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THE TERRESTRIAL ALGAE OF SIGNY ISLAND,
SOUTH ORKNEY ISLANDS

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ABSTRACT

THE general features of Signy Island, particularly the environmental factors relating to the distribution of terrestrial algae, are outlined. Previous investigations of these plants in the Antarctic and particularly in the South Orkney Islands are briefly reviewed.

The sites examined are described and categorized in the subaerial or aerial habitat. Definitions of these are given and they are then subdivided into readily identifiable divisions within each habitat. Sampling methods and techniques used for examination and identification of the algae are described. Keys to the genera and species of the algae are also provided. Each algal taxon is described and illustrated from Signy Island material, and the distribution of each is outlined for Signy Island, other Antarctic localities and, where possible, elsewhere in the world, particularly in the terrestrial habitats. Of the 162 taxa, 30 per cent were Cyanophyceae, while the Euchlorophyceae, Ulothricophyceae, Bacillariophyceae and Xanthophyceae comprised between 10 and 21 per cent of the total flora.

A comparison is made of the efficiency of recovering algae by the three techniques used for examining sample material. The validity of drawing conclusions from comparisons of the algal floras of different sites is discussed. The distribution of each taxon throughout the 122 sample sites is tabulated and general patterns in these data are illustrated and discussed. Major features of the algal floras of each of the habitat divisions are briefly described and related to environmental factors such as water and nutrient availability. Comparisons are also made with investigations of terrestrial algae in other regions.

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I. INTRODUCTION

BETWEEN November 1971 and April 1974 a general survey of the terrestrial algae of Signy Island was made and their qualitative and quantitative distribution at selected sites was examined. Particular emphasis was placed on the two Signy Island terrestrial reference sites (Tilbrook, 1973) as part of a long-term study of their structure and energetics. The ecology of the algae in these two sites and quantitative studies on the algae in several other sites have been published (Broady, 1976*a*, 1977, 1979*a*, *b*). This account includes descriptions of the algae found in several terrestrial habitats and discusses their distribution on Signy Island.

Signy Island (lat. 60°43'S., long. 45°38'W.), a small island in the South Orkney Islands, lies in the South Atlantic Ocean (Fig. 1) 600 km. north-east of the northern extremity of the Antarctic Peninsula. Holdgate

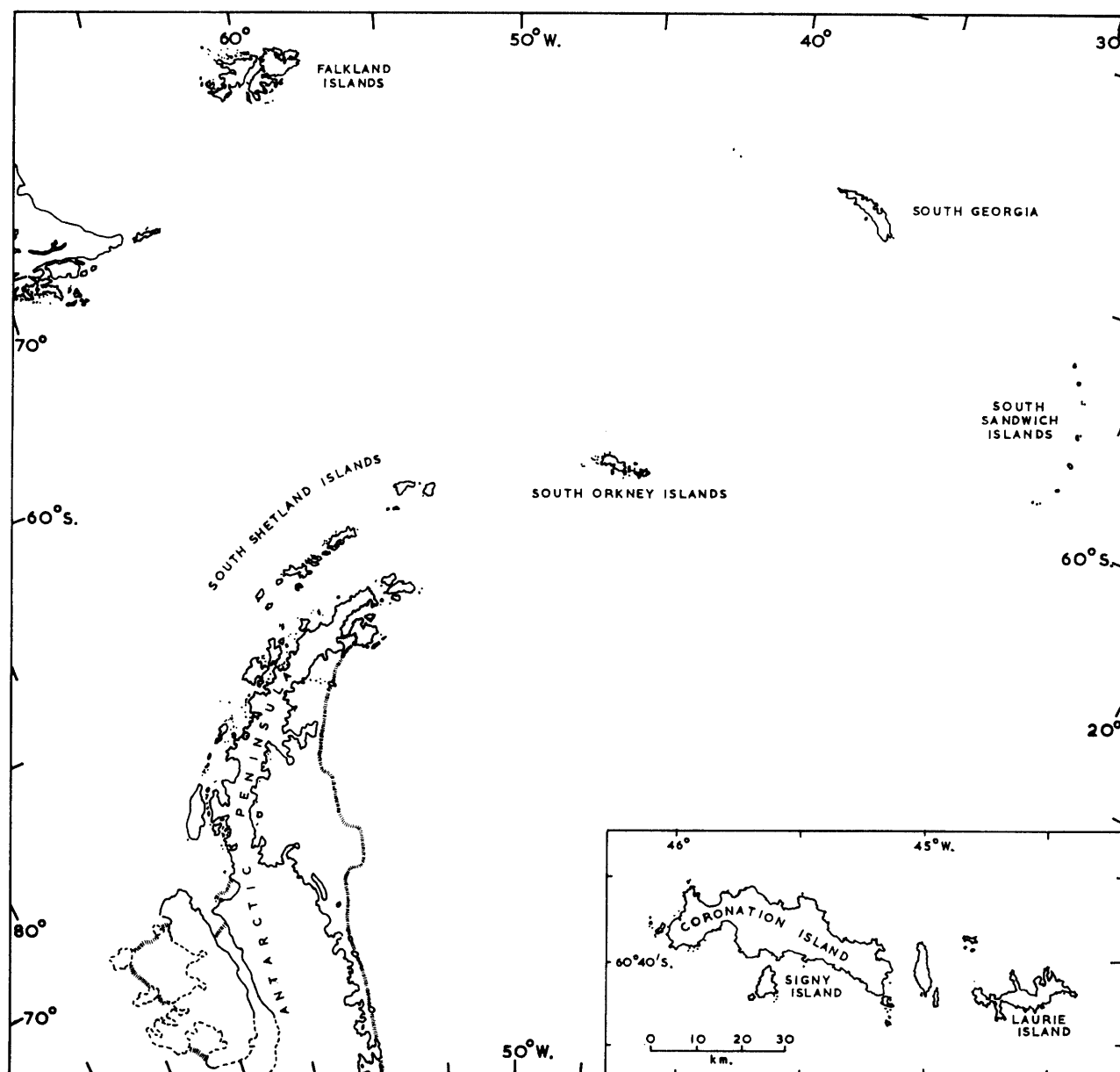


FIGURE 1

The Antarctic regions showing the position of the South Orkney Islands. The inset shows the position of Signy Island within the South Orkney Islands group.

(1967) has described the island in some detail. The geology of Signy Island has been discussed by Matthews and Maling (1967). Garnetiferous quartz-mica-schists predominate but there are associated amphibolites and marbles. The climate of Signy Island is typical of that of the maritime Antarctic as defined by Holdgate (1964). Smith (1972) has summarized meteorological data recorded at Signy Island since 1947 and described the general features of the climate. On summer days with high insolation the surface temperatures of soils, rocks and vegetation rise well above the ambient air temperatures (Holdgate, 1964; Longton and Holdgate, 1967), resulting in a favourable micro-habitat for plants and invertebrates. Snow accumulation commences towards the end of March and there is usually continuous snow cover throughout the winter until at least mid-October; late snow banks persist until around mid-summer. In winter, all lowland areas are snow-covered except for wind-swept knolls and cols, and rock faces.

