-o.
Samples; 2, 3, 6, 7, 10, 11, 20-25, 26, 30.

Adult cells spherical to 6 μm diameter; young cells ellipsoidal (Fig. 26, 27); chloroplast more or less a broad band; pyrenoid situated to one side of chloroplast (Fig. 25), surrounded by two large starch plates; nucleus readily visible. Sporangia releasing 2, 4, 8 and 16 ellipsoidal to sub-spherical spores by irregular rupture of the wall, remains of which are visible (Fig. 156) especially following staining with toluidine blue.

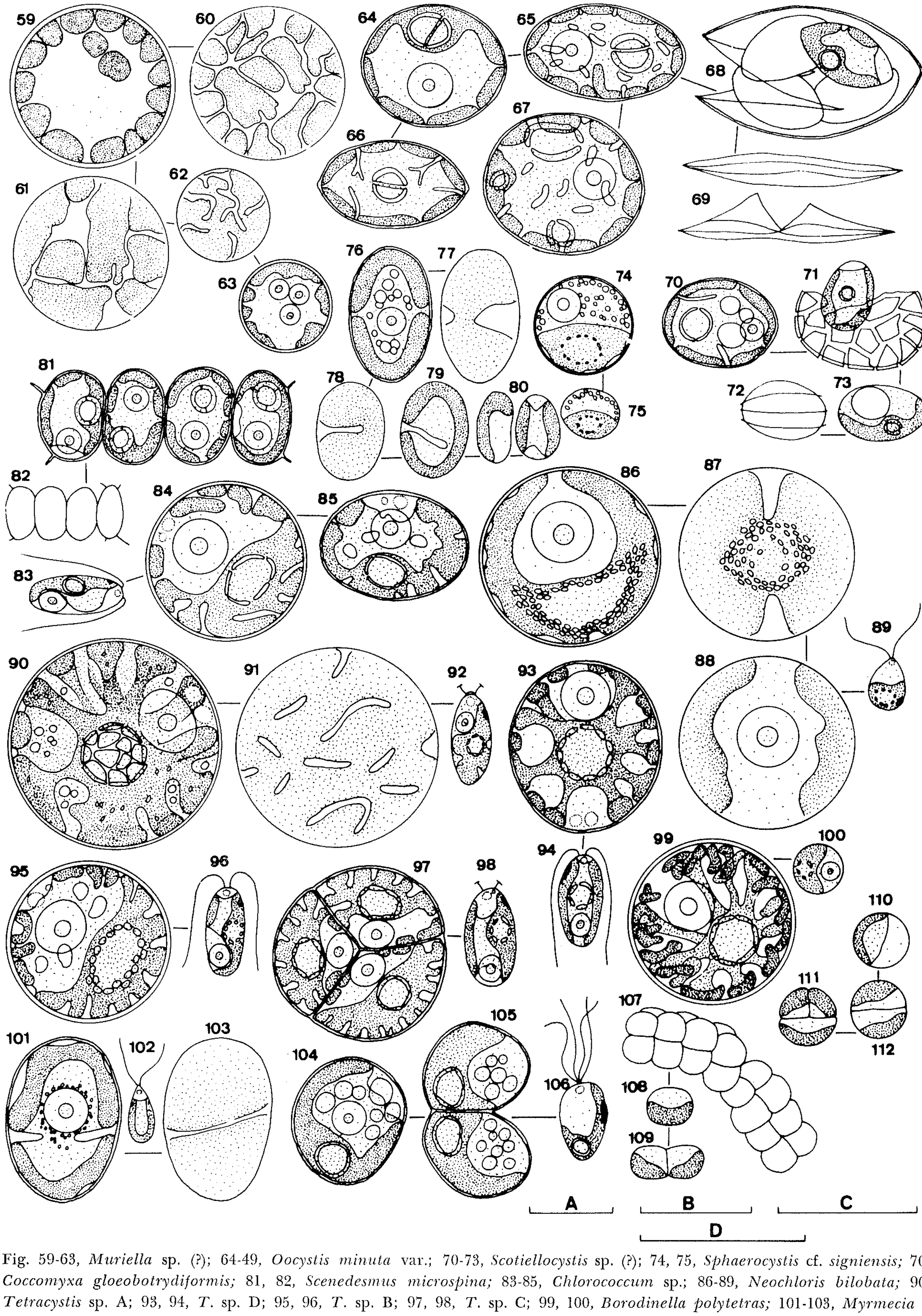


Fig. 59-63, *Muriella* sp. (?); 64-49, *Oocystis minuta* var.; 70-73, *Scotiellocystis* sp. (?); 74, 75, *Sphaerocystis* cf. *signiensis;* 70-80, *Coccomyxa gloeobotrydiformis;* 81, 82, *Scenedesmus microspina;* 83-85, *Chlorococcum* sp.; 86-89, *Neochloris bilobata;* 90-92, *Tetracystis* sp. A; 93, 94, *T.* sp. D; 95, 96, *T.* sp. B; 97, 98, *T.* sp. C; 99, 100, *Borodinella polytetras;* 101-103, *Myrmecia biatorellae* var.; 104-106, *Fernandinella alpina* var. *subglobosa;* 107-109, *Chlorosarcina* sp. A (?); 110-112, *Planophila* sp. (?). The scales represent 10 μm. A; Fig. 81, 82, 90-92, 95, 96, 100-103. B; 59-63, 83-89, 93, 94, 97-100, 104-112. C; 64-73, 76-80.