During summer, about half of the surface of Signy Island is free from ice and snow and, with its varied terrain, the lowland coastal zone provides a diversity of habitats. Descriptions of the physical and chemical composition of the soils and the factors affecting their development have been given by Chambers (1966*a*, *b*, 1967), Allen and Northover (1967), Allen and others (1967), Holdgate and others (1967) and Allen and Heal (1970).

The first ecological survey of the terrestrial vegetation of Signy Island was made by Holdgate (1964). This was subsequently developed by Longton (1967) and Gimingham and Smith (1970). More recently, Smith (1972) provided a detailed description of the lichen, bryophyte and herbaceous plant communities.

The plant communities occurring on stable ground are dominated by bryophytes and lichens of the Antarctic non-vascular cryptogam tundra formation. Communities of the fruticose lichen and moss-cushion sub-formation occur on dry soils and rocks in wind-swept areas from near sea-level to the highest rock exposures. Extensive and often deep moss banks, produced by the turf-forming mosses *Polytrichum alpestre* Hoppe and *Chorisodontium aciphyllum* (Hook. f. and Wils.) Broth., are a prominent feature of the vegetation of Signy Island. These communities of the moss-turf sub-formation are restricted to well-drained usually north-facing slopes. Permanently moist or wet habitats on level or gently sloping ground support extensive communities of the moss-carpet sub-formation, dominated by *Calliergidium austro-stramineum* (C. Muell.) Bartr., *Calliergon sarmentosum* (Wahlenb.) Kindb. and *Drepanocladus uncinatus* (Hedw.) Warnst. The latter has a wide ecological amplitude which allows it to colonize drier habitats and invade other community types.

The Antarctic herb-tundra formation consists, on Signy Island, of localized stands of *Deschampsia antarctica* Desv. and *Colobanthus quitensis* (Kunth) Bartl. The soils developing below these stands are the only relatively mature soils on Signy Island and have been compared to the brown-earth soils of temperate regions (Heal and others, 1967).

In areas of dense seal and penguin populations, a muddy, fairly organic soil is formed from predominantly animal-derived material. *Prasiola crispa* (Lightf.) Menegh., a green foliose alga, forms the predominant macroscopic vegetation on these soils where they are not too physically disturbed.

The supply of nutrients to soils and vegetation on Signy Island has been discussed by Allen and Northover (1967), Allen and others (1967), Holdgate and others (1967) and Northover and Allen (1967). The three principal sources of nutrients are first physical and chemical rock break-down, secondly high salt concentrations in precipitation and wind blown sea-spray, and thirdly nutrients originating from bird and seal colonies. It appears that the supply of all the major nutrients is more than adequate for the growth and maintenance of the vegetation.

II. PREVIOUS INVESTIGATIONS OF THE TERRESTRIAL ALGAE OF ANTARCTICA

THE first collection of a terrestrial alga from Antarctic regions appears to be that reported by Harvey and Hooker (1844). Hooker, a member of the British expedition of 1839–43 led by Sir James Clark Ross, collected *Prasiola crispa* (Lightf.) Menegh. from moist rocks. West and West (1911*b*) examined the collections made by Murray of Shackleton's British Antarctic Expedition (1907–09) on Ross Island and in Victoria Land. Most were from fresh-water ponds but soil from a penguin rookery and material from the moraines of Mount Erebus on Ross Island were also collected. Gain (1912) collected algae from rock faces, amongst mosses and in melt water from the Antarctic Peninsula during the Deuxième Expédition Française

Antarctique (1908–10). Carlson (1913) described the fresh-water algal flora of South Georgia, including algae from amongst mosses and in wet soils, from material collected by the Swedish South Polar Expedition (1901–03). Sparse collections of algae were made by the British Antarctic “*Terra Nova*” Expedition (1910–13) mostly at Cape Adare, Victoria Land. Fritsch (1917) described the algae in these collections, including *Prasiola crispa* and associated terrestrial algae. Bourrelly and Manguin (1954) reported on the algal flora of the sub-Antarctic Iles Kerguelen. As well as the fresh-water forms, they listed 120 algae found as “aerophiles” in habitats such as wet rocks, *Sphagnum* and other mosses. Bunt (1954) gave a comparative account of the terrestrial diatoms of Macquarie Island; ten contrasting soil samples were examined and in these 46 diatom taxa were identified. Soil samples from the McMurdo Sound area of Victoria Land were examined by Flint and Stout (1960); ten genera of algae were recorded and all of them were typical of soils in temperate regions. Fukushima (1961) noted one soil alga from sand collected in the Ongul Islands, eastern Antarctica. Toriumi and Mutsuo (1961) presented a preliminary list of 11 taxa of algae found amongst the mosses from these islands. The list was extended by Akiyama (1968), who reported 32 taxa. Holm-Hansen (1963) found nitrogen fixation by *Nostoc commune* Vauch. from terrestrial habitats of Ross Island and Victoria Land, and discussed the importance of nitrogen-fixing algae to terrestrial life. 18 genera of algae were found in terrestrial habitats; these were listed by Holm-Hansen (1964). Moist and dry sand and rocks were included in the habitats examined and the algae were identified from culture and microscopic examination of the samples. Rudolph (1963) described the presence of *Prasiola crispa* (Lightf.) Menegh. with associated filamentous and other microscopic green and blue-green algae on exposed ground in the vicinity of Hallett Station, Victoria Land. Hirano (1965) mentioned terrestrial algae in his extensive review of the fresh-water algae in the Antarctic regions. Another review of the distribution of algae in the Antarctic was given by Koob (1967) and terrestrial forms were briefly mentioned. He stressed the lack of information from which to draw valid conclusions regarding algal distribution in the Antarctic and emphasized the need for further extensive collecting. An ecological study of the moss community in the vicinity of Syowa station, Enderby Land, made by Matsuda (1968) showed the presence of large amounts of *Gloeocapsa* sp., which apparently restrained the growth of the moss. Algae appearing in cultures of soil samples from the continent were described by Kol (1968) from Haswell Island near Cape Adare, Victoria Land (three taxa), and Kol (1970) from Wright Valley, Victoria Land (five taxa). Belcher (1969) recorded the presence of *Prasiococcus calcarius* (Boye Pet.) Vischer in preserved samples of terrestrial algae collected in the South Sandwich Islands. Cameron and others (1970) briefly mentioned the appearance of algae in cultures of soil from the dry valleys of Victoria Land. Cameron and Devaney (1970) used a scanning electron microscope to study Antarctic soil algal crusts. Cameron and Benoit (1970) recorded five species of algae from the soil of cinder cones on Deception Island, South Shetland Islands. Algae were detected by Cameron (1972a) in soil collected at an altitude of 2,000 m. in the La Gorce Mountains, Antarctica (lat. 86°45'S., long. 146°00'W.). The three taxa are the farthest south algae collected to date. Cameron (1972b) made counts of algae in soils from Victoria Valley, Victoria Land; up to 10⁸ algae g⁻¹ soil were detected, and coccoid green and coccoid and filamentous blue-green algae were present. The ecology of blue-green algae in Antarctic soils, mostly from the dry valleys of Victoria Land, was discussed in some detail by Cameron (1972c).

The first collection of algae from the South Orkney Islands was made on Laurie Island by R. N. Rudmose Brown, a member of the 1902–04 Scottish National Antarctic Expedition. Material from red and yellow snow, pools, streams and wet soil was collected. The algae were examined by Fritsch (1912a, b), who identified 68 species. The terrestrial habitats examined were moss-covered rocks, mud and damp moss, and mud from a penguin rookery.

Limited studies have been made on the algae of Signy Island. Fogg (1967) identified, counted and studied the metabolism of algae in green, red and yellow snow. In addition to the abundant chionophilous species, there were lesser numbers of algae apparently derived from fresh water or soil. The latter included species of *Achnanthes*, *Navicula* and *Hantzschia*, and *Pinnularia borealis* Ehr. The snow algae have also been examined by Kol (1972). Fogg and Stewart (1968) examined nitrogen fixation in algae from a number of terrestrial and fresh-water habitats. Appreciable nitrogen fixation was found in terrestrial habitats associated with the presence of *Nostoc commune*, either free-living or as the algal symbiont in the lichens *Leptogium* (quoted as *Collema*; personal communication from R. I. L. Smith) and *Stereocaulon*. These were almost entirely confined to areas subject to the influence of basic rocks. Horne (1972) confirmed these results but he thought that the pH of the surface waters directly determined the rate of nitrogen fixation.

Smith (1972) described two alga sub-formations in his account of the vegetation of the South Orkney Islands. The soil-alga sub-formation comprises two associations dominated by foliose species, one with *Prasiola crispa* as the predominant species and the other with *Nostoc* cf. *commune*. The snow-alga sub-formation consists of varying proportions of *Chlamydomonas nivalis* Wille, *Raphidonema nivale* Lagerh., *Ochromonas* sp. and other species. Smith (1973), in his study of the ecology of the Protozoa in a chinstrap penguin (*Pygoscelis antarctica* Forster) rookery, measured the increase in *Prasiola crispa* cover over a summer using a point-quadrat technique.

The author has undertaken an intensive study of the terrestrial algae at Signy Island (Broady, 1976, 1977a, b, 1979a, b) and the present work is a systematic account of the species recorded.

III. SITES EXAMINED FOR ALGAE

A. TERMINOLOGY

The sites examined ranged from bare, wind-swept rock faces to semi-aquatic habitats, where the vegetation was permanently saturated though none was permanently covered by standing water. Table I gives a scheme for their classification. All the algae can be referred to the *aerial algae* group as defined by Petersen (1935), i.e. those which grow out of water, in contrast to the *hydrophytic algae*, i.e. those which grow submerged in water.

The sites examined in the present study are placed in two major categories:

- i. *Subaerial sites*. Samples consisting of soil and where present the overlying vegetation.
- ii. *Aerial sites*. Samples consisting of superficial growths of algae on rock faces and in crevices in rock faces where there was no soil formation and, except for occasional lichens, algae were the only forms of plant life.

Aerial is used in a different more limited sense to that of Petersen (1935) mentioned above. Schlichting (1975) used the term *subaerial* or *aerophilous* for those algae inhabiting any object in the air above the soil, litter or water surface. However, in the present study such habitats are termed *aerial*. There is apparently a need for a standardized nomenclature for terrestrial algal habitats. Round (1973) described aerial growths of algae according to two habitat categories, namely, epilithic (on rock and stone surfaces) and epiphytic (on vegetation). In the latter, he included the epiphytic flora of Bryophyta. The classification of sites on Signy Island (Table I) includes these in the subaerial category. The bryophytes and the underlying soils provide some protection for the algae from climatic extremes, protection which is not usually present in the aerial situation. Samples from the bryophyte sites consisted of both the living vegetation and c. 1 cm. of the underlying soil. There was no evidence of the soil having a different flora to the living vegetation.

B. SUBAERIAL SITES

Short descriptions of the subaerial sites (sites 1–72) and their locations are given in Table II.

The mineral soil samples were free of macroscopic vegetation cover although moss communities were often present nearby. The lack of vegetation was due to the recent exposure by ice retreat, recent *in situ* formation by weathering of the parent rock or the instability of the soils due to cryoturbation, solifluction or disturbance by penguins or seals.

A wide variety of bryophyte associations (Smith, 1972) was sampled, particularly those with a more extensive and widespread distribution, but also some of the more restricted communities. The three most widespread communities sampled were the fellfield communities dominated by *Andreaea* spp., the moss turves of *Polytrichum alpestre* and *Chorisodontium aciphyllum*, and the carpet- and mat-forming bryophytes of wet communities dominated by *Drepanocladus uncinatus*, *Calliargon sarmentosum* and *Cephaloziella varians*. The tall hummocky cushions of *Brachythecium austro-salebrosum* in wet somewhat nutrient-enriched areas were also sampled.

The samples from stands of *Deschampsia antarctica* included the dead lower leaves of the plants and the upper 1 cm. of the underlying loamy soil. The *Colobanthus quitensis* sample included the upper living vegetation.