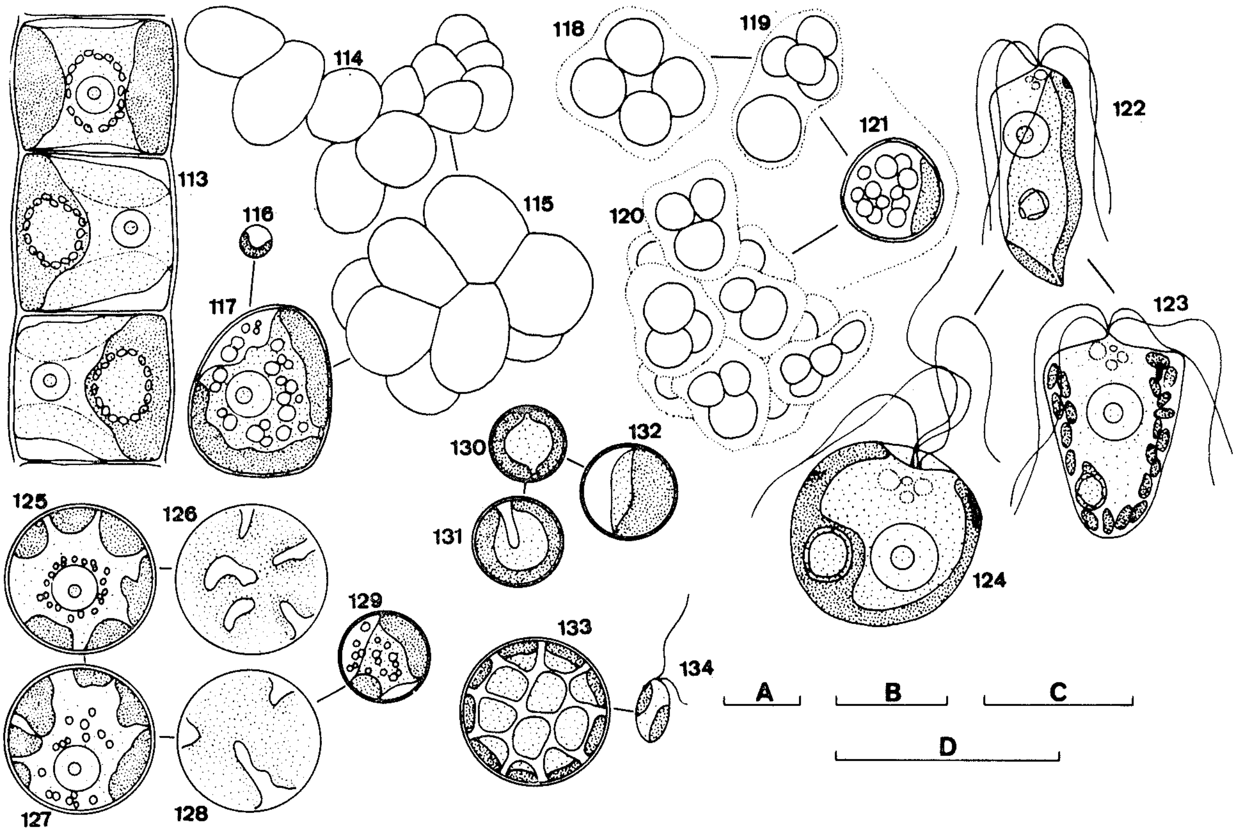


Fig. 113, *Ulothrix implexa;* 114-117, cf. *Apatococcus lobatus;* 118-121, unidentified chaetophoralean alga; 122-124, *Prasinochloris* sp. (?); 125-129, *Chloridella* sp. (?); 130-132, *C. minuta;* 133, 134, *Gloeobotrys* sp. (?). The scales represent 10 µm. A; Fig. 114, 115, 118-120. B; Fig. 116, 117, C; Fig. 113, 121, 125-129, 133, 134. D; Fig. 122-124, 130-132.

Previous records: Surtsey, *C. vulgaris,* Schwabe and Behre (1972). Glerárdalur, *C. vulgaris* var. A and B, Broady (1978).

Chlorella zofingensis Doenz var. A
Fig. 38-42, 160, 161
Fott and Nováková, 1969, p. 42-44, Plate XIII
Samples; 2, 14, 16-19, 23, 24, 28, 31, 32.

Adult cells spherical, to 6.5 µm diameter, young cells ellipsoidal, subspherical; chloroplast parietal, lobed plate covering most of the cell wall; starch grains observed in chloroplast. 2, 4 and 8 spores released by irregular rupture of sporangium wall, remains of which are visible (Fig. 161); spores tending to remain aggregated (Fig. 40, 160).

Previous records: Glerárdalur, *Chlorella* cf. *zofingensis,* Broady (1978).

Chlorella zofingensis Doenz. var. B.
Fig. 43-49, 166
Samples; 16.

Adult cells spherical, to 8 µm diameter; chloroplast often bi-lobed (Fig. 45, 46, 166) with small starch grains scattered throughout; nucleus distinct and often surrounded by small granules. Sporangia release 2, 4, 8 and 16 subspherical spores from 2.5 µm diameter (Fig. 48), these remain adherent to sporangium wall, often in an approximately saucer-shaped arrangement (Fig. 47).

Chlorella sp. A
Fig. 31-34
Samples; 6, 11.

Adult cells mostly ellipsoidal or sub-spherical, few spherical, to 6 by 5.5 µm; chloroplast a broad parietal band; pyrenoid surrounded by two to several starch grains of variable size; nucleus readily visible. Sporangia up to 10 µm diameter, contain 2, 4, 8, 16 and more (32?) spores released by irregular rupture of wall, remains of which are visible (Fig. 34).

Chlorella sp. B
Fig. 28-30, 157-159
Samples; 26, 31, 32.

Adult cells broadly ellipsoidal (Fig. 28, 159), to 7.5 by 6 µm; chloroplast saucer-shaped occupying about half of cell; pyrenoid indistinct, surrounded by small starch grains. Sporangia contain 2, 4 and 8 ellipsoidal spores, released by