TABLE I
CLASSIFICATION OF TERRESTRIAL SITES SAMPLED FOR ALGAE

Major characters used to classify sites				Dominant vegetation of sample material	Site numbers	Sample material		
Subaerial	Mineral soils without macroscopic vegetation cover	Soils formed by glacial action		Microscopic algae	1-7	Largely mineral soil cored to a depth of 1.5 cm.		
		Soils formed by <i>in situ</i> weathering		Parent rock acid (quartz-mica-schist)	Microscopic algae		8, 9	
				Parent rock alkaline (marble or amphibolite)	Microscopic algae		10-12	
		Soil with high organic content from penguin guano		Microscopic algae	13			
	Macroscopic vegetation cover present	Cryptogams	Bryophytes (with associated lichens)	Dry moss-cushion fellfield (with associated lichens)	On acid soil	<i>Andreaea</i> spp. <i>Dicranoweisia grimmiaea</i>	14-24 25	Living moss and underlying soil cored to a depth of 1.5 cm.
					On basic soil	<i>Tortula</i> spp.	26-28	
				Moist moss turves (with associated lichens)	Below bird's nest (<i>Daption capensis</i>)	<i>Pottia austro-georgica</i>	29	
					Healthy growth on surface	<i>Polytrichum alpestre</i> and <i>Chorisodontium aciphyllum</i> <i>Polytrichum alpestre</i>	30, 31 32-38	
				Moribund bare peat surface	Microscopic algae	39, 40	Peat cored to a depth of 1.5 cm.	
				Wet bryophyte carpets, mats and hummocks	Healthy growth on surface	<i>Calliergon sarmentosum</i> and <i>Chorisodontium aciphyllum</i> <i>Calliergon sarmentosum</i> <i>Drepanocladus uncinatus</i> <i>Brachythecium austro-salebrosum</i> <i>Cephaloziella varians</i>	41 42-45 45-56 57, 58 59	Living bryophytes and underlying soil cored to a depth of 1.5 cm.
			Moribund bare peat surface		Microscopic algae	60	Peat cored to a depth of 1.5 cm.	
			Algae	Foliose <i>Prasiola crispa</i>		<i>Prasiola crispa</i>	61-63	Alga and underlying soil cored to a depth of 1.5 cm.
	Phanerogams		Loamy soil developing below <i>Deschampsia antarctica</i>		Microscopic algae	64-71	Dead lower leaves and underlying soil cored to a depth of 1.5 cm.	
			<i>Colobanthus quitensis</i> and underlying soil		<i>Colobanthus quitensis</i>	72	Living vegetation and underlying soil cored to depth of 1.5 cm.	
Aerial	Rock surfaces and crevices with a superficial growth of algae	Dry exposed rock surfaces		Acidic rocks (quartz-mica-schist)	Microscopic algae	73-87	Scrapings of algae from rock surfaces and from within cracks and crevices	
				Basic rocks (marble or amphibolite)	Microscopic algae	88-93		
		Rock surfaces irrigated with melt water		In sea-spray zone but not in immediate vicinity of nesting birds	Microscopic algae	94-101		
				In immediate vicinity of nesting birds	Microscopic algae	102-111		
		Moist cracks and crevices in marble rocks		Microscopic algae	112-122			

Many of the sites were affected by birds or seals to some extent, often with nutrients from nest sites and wallow areas washed down on to the sites. Any such effects are mentioned in Table II. Two of the sites, namely 13 and 61, were areas where animal disturbance and the deposition of faeces, moulted skin, hair or feathers was considerable. The former would be termed an *ornithogenic soil* by Ugolini (1972) but it has been included in the mineral soils because of the mixing of the underlying mineral material with the penguin-deposited guano and the absence of a macroscopic vegetation cover. Site 61, which was largely composed of elephant seal (*Mirounga leonina* (L.)) faeces and hair, was in an area away from physical disturbance by the seals and had developed an overlying growth of *Prasiola crispa*. This site is placed in the division where macroscopic vegetation was present in the form of algal growths. Both of these sites would have been included in soils of areas contaminated by birds or seals by Holdgate and others (1967).

C. AERIAL SITES

Short descriptions of the aerial sites (sites 73–122) and their locations are given in Table II. They can readily be subdivided into three categories.

On dry exposed rock surfaces there was often a dry, green encrusting growth of algae. These sites were not irrigated by snow melt water except in some cases during the early summer thaw of the winter snow accumulations. Water was supplied by precipitation and atmospheric moisture. Algal growths such as these occurred locally from close to sea-level to the summits of several of the hills.

A second category of sites includes those which were irrigated with melt water for longer periods. In the coastal sea-spray zone from maximum high-water mark to a few metres above sea-level, green filamentous and red encrusting growths of algae were often present towards the end of winter when fast ice was still present around the coasts but snow melt was taking place. Where rocks were exposed on days of high insolation, the warm surfaces caused rapid melting of the surrounding snow and thin films of melt water irrigated the rock surfaces. When these ceased, the algal growths became dry and crusty. A more diverse collection of sites, in which the algal growths varied in colour from green, brown and blue-green to almost black, occurred in rock gullies, fissures or on rock ledges which periodically received trickles of water from melting snow throughout summer. Most were on coastal cliffs and all were in the vicinity of nesting birds.

A third distinct group of sites consists of moist cracks and crevices, all in marbles undergoing decay due to frost shatter, in which there were blue-green or pink algal growths. The algae never formed a surface growth over the exposed rock faces but were always in the damper cracks. Portions of rock had to be prised away in order to reveal their presence.

IV. METHODS AND MATERIALS

A. SAMPLING

1. *Subaerial sites*

Because of the broad survey requirements of this study, it was not possible to standardize sampling methods. Various techniques were used depending on the type of site to be sampled and whether or not the ground was frozen. All apparatus used for removing the samples was either sterile or clean. If clean, the instrument was first coated with the algal flora of the sampling area by repeatedly pushing it in and out of the soil or vegetation. Samples were stored in sterile, screw-topped aluminium canisters for transport back to the laboratory. Moss samples were removed using a variety of instruments on different occasions, e.g. cylindrical corers, scissors, forceps or a knife. Sometimes small cushions of moss could simply be dislodged into the sample containers. Mineral soils were best collected by removing the surface soil to a depth of about 1 cm. with the blade of a knife. On the few occasions when samples were taken in winter an axe was useful for obtaining pieces of moss and peat from the frozen ground.

2. *Aerial sites*

Algae coating exposed rock surfaces, in small cracks and crevices, and under loose pieces of rock, were usually removed by scraping off the growths with a clean knife or spatula. The samples were stored in small glass vials. Occasionally, rocks bearing the algal growths were brought back to the laboratory.

B. EXAMINATION OF SAMPLES

1. *Subaerial sites*

It was hoped that by using a combination of three methods for the qualitative examination of samples a large proportion of the algal flora would be recovered.

- i. *Direct microscopic examination.* All the subaerial samples were examined using this technique. Aqueous sample suspensions were observed at magnifications up to 1,000 diameters and where possible material was identified. When diatoms were present, samples were cleared of organic material by treatment with hot chromic acid (5 g. potassium dichromate, 10 ml. concentrated sulphuric acid and 30 ml. distilled water) at 100°C for 1–2 hr., followed by up to five water washings of the precipitate formed by centrifugation (1,000 r.p.m. for 1 min.). A drop of the final suspension was allowed to dry on a coverslip. This was then mounted in Naphrax diatom mountant (N.B.S. Ltd.; refractive index = 1.74).
- ii. *Moist plate enrichment culture.* The technique was similar to that used by John (1942) and Lund (1945). Of the 72 subaerial sites, only 33 were examined in this manner (Table IV). Repeated and lengthy microscopic examination of developing algae was required and time limitations prevented all samples being examined. Portions of the samples were placed in sterile 9 cm. wide Petri dishes. Enough sterile water was added to thoroughly moisten the sample without it being waterlogged. Flame-sterilized coverslips were then placed on the surface. The dishes were incubated in constant light supplied by four 30 W daylight fluorescent tubes at room temperature (*c.* 18°C). All were examined after 1, 2, 4, 6, 10, 14, 18, 22 and 26 weeks incubation. In the moist, warm and light conditions, an enriched growth of algae usually developed in the sample and on the undersides of the coverslips. The latter were removed from the plates and examined microscopically. Little detritus was carried over on the coverslips and the often rich algal growths were readily visible. When diatoms were present, material was acid cleared as described in (i) above.
- iii. *Culture in mineral salts medium.* Every site was examined by this technique. Bold's modified Bristol's medium (BBM) (Chantanachat and Bold, 1962) was used for all the culture work, solidified with 2 per cent agar (Oxoid Ltd., agar No. 3). For the growth of the Cyanophyceae alone, the medium was supplemented with the antibiotic cycloheximide at a concentration of 100 µg. ml.⁻¹. Growth of the eucaryotic algae was prevented by this treatment. Material for innoculating the media was derived from untreated sample material, homogenized sample material and from the enrichment cultures. Soil and vegetation were spread over the agar plates in small quantities. Homogenized material was dropped on to the surface from Pasteur pipettes. The water was absorbed by the agar, leaving the suspended particles on the surface, the plates having been previously dried at 50°C for 1 hr. with the tops slightly open. All cultures were incubated under constant illumination as described in (ii) above.

Good growth usually appeared after about 2 weeks incubation and the plates were examined after 3 or 4 weeks. Any algal growth appearing on the plates was examined microscopically. Material was scraped from the surface using a wire loop and individual colonies were removed using finely pointed needles and with the aid of a binocular microscope. Single discrete colonies were removed for the innoculation of uni-algal cultures which were grown on BBM 2 per cent agar slopes in screw-capped McCartney vials. When diatoms developed, these were scraped off the plates and acid cleared as described in (i) above. The uni-algal cultures were observed at regular intervals for the compilation of life-cycle information.

2. *Aerial sites*

Only the direct microscopic examination technique was used. Samples of algae scraped from the macroscopic growths were examined in aqueous microscopic preparations and the algae present were noted. Samples in which diatoms were present were acid cleared for their identification.

C. IDENTIFICATION OF THE ALGAE

Whichever method of examination was used, drawings and notes were made of the algae observed under the microscope. As complete a set of drawings as possible of all the algae was made whilst the author was on

Signy Island. These were used in the subsequent identification procedures, most of which were undertaken in the United Kingdom because of the restricted library facilities at Signy Island. The works of Bourrelly (1966, 1968, 1970) were used for identification to generic level. The broader taxonomic groups of Bourrelly, at least to the family level, are used throughout this report, although it is recognized that other classification schemes are widely used, for example, that of Round (1973). Classical taxonomic works were used for most of the identifications to the specific level, in particular Geitler (1932) for the Cyanophyceae, Hustedt (1930, 1959, 1961, 1962, 1966) for the Bacillariophyceae, Printz (1964) for the Ulothricophyceae and Pascher (1939) for the Xanthophyceae. Other identifications were made from a varied literature which is referred to in the following systematic account. The Fritsch Collection of algal drawings lodged at the Freshwater Biological Association, Ambleside, Cumbria, was useful as was the micro-film copy of this collection at the Culture Centre of Algae and Protozoa, Cambridge.

The revisions of the Oscillatoriaceae (Drouet, 1968) and the coccoid Cyanophyceae (Drouet and Daily, 1956) combined many formerly distinct genera and species into fewer new taxa, each with a large synonymy. In the present study, it was considered preferable to follow the work of Geitler (1932) to distinguish the many taxa grouped together by the former authors. Few of the Cyanophyceae produced growth in culture and it was usually unknown whether taxa with different growth forms in different field situations were, in fact, ecotypes which may develop a similar morphology if grown under the same culture regime.

Whenever possible, observations were made on uni-algal cultures of Chlorophyta and Xanthophyceae. The unicellular algae in particular often need prolonged studies of morphology and reproduction before they can be identified. The difficulties encountered in, and the modern methods of, identifying such algae have been summarized by Bold (1970). The importance of the use of cultures in the study of Antarctic algae has been stressed by Drouet (1961) and Koob (1967). In the present study, as many of these algae as possible were examined in culture but because of their large variety and number the culture studies were not so intensive as those of, for example, Starr (1955), Herndon (1958), and Brown and Bold (1964). Where it proved impossible to obtain cultures or where cultures failed to survive transport to the United Kingdom, the algae could be identified only by the less satisfactory techniques of direct microscopic examination of field and preserved material or from the information obtained from cultures studied only on Signy Island. The eight new species and one new genus (Broady, 1976, 1977a) were more intensively studied using uni-algal cultures returned to the United Kingdom. It has not been possible to designate each of the 162 algae a specific identity but each is identified as far as possible in the following account.

V. SYSTEMATIC ACCOUNT

A. ARRANGEMENT OF TEXT

A systematic classification of all terrestrial algal genera so far known from Signy Island is given below. The nomenclature of Bourrelly (1966, 1968, 1970) is followed to the family level at least. In some taxa, a more commonly accepted generic synonym has been used in place of Bourrelly's nomenclature.

CLASSIFICATION OF SIGNY ISLAND TERRESTRIAL ALGAE

PHYLUM SCHIZOPHYTA

CLASS CYANOPHYCEAE

SUBCLASS COCCOGONOPHYCIDAE

ORDER CHROOCOCCALES

Chroococcaceae

Aphanocapsa (2 spp.)

Aphanothece (1 sp.)

Chlorogloea (1 sp.)

Chroococcus (2 spp.)

Gloeocapsa (1 sp.)

Gloeothece (1 sp.)

Merismopedia (1 sp.)

Synechococcus (2 spp.)

Synechocystis (1 sp.)

ORDER PLEUROCAPSALES

- Chroococciaceae
Myxosarcina (1 sp.)

ORDER CHAMAESIPHONALES

- Chamaesiphonaceae
Chamaesiphon (1 sp.)

- Clastidiaceae
Chroococciopsis (1 sp.)

SUBCLASS HORMOGONOPHYCIDAE

ORDER NOSTOCALES

- Scytonemataceae
Plectonema (2 spp.)
Tolypothrix (1 sp.)
Rivulariaceae
Calothrix (1 sp.)
Nostocaceae
Nodularia (1 sp.)
Nostoc (3 spp.)