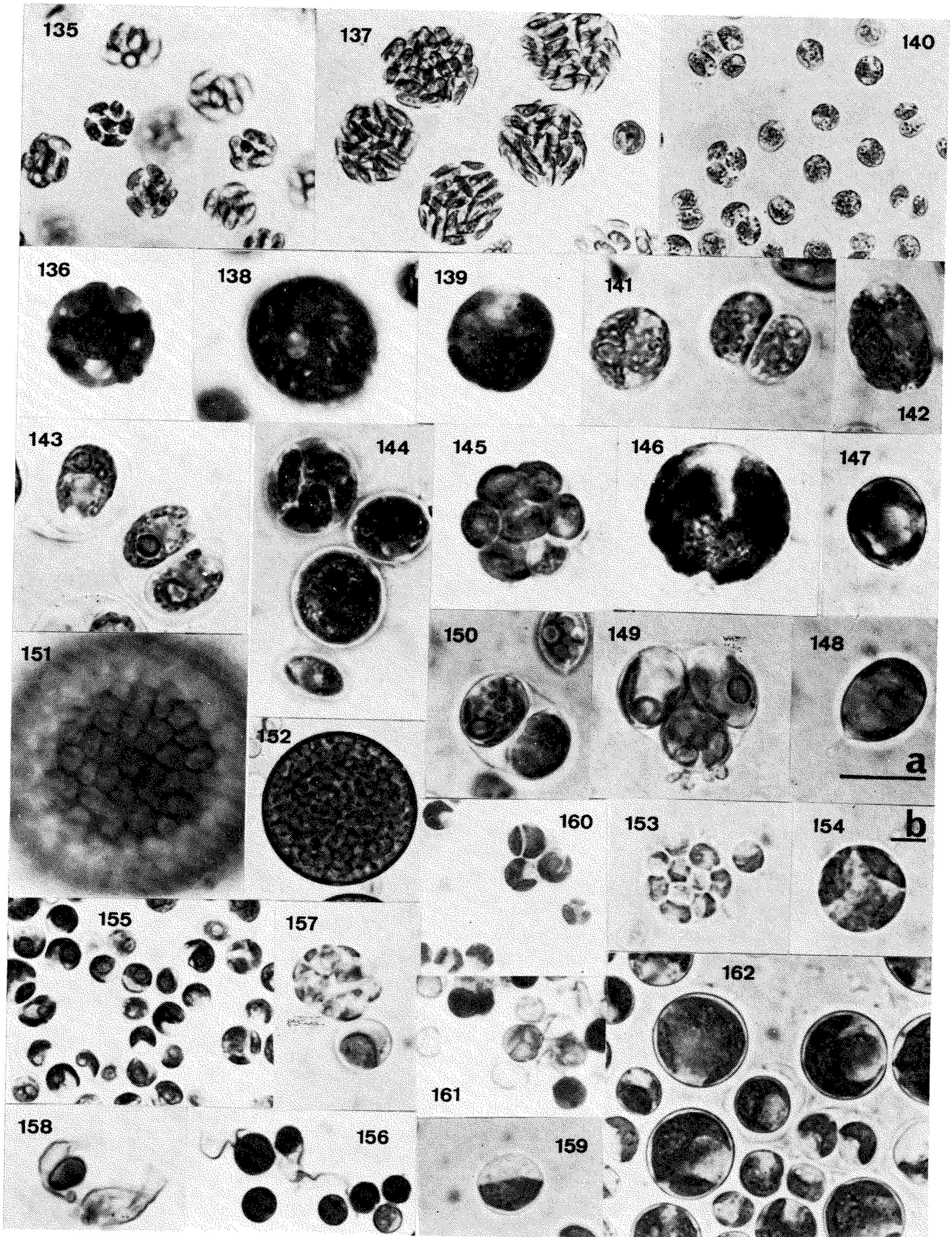


Fig. 135, 136, *Chlamydocapsa* sp. B; 137-139, *Palmellopsis* sp.; 140, 141, *Chlamydocapsa* sp. A; 142, *Chlamydomonas* sp. B; 143, *Chlamydomonas pseudintermedia;* 144, *Chlorococcum* sp.; 145, 146, *Neochloris bilobata;* 147-150, *Characium* sp.; 151, 152, *Bracteacoccus* cf. *giganteus;* 153, 154, *B. minor;* 155, 156, *Chlorella vulgaris* var. *autotrophica;* 157-159, *C.* sp. B; 160, 161, *C. zofingensis* var. A; 162, *C.* sp. C. The scale represents 10 μm. A; Fig. 136, 138, 139, 141-151, 153-162. B; 135, 137, 140, 152.

irregular rupture of sporangium wall (Fig. 157) which remains readily visible (Fig. 158).

Chlorella sp. C?
Fig. 50, 51, 162
Samples; 3, 12, 16, 25.

Adult cells spherical, to 12 µm diameter; chloroplast a broadly lobed cup (Fig. 50, 51); pyrenoid distinct, surrounded by several large starch grains; nucleus distinct. Sporangia contain 2, 4, 8 and 16 almost spherical spores (Fig. 162) released by irregular rupture of sporangium wall which remains readily visible.

Coccomyxa gloeobotrydiformis Reisigl var.
Fig. 76-80, 178
Reisigl, 1969, p. 498-499, Abb. 3
Samples; 6, 8, 9, 16, 19.

Colonies mucilaginous, containing irregulary distributed cells (Fig. 178) and temporary groups of 2, 4, 8 and 16 recently released spores. Adult cells ellipsoidal, to 13 by 9 µm but mostly 7 by 5 µm; chloroplast parietal, often bi-lobed, containing scattered starch grains; oil globules formed. Spores (Fig. 80) released by rupture and partial gelatinization of sporangium wall.

Reisigl (1969) described slightly smaller cells with the production of only 2 and 4 spores.

Previous records: Surtsey, *Coccomyxa* sp., Schwabe (1970).

Muriella terrestris Petersen var. A
Fig. 52-54, 167-169
Petersen, 1932, p. 403, Fig. 9
Samples; 2, 3, 6-9, 12, 16, 18, 19, 22, 24, 26, 30, 32.

Adult cells spherical, to 12 µm diameter; chloroplasts numerous, parietal, plate-like. Sporangia release 2, 4 and 8 spherical to ellipsoidal spores (Fig. 168) through an almost circular rupture of the sporangium wall. On staining with toluidine blue the inner surface of the empty sporangium wall can be seen to have internal slightly thickened ribs of wall material giving a reticulated appearance (Fig. 54, 169).

The cells of this isolate are larger than those described by Petersen (1932) and resemble those found by Reisigl (1964).

Previous records: Surtsey, *M. terrestris,* Behre and Schwabe (1970); *M. decolor,* Schwabe (1970); Glerárdalur, *M.* cf. *terrestris,* Broady (1978).

Muriella terrestris Petersen var. B.
Fig. 55-58, 172-174
Petersen, 1932, p. 403, Fig. 9
Samples; 7, 8, 18, 19, 23.

Adult cells spherical and broadly ellipsoidal, to 9 µm diameter; chloroplasts parietal plates, one to 4 per cell. Sporangia contain 2, 4 and 8 spores released by irregular rupture of sporangium wall (Fig. 172); young cells often surrounded by the remains of the sporangium wall (Fig. 57).

Muriella sp.?
Fig. 59-63, 179-182
Samples; 20, 23.

Adult cells spherical, to 16 µm diameter; chloroplasts numerous, parietal, irregulary shaped plates (Fig. 59-61, 179; in young cells the single chloroplast perforate and lobed (Fig. 62). Sporangia contain from (Fig. 181) to over 16 spores, spores themselves often undergo protoplast division before their release through the ruptured sporangium wall (Fig. 180); young cells occasionally surrounded by sporangium wall remains (Fig. 182).

The chloroplasts are unlike those of other *Muriella* spp. in their irregularity of shape.

Oocystis minuta Guillard, Bold and MacEntee var.
Fig. 64-69, 170
Guillard and others, 1975, p. 21-22, Fig 17-20; Watanabe, 1978, p. 15, Fig. 1-3
Samples; 10, 12, 13, 17, 18, 24, 31.

Adult cells broadly ellipsoidal, 6-13 µm by 4.5 - 11 µm; chloroplast parietal, extensive, often perforate (Fig. 65, 67); wall occasionally slightly thickened at each pole (Fig. 66); pyrenoid distinct, surrounded by two thick starch plates although occasionally several large grains present. Sporangia contain 2, 4, 8 and 16 spores, released after development of a wide polar split in the wall (Fig. 68, 170).

Previous records: Glerárdalur, cf. *Oocystis* sp. Broady (1978).

Scenedesmus microspina Chodat
Fig. 81, 82, 171
Uherkovich, 1973, p. 3, Fig. 24, 25
Samples; 23, 24.

Coenobia of 4 and 8 ellipsoidal cells; terminal cells often bearing two short spines; coenobia with 4 cells 14-31 µm long by 7-13 µm broad.

Previous records: Surtsey, Schwabe and Behre (1972).

Scotiellocystis sp.?
Fig. 70-73, 175
Samples; 20, 21, 23.