- Oscillatoriaceae
Isocystis (1 sp.)
Lyngbya (5 spp.)
Microcoleus (1 sp.)
Oscillatoria (9 spp.)
Phormidium (5 spp.)
Pseudanabaena (2 spp.)
Schizothrix (2 spp.)
Spirulina (1 sp.)

PHYLUM PYRRHOPHYTA

CLASS DINOPHYCEAE

SUBCLASS DINOPHYCIDAE

ORDER DINOCOCCALES

- Gloeodiniaceae
Gloeodinium (1 sp.)

PHYLUM CHROMOPHYTA

CLASS CHRYSOPHYCEAE

SUBCLASS ACANTOCHRYSOPHYCIDAE

ORDER STICHOGLOEALES

- Stichogloeaceae
Unidentified genus (1 sp.)

CLASS XANTHOPHYCEAE

ORDER MISCHOCOCCALES

- Pleurochloridaceae
Botrydiopsis (1 sp.)
Chloridella (3 spp.)
Ellipsoidion (2 spp.)
Monodus (1 sp.)
Unidentified genus (1 sp.)

- Chlorobotrydaceae
Gloeobotrys (2 spp.)
Characiopsidaceae
Characiopsis (1 sp.)

ORDER TRIBONEMATALES

- Tribonemataceae
Heterothrix (3 spp.)
Heterotrichella (1 sp.)
Tribonema (1 sp.)

- Heterodendraceae
Heterococcus (1 sp.)

CLASS BACILLARIOPHYCEAE

SUBCLASS CENTROPHYCIDAE

ORDER COSCINODISCALES

Coscinodiscaceae

Melosira (1 sp.)

SUBCLASS PENNATOPHYCIDAE

ORDER DIATOMALES

Diatomaceae

Diatoma (1 sp.)*Fragilaria* (1 sp.)

ORDER EUNOTIALES

Eunotiaceae

Eunotia (2 spp.)

ORDER ACHNANTHALES

Achnanthaceae

Achnanthes (4 spp.)

ORDER NAVICULALES

Naviculaceae

Navicula (7 spp.)*Pinnularia* (6 spp.)*Stauroneis* (2 spp.)

Nitzschiaceae

Hantzschia (1 sp.)*Nitzschia* (3 spp.)

PHYLUM CHLOROPHYTA

CLASS EUCHLOROPHYCEAE

ORDER VOLVOCALES

Chlamydomonadaceae

Chlamydomonas (3 spp.)*Chloromonas* (2 spp.)

ORDER TETRASPORALES

Gloeocystaceae

Chlamydocapsa (2 spp.)

Hypnomonadaceae

Hypnomonas (1 sp.)*Signiosphaera* (1 sp.)

ORDER CHLOROCOCCALES

Chlorococcaceae

Bracteacoccus (1 sp.)*Chlorococcum* (2 spp.)*Myrmecia* (1 sp.)*Rhopalocystis* (1 sp.)*Trebouxia* (1 sp.)

Unidentified genus (1 sp.)

Palmellaceae

Sphaerocystis (3 spp.)

Hormotilaceae

Unidentified genus (1 sp.)

Oocystaceae

Chlorella (2 spp.)*Chondrosphaera* (1 sp.)*Monoraphidium* (1 sp.)*Planktosphaerella* (1 sp.)*Pseudochlorella* (1 sp.)*Scotiella* (1 sp.)*Trochiscia* (1 sp.)

Dictyosphaeraceae

Dictyosphaerium (1 sp.)

Unidentified genus (1 sp.)

Coccomyxaceae

Elakatothrix (1 sp.)*Ourococcus* (1 sp.)

Unidentified family and genus (1 sp.)

CLASS ULOTHRICOPHYCEAE

ORDER ULOTHRICALES

Ulothricaceae

Chlorhormidium (2 spp.)*Fottea* (1 sp.)*Raphidonemopsis* (1 sp.)*Stichococcus* (2 spp.)*Ulothrix* (1 sp.)

Microsporaceae

Microspora (1 sp.)

ORDER ULVALES

Prasiolaceae

Prasiococcus (1 sp.)*Prasiola* (1 sp.)

ORDER CHAETOPHORALES

Chlorosarcinaceae

Chlorosarcinopsis (2 spp.)*Planophila* (2 spp.)

Chaetophoraceae

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

CLASS ZYGOPHYCEAE

ORDER ZYGNEMATALES

Mesotaeniaceae

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

Desmidiaceae

Cosmarium (6 spp.)*Staurastrum* (1 sp.)

In the following account the descriptions of the algae are arranged systematically to the order level and then alphabetically for convenience within each order. The species descriptions have been compiled from Signy Island material. The habitat notes briefly describe where the alga was found on Signy Island and ecological preferences are stated where these are apparent. Tables IV and V provide the detailed distribution data for each alga and the sites are described in Table II. Notes on the known distribution of each alga are given; first, as recorded from terrestrial or aquatic Antarctic localities and, secondly, from terrestrial habitats in other regions of the world. In the latter, fresh-water occurrences are occasionally noted if the alga is not known in terrestrial situations according to the literature. The Antarctic is regarded here as including the sub-Antarctic islands (South Georgia, Macquarie Island, Marion and Prince Edward Islands, Heard Island, Iles Crozet and Iles Kerguelen) and all regions to the south of these.

B. ARTIFICIAL KEY TO THE GENERA

The following key is based as far as possible on the pigmentation and morphology of the vegetative cells and, where necessary, on their reproductive mechanisms. It includes all the known genera of terrestrial algae on Signy Island. However, three doubtful taxa cannot be keyed out. These are an unidentified genus of Chlorococcales, which forms bright red encrustations on coastal rocks and two small green unicellular algae, an unidentified genus of the family (?) Dictyosphaeriaceae and (?) *Planophila* sp. B, which were rarely observed in the subaerial sites.

Certain taxa are recognizable by direct microscopic examination of field material but most require moist plate enrichment culture before they are present in sufficient numbers to be detected. The characters marked with an asterisk (*) are either only of real value when used with uni-algal cultures or are used for keying out genera only detected by culture in mineral salts medium in the present study. The diatoms require hot acid digestion and the preparation of permanent microscopic preparations before they can be identified from the markings on the valves. With experience, some of the more distinctively shaped diatoms can be recognized without this treatment.