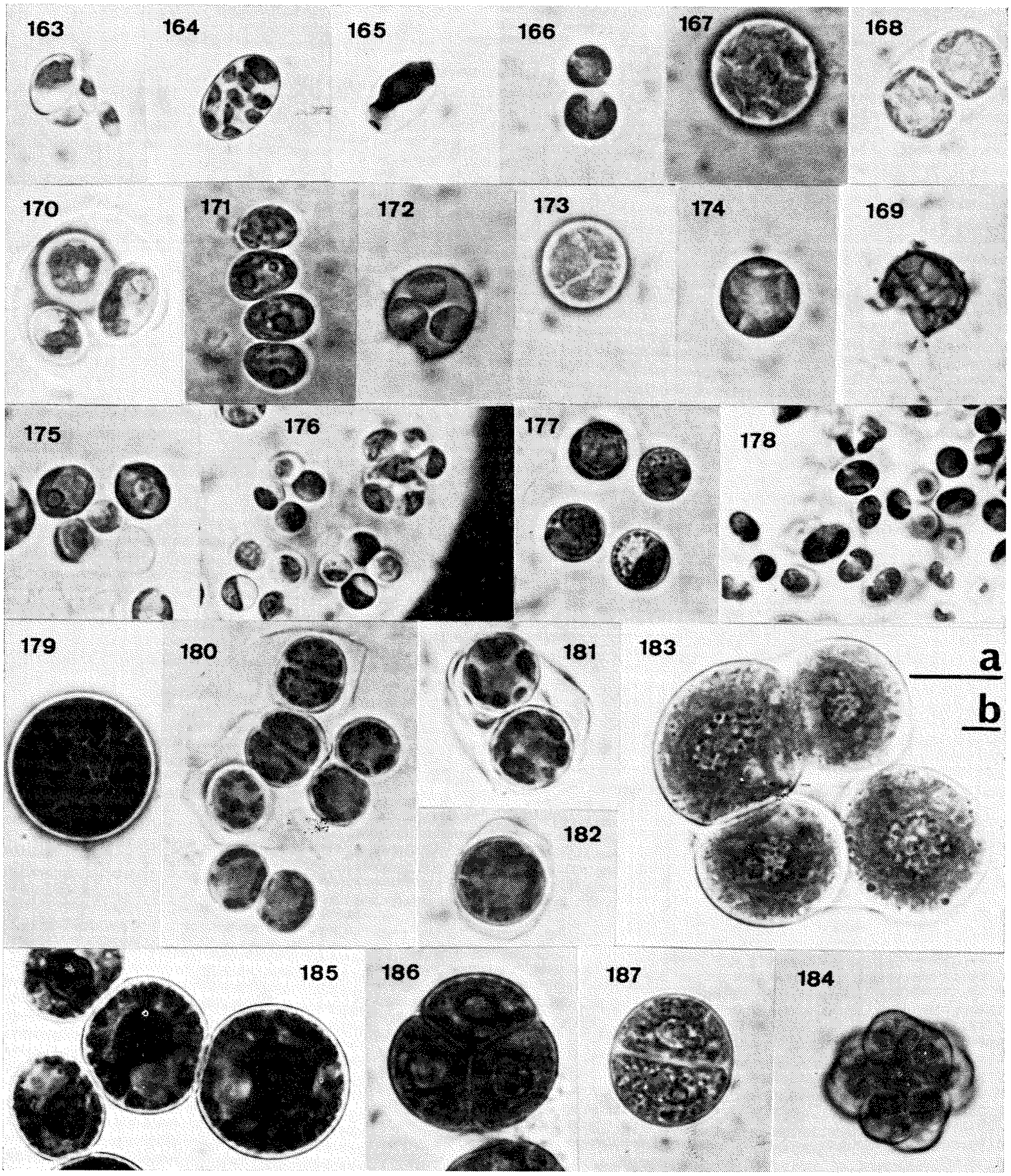


Fig. 163-165, *Chlorella saccharophila* var. *ellipsoidea;* 166, *C. zofingensis* var. B; 167-169, *Muriella terrestris* var. A; 170, *Oocystis minuta;* 171, *Scenedesmus microspina;* 172-174, *Muriella terrestris* var. B; 175, *Scotiellocystis* sp. (?); 176, 177, *Sphaerocystis* cf. *signiensis;* 178, *Coccomyxa gloeobotrydiformis;* 179-182, *Muriella* sp. (?); 183, 184, *Tetracystis* sp. B; 185-187, *T.* sp. D. The scales represent 10 μm. A; Fig. 163-183, 185-187. B; Fig. 184.

Adult cells ellipsoidal, 4-7 (-10) μm by 2.5 - 5 (-7) μm; chloroplast parietal, fissured, plate-like; pyrenoid distinct, surrounded by two large starch plates; cell contents vacuolate (Fig. 70); sporangia and adult cell walls occasionally covered by irregular plates of material (Fig. 71); recently released spores with faint parallel ridges across wall (Fig. 72, 73). Sporangia contain 2, 4, 8 and 16 spores released by irregular rupture of sporangium wall.

This isolate appears to belong in *Scotiellocystis* as defined by Fott (1976).

Sphaerocystis sf. *signiensis* Broady
Fig. 74, 75, 176, 177
Broady, 1976, p. 396-397, Fig 4
Samples; 3.

Colonies mucilaginous, containing groups of 2, 4 and 8 cells. Adult cells spherical to 7 µm diameter (Fig. 74, 177) and occasionally broadly ellipsoidal; chloroplast saucer-shaped occupying about half of wall surface and somewhat non-adherent; pyrenoid faint, surrounded by small starch granules. Partial gelatinization and rupture of sporangium wall releasing 2, 4, and 8 ellipsoidal spores from 3.5 by 3 µm (Fig. 75) in size.

Previous records: Glerárdalur, *S.* cf. *signiensis* with slightly larger cells, Broady (1978).

Chlorosarcinales

Borodinella polytetras Miller
Fig. 99, 100, 195-197
Bourrelly, 1966, p. 137, Pl. 20, Fig. 1; Fritsch and John, 1942, p. 377-378, Fig. 2, S-Y
Samples; 20, 22, 23, 24, 26, 27, 31.

Cells spherical, to 14 µm diameter; chloroplast axial with arms radiating from the slightly eccentric pyrenoid. Zoospores naked with a stigma and two equal flagella, becoming spherical on quiescence (Fig. 100). Desmoschisis resulting in the formation of diads (Fig. 195), tetrads and tedrad complexes (Fig. 197).

Chlorosarcina sp. A?
Fig. 107-109, 208
Samples; 26.

Cells usually single and in temporary pairs (Fig. 108, 109, 208) resulting from vegetative division, occasionally larger aggregates observed (Fig. 107) in which cells remain adherent after division in three planes; single cells slightly longer than wide (Fig. 108), 3-4 µm long.

Chlorosarcina sp. B?
Fig. 207
Samples; 19.

Cells 3.5 - 7 µm diameter, in cubical and more irregular aggregates formed by vegetative division in three planes.

Fernandinella alpina var. *semiglobosa* Fritsch and John fo.
Fig. 104-106, 206
Fritsch and John, 1942, p. 380, Fig. K-Q
Samples; 14.

Cells subspherical (Fig. 104), up to 12 µm diameter; chloroplast parietal, cup-like; pyrenoid distinct. Sporangia forming 4 zoospores; zoospores quadriflagellate, stigma large, median to posterior (Fig. 106). Desmoschsis results in diad (Fig. 105) and tetrad (Fig. 206) production.

In the description of *F. alpina* var. *subglobosa* given by Fritsch and John (1942) colonies of 4 to 32 cells are formed and the cells are often somewhat pyriform.

Myremecia biatorellae (Tschermak-Woess and Plessl) Petersen var.
Fig. 101-103, 198-205
Tschermak-Woess and Plessl, 1949, p. 203, Fig. 1-4; Andreyeva, 1978, p. 449, Fig. 3, 4
Samples; 3, 16.

Adult cells subspherical, pyriform and broadly ellipsoidal, to 26 by 20 µm (Fig. 101, 198, 199, 204); chloroplast extensive, bilobed, parietal (Fig. 101, 103, 200). Zoospores naked, pyriform (Fig. 102) formed in large numbers and released through apical rupture of sporangium wall; aplanospores spherical, 3-5 µm diameter (Fig. 205) also released in large numbers. Desmoschisis results in formation of diads (Fig. 201), tetrads (Fig. 202) and tetrad complexes (Fig. 203).

This genus is usually placed in the Chlorococcales, for instance by Bourrelly (1966) and Andreyeva (1978). However, the vegetative division (desmoschisis) of the cells into diads and tetrads, which dissociate slowly, indicates that this species has close affinities with the members of the Chlorosarcinales. The present isolate differs from *M. biatorellae* by the absence of a stigma from the zoospore.

Previous records: Iceland, *M. pyriformis* Petersen (1928a).

Planophila sp. ?
Fig. 110-112, 209
Samples; 18.

Cells single, in temporary pairs and occasionally in gropus of 3 (Fig. 111) or 4 resulting from vegetative division in one or two planes; single cells spherical, to 5 µm diameter; chloroplast saucer-shaped covering half of cell wall; pyrenoid occasionally indistinctly visible (Fig 209).

Tetracystis sp. A
Fig. 90-92, 191-194
Samples; 11, 14, 22, 31.

Adult cells spherical to 26 µm diameter (Fig. 191); young cells ellipsoidal (Fig. 192); chloroplast massive with axial portion surrounding an almost central pyrenoid (Fig. 90), and radiating arms joining with a perforate parietal portion (Fig. 91); perforations in chloroplast surface

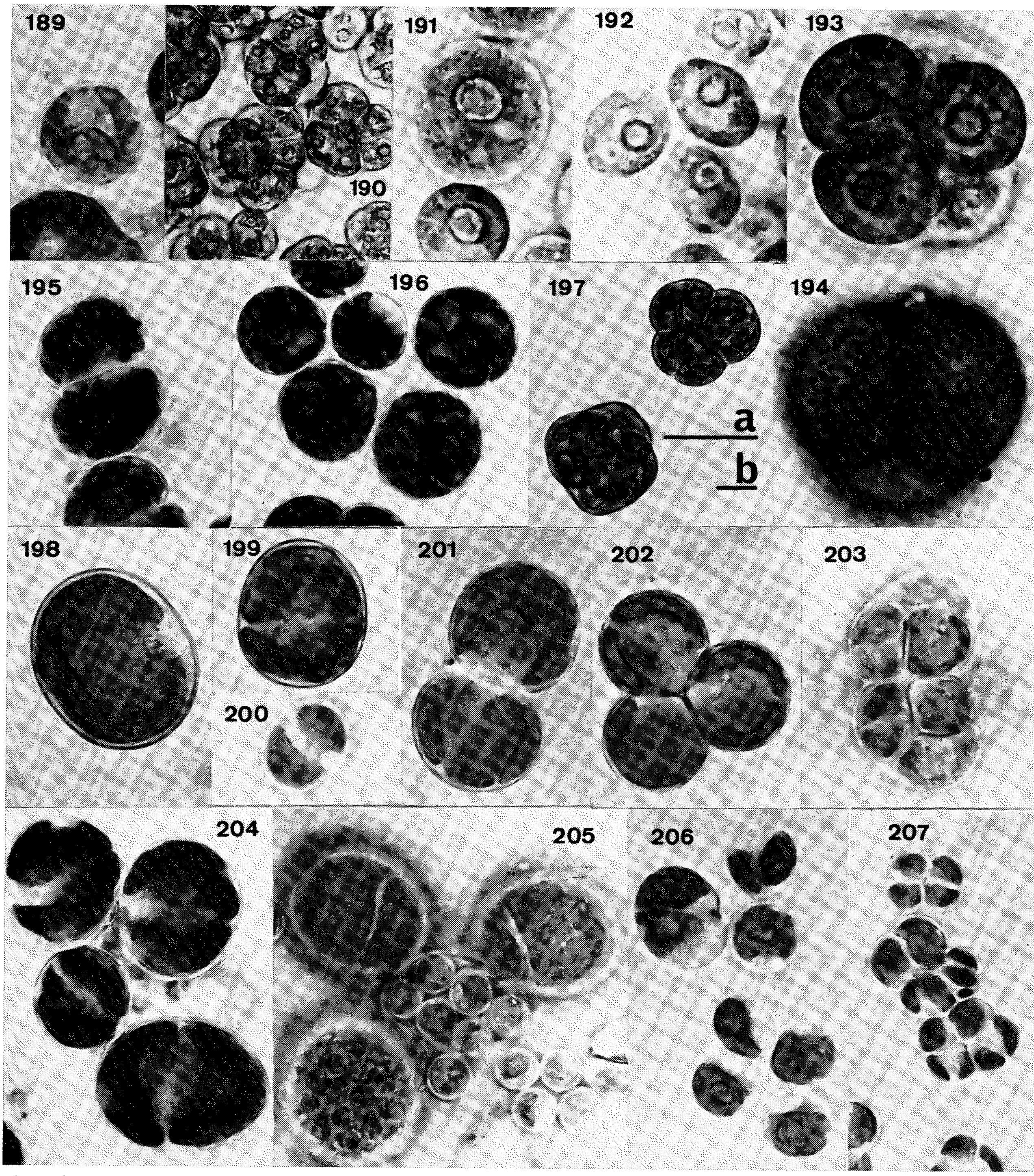


Fig. 189, 190 *Tetracystis* sp. C; 191-194, *T.* sp. A; 195-197, *Borodinella polytetras;* 198-205, *Myrmecia biatorellae var.;* 206, *Fernandinella alpina* var. *subglobosa;* 207, *Chlorosarcina* sp. B (?). The scales represent 10 μm. A; Fig. 189, 191-196, 198-207. B; Fig. 190, 197.

readily visible as dark areas after staining with toluidine blue (Fig. 194); pyrenoid surrounded by large starch grains; a pair of contractile vacuoles lie in an opening in chloroplast immediately above large nucleus. Sporangia release 16 and 32 (?) ellipsoidal zoospores, 11 μm by 5 μm, with anterior nucleus and stigma; aplanospores ellipsoidal; tetrads (Fig. 194), octads (Fig. 193) and tetrad complexes formed.

Neither this isolate nor the following three isolates could be identified to any of the species described by Brown and Bold (1964).

Previous records: Glerárdalur, unidentified *Tetracystis* spp. Broady (1978).

Tetracystis sp. B
Fig. 95, 96, 183, 184
Samples; 30.