1. Pigments localized in chromatophores, algae green, yellow-green or yellow-brown	2
Pigments not localized in chromatophores, algae usually a bluish green colour, rarely pink-purple or red-brown	70
2. Chromatophores yellow-brown	3
Chromatophores green or yellow-green	14
3. Cells composed of two siliceous valves, surviving hot acid digestion and after such treatment usually seen to be delicately marked with striae or punctae	4
Cells not composed of two siliceous valves and not surviving hot acid digestion	13
4. Cells spherical in valve view	<i>Melosira</i>
Cells not spherical in valve view	5
5. Valves both with raphes	6
Valves not both with raphes, one with raphe and second with pseudoraphe, or both with pseudoraphe	11
6. Raphes long and marginal or short terminal hooks	7
Raphes long and central	9
7. Raphes consisting of short terminal hooks	<i>Eunotia</i>
Raphes long and marginal	8
8. Striae across valves unable to be resolved or terminating half-way across valve	<i>Nitzschia</i>
Striae across valves consisting of rows of fine punctae crossing most of valve	<i>Hantzschia</i>
9. Valves with transverse markings consisting of wide costae	<i>Pinnularia</i>
Valves with transverse markings appearing as rows of punctae or fine lines or unable to be resolved	10
10. Valves with central transverse area clearly free of striae	<i>Stauroneis</i>
Valves with striae present along entire length or striae cannot be resolved	<i>Navicula</i>
11. Valves dissimilar, one with pseudoraphe and one with raphe	<i>Achnanthes</i>
Valves both with pseudoraphe	12
12. Valves with transverse costae	<i>Diatoma</i>
Valves without costae	<i>Fragilaria</i>
13. Cells spherical, single or in small colonies, surrounded by stratified mucilaginous sheaths	<i>Gleodinium</i>
Cells ellipsoidal, free-living, no mucilaginous sheaths.	Unidentified genus of the family Stichogloeaceae
14. Chromatophores green, starch often detected by Lugol's iodine solution, pyrenoids often present	15
Chromatophores yellow-green, starch absent, pyrenoids absent	59
15. Cells single, free-living or in mucilaginous colonies or rarely held together by remains of sporangium wall	16
Cells forming simple or branching filaments sometimes readily fragmenting, two-dimensional sheets of cells, pseudoparenchymatous aggregates of cells or cubical packets of cells formed by cell division in three planes	46
16. Cells normally motile in vegetative stage, with two flagella, may form a palmella stage	17
Cells non-motile in vegetative stage, flagella absent	18
17. Pyrenoid present	<i>Chlamydomonas</i>
Pyrenoid absent	<i>Chloromonas</i>
18. Cells in mucilaginous colonies which are irregular masses or branching	19
Cells single, free-living or rarely held together temporarily by remains of sporangium wall	25
19. Cells cylindrical or fusiform	20
Cells spherical or ellipsoidal	22
20. Cells fusiform, oblique transverse wall forming in cell division	<i>Elakatothrix</i>
Cells cylindrical with broadly rounded apices, vertical transverse wall forming in cell division	21
21. Cells with single parietal chromatophore*	<i>Fottea</i>
Cells with two axial stellate chromatophores*	<i>Cylindrocystis</i>
22. Cells with permanent contractile vacuoles*	<i>Chlamydocapsa</i>
Cells without contractile vacuoles*	23

23. Colonies branching	Unidentified genus of the family Hormotilaceae	
Colonies irregular masses		24
24. Chromatophore axial with central pyrenoid	<i>Chondrosphaera</i>	
Chromatophore parietal with lateral pyrenoid.	<i>Sphaerocystis</i>	
25. Cells comprising two similar half cells separated by median constriction		26
Cells without median constriction		27
26. Cells with each half cell bearing three or four short, broadly rounded, radiating processes in apical view	<i>Staurostrum</i>	
Cells not as above, each half cell either semi-circular or almost trapezium-shaped with undulating or smooth wall	<i>Cosmarium</i>	
27. Adult cells with permanent contractile vacuoles*		28
Adult cells without permanent contractile vacuoles*		29
28. Chromatophore parietal, cup-shaped with basal pyrenoid; two contractile vacuoles present	<i>Hypnomonas</i>	
Chromatophore parietal, reticulate, pyrenoid absent; several contractile vacuoles present	<i>Signiosphaera</i>	
29. Cells cylindrical		30
Cells not cylindrical		31
30. Cells with two axial, stellate chromatophores	<i>Cylindrocystis</i>	
Cells with two axial, ribbon-like chromatophores	<i>Netrium</i>	
31. Cells bearing numerous short wart-like protuberances	<i>Trochiscia</i>	
Cells without wart-like protuberances		32
32. Cells fusiform, curved, with each pole extending to form a short spine	<i>Ourococcus</i>	
Cells not as above		33
33. Cells large ellipsoidal, c. 60 μm . by 45 μm ., with lateral wing-like wall extensions	<i>Scotiella</i>	
Cells not as above		34
34. Cells fusiform to almost pyriform		35
Cells spherical to ellipsoidal		36
35. Cells almost pyriform, one apex broadly rounded, the other narrowly rounded; biflagellate zoospores and autospores formed, portion of mother cell remaining at base of sporangium after spore release*	<i>Rhopalocystis</i>	
Cells fusiform; autospores formed, sporangium empty after spore release	<i>Monoraphidium</i>	
36. Chromatophore single, axial	<i>Trebouxia</i>	
Chromatophore(s) parietal		37
37. Chromatophores numerous plate-like		38
Chromatophore single		39
38. Pyrenoid in each chromatophore, autospores formed*	<i>Planktosphaerella</i>	
Pyrenoids absent, zoospores and aplanospores formed*	<i>Bracteacoccus</i>	
39. Pyrenoid present		40
Pyrenoid absent		45
40. Autospores temporarily attached to ends of cruciform remains of sporangium wall*	<i>Dictyosphaerium</i>	
Autospores, if produced, not remaining attached to remains of sporangium wall		41
41. Zoospores produced*		42
Zoospores not produced*		44
42. Zoospores biflagellate*	<i>Chlorococcum</i>	
Zoospores quadriflagellate*		43
43. Transverse cell division; cells almost spherical; autospores not produced*	<i>Planophila</i>	
Transverse cell division not occurring; cells spherical, ellipsoidal, pyriform and other shapes; autospores or zoospores produced*	Unidentified genus of the family Chlorococcaceae	