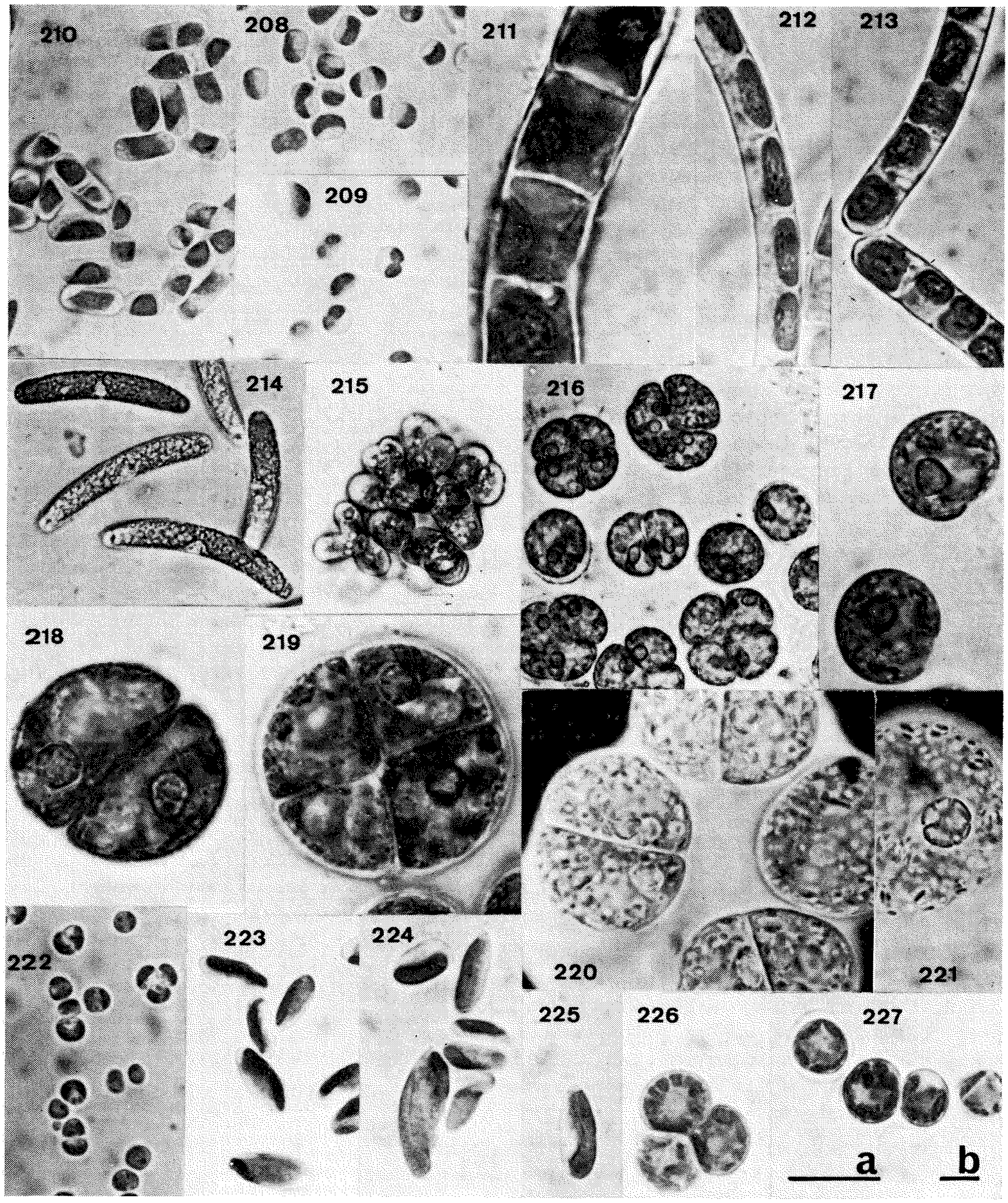


Fig. 208, *Chlorosarcina* sp. A (?); 209, *Planophila* sp. (?); 210, *Stichococcus bacillaris;* 211, *Ulothrix implexa;* 212, 213, *Klebsormidium flaccidum;* 214, *Closterium pusillum;* 215, cf. *Apatococcus lobatus;* 216-221, *Prasinochloris* sp. (?); 222, *Chloridella minuta;* 223, *Monodus subterraneus* var. A; 224, 225, *M. subterraneus* var. B; 226, 227, *Chloridella* sp. (?). The scales represent 10 μm. A; Fig. 208-213, 217-227. B; 214-216.

Adult cells spherical, 16-22 μm diameter; chloroplast cup-shaped, fissures in thick portion surrounding eccentric pyrenoid, perforations through thin portion above pyrenoid (Fig. 95); a pair of contractile vacuoles occupying opening in chloroplast, adjacent to nucleus; pyrenoid surrounded by numerous small starch grains. Zoospores ellipsoidal, 10-12 μm by 4-5 μm, with a posterior nucleus and anterior stigma. Desmoschisis results in tetrad (Fig. 183) and tetrad complex (Fig. 184) formation.

Tetracystis sp. C
Fig. 97, 98, 189, 190
Samples; 30.

Adult cells spherical when single (Fig. 189), to 13 µm diameter; chloroplast cup-shaped with basal, thickened, fissured portion containing a pyrenoid surrounded by large starch grains. Zoospores with posterior nucleus and anterior stigma (Fig. 98). Desmoschisis resulting in tetrad and tetrad complex (Fig. 190) formation.

Tetracystis sp. D
Fig. 93, 94, 185-187
Samples; 32.

Adult cells broadly ellipsoidal (Fig. 93) and spherical, to 17 µm diameter; chloroplast massive with axial portion, surrounding slightly eccentric pyrenoid, and radiating arms poining perforate parietal portion; a pair of contractile vacuoles situated at opposite pole to distinct nucleus; pyrenoid surrounded by small starch grains. Zoospores 9.5 - 13 µm by 5 µm, with large anterior stigma and posterior nucleus (Fig. 94). Desmoschisis results in formation of diads (Fig. 187) and tetrads (Fig. 186).

Ulotrichales

Klebsormidium flaccidum (Kuetz.) Silva, Mattox and Blackwell
Fig. 212, 213
Syn: *Hormidium flaccidum* Kuetz. in Mattox and Bold, 1962, p. 31, Fig. 33-42
Samples; 3, 9, 10, 12-14, 16, 17, 20, 23, 24, 26, 27, 31.

Filaments long, fragmenting in old cultures (Fig. 213), 4.5 - 8 µm wide. Cells 3.5 - 20 µm long, mostly about 6 µm long in active cultures; chloroplast occupying about half of wall; pyrenoid surrounded by several small starch grains.

Previous records: Surtsey, as *Chlorhormidium flaccidum,* Schwabe and Behre (1972); Glerárdalur, *C. flaccidum* (A. Br.) Fott, Broady (1978).

Stichococcus bacillaris Naegeli
Fig. 210
Mattox and Bold, 1962, p. 36-37, Fig. 45-49
Samples; 9, 26.

Filaments short, composed of no more than 4 cells, readily fragmenting. Cells 2.5 - 3.5 µm wide by 3.5 - 7.5 µm long; pyrenoid faintly visible.

An appearance of a similar faint pyrenoid is visible in Fig. 48 and 49 of Mattox and Bold (1962).

Previous records: Surtsey, *S. bacillaris* Naeg. s. ampl., Behre and Schwabe (1970); Iceland, Petersen (1928a); Glerárdalur, Broady (1978).

Ulothrix implexa Kuetzing
Fig. 113, 211
Printz, 1964, p. 14, Tab. I; 16, 17
Samples 27.

Filaments long, 10.5 - 14 µm wide, slightly constricted at transverse walls. Cells 7-16 µm long; chloroplast encircling about two-thirds of cell, containing a single pyrenoid.

Chaetophorales

cf. *Apatococcus lobatus* (Chodat) Petersen
Fig. 114-117, 215
Vischer, 1960, p. 337-338, Abb. 5
Samples, 3, 8.

Irregularly branching filaments and aggregates of cells. Cells to 20 µm diameter; cell contents not clearly observed due to large oil accumulations; chloroplast parietal; aplanospores (Fig. 116) spherical, 3 µm diameter, released in large numbers by rupture of sporangium wall.

Previous records: Surtsey, cf. *A. lobatus,* Schwabe (1970).

Unidentified
Fig. 118-121
Samples; 1, 9.

Only wild material examined, no growth in BBM. Cells spherical and subspherical, to 12 µm diameter, usually 6-8 µm, single, in tetrahedral groups and small branching aggregates (Fig. 118-120), embedded in mucilage; cell contents not clearly observed due to large quantities of oil globules; chloroplast parietal (Fig. 121).

Ulvales

Prasiola crispa (Lightf.) Meneghini
Printz, 1964, p. 104, Tab. XXIII, Fig. 2
Samples; 13, 14, 15.

Uniseriate filaments of the "*Hormidium*" stage observed.

Zygnematales

Actinotaenium cucurbita var. *attenuatum* Teiling
Teiling, 1954, p. 406, Fig. 67-69
Samples; 27.

Previous records: Surtsey, *Actinotaenium* sp., Schwabe and Behre (1972); Glerárdalur, Broady (1978).

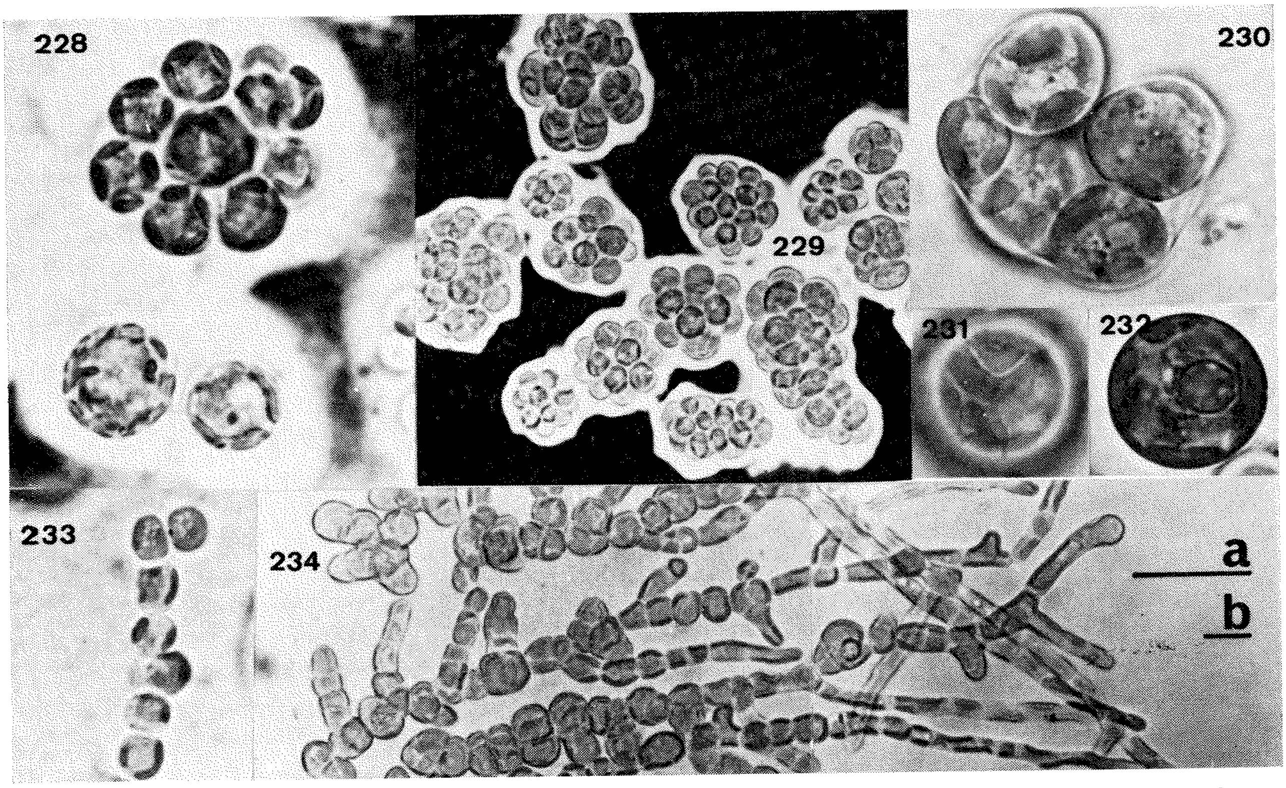


Fig. 228, 229, *Gloeobotrys* sp. (?); 230-232, unidentified eustigmatophycean alga; 233, 234, *Heterococcus* sp. The scales represent 10 μm. A; Fig. 228, 230-234. B; Fig. 229.

Closterium pusillum Hantzsch
Fig. 214
Krieger, 1937, p. 279, Taf. 14, Fig. 6
Samples; 26, 31.

Cells 31-55 μm long by 8-9 μm wide; each of the two chloroplasts containing one or two pyrenoids; a single crystal present in a vacuole at each pole.

Previous records: Surtsey, Schwabe and Behre (1972); Glerárdalur, *C. pusillum* var. *major* Racib., Broady (1978).

Cylindrocystis brebissonii (Ralfs) De Bary
Krieger, 1937, p. 207, Taf. 6, Fig. 4
Samples; 26, 27.

Previous records: Glerárdalur, Broady (1978).

PRASINOPHYCEAE

Prasinochloris sp.?
Fig. 122-124, 216-221
Samples, 20, 22, 23.

Mucilaginous, colonial stage dominant in culture (Fig. 16, 220) in which cells single, in pairs (Fig. 218), isobilateral tedras (Fig. 219) and octads; mucilage often lamellate, distinctly so on staining with toluidine blue. Cells spherical and subspherical due to mutual adpression, 7-30 μm diameter; chloroplast in young cultures cup-shaped, in older cultures becoming perforated and fragmented (Fig. 218, 219); pyrenoid single in small cells, often two or more in larger cells, surrounded by large starch plates (Fig. 221); small starch grains scattered throughout chloroplast; nucleus large, distinct; several contractile vacuoles occupy an opening in chloroplast and cell in this region is often slightly concave (Fig. 124, 217). Quadriflagellate, pleiomorphic zoospores formed on transfer of material from agar to aqueous medium, cells dividing into 2, 4 and 8 spores; chloroplast single (Fig. 122) or fragmented (Fig. 123); stigma anterior. On cessation of activity cells become approximately spherical (Fig. 124) with a depression where flagella emerge; long, branching pseudo-cilia observed on one occasion, prior to mucilage secretion.

This alga is similar to *P. sessilis* Belcher (1966) in the possession of a sedentary phase forming naked quadriflagellate zoospores but differs in the production of copious mucilage, the release of more than two zoospores and in zoospore morphology.

Pedinomonas minor Korschikoff
Fig. 11
Ettl, 1967, p. 3-4, Fig. 1:7, 2:6-8
Samples; 28.

Cells ellipsoidal in lateral view, flattened in dorsal view, 4-5 μm long by 2.5 - 3 μm wide; chloroplast a parietal plate; pyrenoid faint.

XANTHOPHYCEAE

Mischococcales

Chloridella minuta Gayral and Mazancourt var.
Fig. 130-132, 222
Gayral and Mazancourt, 1958, p. 347, Fig. II. 1
Samples; 16.

Cells spherical, 3 - 4.5 (-6) μm diameter; chloroplast parietal occupying more than half of wall. Sporangia releasing 2, 4 and 8 subspherical spores, ruptured sporangia walls only occasionally remaining visible.

The Surtsey isolate has slightly larger cells and a more extensive chloroplast than *C. minuta* Gay. and Maz.

Previous records: Glerárdalur, *C. minuta,* Broady (1978).

Chloridella sp.?
Fig. 125-129, 226, 227
Samples; 16, 23, 27.

Cells spherical and subspherical, to 13 μm diameter; chloraplast a perforate, lobed, parietal plate, fragmenting in largest cells into irregular plates. Sporangia releasing 2, 4, 8 and 16 spherical to subspherical spores (Fig. 129) by irregular rupture of wall; sporangium wall remains are often visible around single cells (Fig. 227).

Gloeobotrys sp.?
Fig. 133, 134, 228, 229
Samples; 16.

Cells embedded in mucilage in aggregates containing 4, 8 and larger numbers of cells (Fig. 228, 229); mucilage without lamellations. Adult cells spherical, to 18 μm diameter; chloroplasts numerous, parietal plates (Fig. 133). Sporangia release numerous zoospores (Fig. 134) and aplanospores by gelatinization of sporangium wall; zoospores with two chloroplasts.

The cells resemble those of *Botrydiopsis* in the possession of numerous parietal chloroplasts but the presence of mucilage secretions is a character of *Gloeobotrys.* Pascher (1937) describes the subgenus *Gloeobotrys* s. stricta for the forms with spherical cells. The isolate under examination here, however, possesses larger cells and has less extensive mucilage development than the single described species of that sub-genus.

Previous records: Glerárdalur, *G.* cf. *terrestris* Resigl of the sub-genus *Allantogloea,* Broady (1978).

Monodus subterraneus Petersen var. A
Fig. 223
Petersen, 1932, p. 406, Fig. 13
Samples; 9, 12, 26.

Cells 6.5 - 10.5 μm. Sporangia containing usually 2 and 4, rarely 8 spores.

Petersen (1932) described the production of only two spores in each sporangium.

Previous records: Surtsey, Schwabe and Behre (1972); Glerárdalur, Broady (1978).

Monodus subterraneus Petersen var. B
Fig. 224, 225
Samples; 3, 14, 21.

Cells 6.5 - 15 μm by 3-6 μm. Sporangia containing usually 8, infrequently 2 and 4 spores.

This isolate differed slightly in cell size and spore production from the previous isolate. The size range is greater than described by Petersen (1932).

Tribonematales

Heterococcus sp.
Fig. 223, 234
Samples; 28.

Filaments richly branched, 3-9 μm wide (Fig. 234). Zoosporangia produced (Fig. 233). Further study required.

Heterothrix exilis Pascher
Pascher, 1937, p. 921, Fig. 774, 777b
Samples; 6, 18.

Filaments often over 20 cells in length with little fragmentation. Cells 3.5 - 5 μm wide by 4.5 - 9 μm long, slightly inflated in central region; chloroplasts parietal, 2 to 4 in each cell.

EUSTIGMATOPHYCEAE

Unidentified genus
Fig. 230-232
Samples; 8, 12, 16, 21, 22, 25, 26.

Adult cells spherical, to 16 μm diameter; chloroplast parietal, perforated by narrow slits (Fig. 231); pyrenoid distinct with an angular outline, not embedded within chloroplast (Fig. 232). Aplanospore formation (Fig. 230).

Previous records: Glerárdalur, a similar, unidentified alga was recovered by Broady (1978).

TABLE I. Genera of green and yellow algae recovered from Surtsey 1967-1978.

	Sampling date			
Genus	1967[1]	1968[2,3]	1969-70[4]	1978[5]
Characiopsis	..	..	+	..
Chloridella	..	..	..	+
Gloeobotrys (?)	..	..	..	+
Monodus	..	..	+	+
Pleurochloris	..	+	..	..
Heterococcus	..	..	..	+
Heterothrix	..	..	+	+
Tribonema	..	..	+	..
Unident. Eustigmatophyceae	..	..	..	+
Euglena	..	+	+	..
Petalomonas	..	+	+	..
Pedinomonas	..	..	..	+
Prasinochloris (?)	..	..	..	+
Carteria	..	..	+	..
Chlamydomonas	+	+	+	+
Dunaliella	+	..	..	..
Chlamydocapsa	..	..	..	+
Palmellopsis	..	..	..	+
Chlorella - like	+	..	..	..
Chlorella	..	+	+	+
Coccomyxa (?)	..	+	..	..
Coccomyxa	..	..	..	+
Dictyosphaerium	..	..	+	..
Muriella	..	+	..	+
Nannochloris	+	..	..	..
Oocystis	..	..	..	+
Scenedesmus	..	..	+	+
Scotiellocystis	..	..	..	+
Sphaerocystis	..	..	..	+
Characium	..	..	..	+
Bracteacoccus	..	..	..	+
Chlorococcalean - like	+	+	+	..
Chlorococcum	+	..	+	+
Neochloris	..	..	..	+
Fasciculochloris	+	..	..	..
Borodinella	..	..	..	+
Chlorosarcina (?)	..	..	..	+
Fernandinella	..	..	..	+
Myrmecia	..	..	..	+
Planophila (?)	..	..	..	+
Tetracystis	..	..	..	+
Gloeotila	..	+	+	..
Klebsormidium	..	..	+	+
Stichococcus	+	+	+	+
Ulothrix	..	..	..	+
cf. *Apatococcus*	..	+	..	+
Unident. Chaetophorales	..	..	..	+
Prasiola	..	..	..	+
Actinotaenium	..	..	+	+
Closterium	..	..	+	+
Cylindrocystis	..	..	..	+
Mesotaenium	..	..	+	..
TOTAL	8	11	19	37

[1]Maguire (1968), [2]Schwabe (1970), [3]Behre and Schwabe (1970), [4]Schwabe and Behre (1972), [5]this study.

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