44.	Cells ellipsoidal to oval*	<i>Pseudochlorella</i>
	Cells spherical	<i>Chlorella</i>
45.	Chromatophore parietal, bilobed*	<i>Myrmecea</i>
	Chromatophore parietal completely covering cell wall*	<i>Chlorella</i>
46.	Thallus foliose, unistratose, macroscopic	<i>Prasiola</i>
	Thallus not as above	47
47.	Filaments uniseriate, unbranched	48
	Filaments uniseriate, branched or cubical or irregular masses of cells	53
48.	Chromatophore axial	<i>Prasiola</i>
		(“ <i>Hormidium</i> ” stage)
	Chromatophore parietal	49
49.	Chromatophore with pyrenoid(s)	50
	Chromatophore without pyrenoid	51
50.	Chromatophore with several pyrenoids; filaments with terminal holdfast, long, multicellular	<i>Ulothrix</i>
	Chromatophore with single pyrenoid; filaments without holdfast, often readily fragmenting	<i>Chlorhormidium</i>
51.	Chromatophore parietal, reticulate; filaments long, multicellular	<i>Microspora</i>
	Chromatophore parietal, plate-like; filaments readily fragmenting	52
52.	Cells cylindrical, one apex tapering to short stalk sometimes with small terminal button*	
		<i>Raphidonemopsis</i>
	Cells short cylinders or spherical, both apices of cylindrical cells rounded	<i>Stichococcus</i>
53.	Cells forming branching uniseriate filaments	54
	Cells forming cubical or irregular masses by division in three planes	57
54.	Filaments surrounded by mucilaginous sheath; cells just touching or separated by mucilaginous matrix	(?) <i>Hazenia</i>
	Filaments not surrounded by mucilaginous sheath	55
55.	Chromatophore with pyrenoid	56
	Chromatophore without pyrenoid	<i>Microthamnion</i>
56.	Zoospores produced*	<i>Gongrosira</i>
	Zoospores not produced*	<i>Desmococcus</i>
57.	Chromatophore axial with central pyrenoid	<i>Prasiococcus</i>
	Chromatophore parietal with lateral pyrenoid.	58
58.	Cells in cubical groups of eight cells or more*	<i>Chlorosarcinopsis</i>
	Cells in more irregular masses with occasional emerging branches*	<i>Desmococcus</i>
59.	Cells single, free-living, attached to substrate or in mucilaginous colonies	60
	Cells forming simple or branching filaments, occasionally readily fragmenting or three-dimensional cell masses	67
60.	Cells with terminal holdfast	<i>Characiopsis</i>
	Cells without terminal holdfast	61
61.	Cells in mucilaginous colonies	<i>Gloeobotrys</i>
	Cells free-living	62
62.	Cells with single chromatophore	63
	Cells with more than one chromatophore	65
63.	Cells spherical	<i>Chloridella</i>
	Cells ellipsoidal or pyriform	64
64.	Cells pyriform often with terminal papillate wall thickening*	<i>Monodus</i>
	Cells ellipsoidal, no wall thickening*	<i>Ellipsoidion</i>
65.	Cells spherical, ellipsoidal, pyriform or other more irregular shapes, terminal wall papilla occasionally present*	Unidentified genus of the family Pleurochloridaceae
	Cells spherical, smooth wall	66

66.	Cell diameter 3·5–12 μm .; chromatophores parietal plates, four to several per cell; four or eight autospores formed*	<i>Chloridella</i>	
	Cell diameter 6–42 μm ., chromatophores parietal, plate-like or fusiform, numerous; aplanospores or zoospores formed in large numbers*	<i>Botrydiopsis</i>	
67.	Cells forming branching filaments or three-dimensional cell masses	<i>Heterococcus</i>	
	Cells forming simple filaments		68
68.	Chromatophores several per cell; filaments long; H-shaped cell wall remains after fragmentation	<i>Tribonema</i>	
	Chromatophores one or two per cell; filaments readily fragmenting; no H-shaped cell wall remains after fragmentation		69
69.	Chromatophore one per cell; terminal cell often with small apical wall papilla*	<i>Heterotrichella</i>	
	Chromatophores one or two per cell; no wall papilla*	<i>Heterothrix</i>	
70.	Cells united in trichomes		71
	Cells not united in trichomes		83
71.	Trichomes with false branching		72
	Trichomes without false branching		75
72.	Heterocysts present		73
	Heterocysts absent		74
73.	Trichomes of nearly uniform width throughout length, with thin sheaths	<i>Tolypothrix</i>	
	Trichomes attenuated towards the apices, often with thick stratified sheaths	<i>Calothrix</i>	
74.	Trichomes single within sheath	<i>Plectonema</i>	
	Trichomes in small numbers within a single sheath	<i>Schizothrix</i>	
75.	Sheaths present but may be narrow and difficult to resolve, or trichomes embedded in mucilaginous matrix		76
	Sheaths absent, no mucilaginous matrix		80
76.	Trichomes numerous, in bundles, surrounded by thick stratified sheath	<i>Microcoleus</i>	
	Trichomes single, each surrounded by individual sheath or embedded in mucilaginous matrix		77
77.	Heterocysts present		78
	Heterocysts absent		79
78.	Trichomes straight, each with thin sheath	<i>Nodularia</i>	
	Trichomes often twisted and closely packed within sheath or twisted in mucilaginous matrix	<i>Nostoc</i>	
79.	Trichomes forming confluent felt-like growths	<i>Phormidium</i>	
	Trichomes remaining single	<i>Lyngbya</i>	
80.	Trichomes consisting of globular or ellipsoidal cells of various widths	<i>Isocystis</i>	
	Trichomes not as above		81
81.	Trichomes spirally wound along their whole length	<i>Spirulina</i>	
	Trichomes not as above		82
82.	Cells joined by mucilaginous pads	<i>Pseudanabaena</i>	
	Cells joined directly to one another		83
83.	Cells single, free-living or fixed, or in parenchymatous masses; exospores or endospores produced		84
	Cells single, free-living or in mucilaginous colonies; no spore formation		86
84.	Cells single, ellipsoidal to pyriform; exospores formed	<i>Chamaesiphon</i>	
	Cells single or in parenchymatous masses; endospores formed		85
85.	Cells single or in loose aggregates	<i>Chroococciopsis</i>	
	Cells forming parenchymatous masses	<i>Myxosarcina</i>	
86.	Cells in mucilaginous capsules, usually forming colonies		87
	Cells free-living		93
87.	Cells cylindrical		88
	Cells spherical to ellipsoidal		89
88.	Colonies non-stratified	<i>Aphanothece</i>	
	Colonies stratified	<i>Gloeothece</i>	
89.	Cells in flat two-dimensional colonies, often in regular arrangements of four cells or multiples of four	<i>Merismopedia</i>	

	Cells in three-dimensional mucilaginous colonies	90
90.	Cells tightly packed with pseudofilamentous arrangement towards edge of pink-purple colonies*	<i>Chlorogloea</i>
	Cells well spaced in mucilaginous colonies	91
91.	Colonies non-stratified	<i>Aphanocapsa</i>
	Colonies stratified	92
92.	Colonies multicellular, mucilage clearly stratified; cells 1.5–2.5 μm . in diameter	<i>Gloeocapsa</i>
	Colonies small, often containing up to only eight cells, mucilage faintly or clearly stratified; cells 5–8 μm . in diameter	<i>Chroococcus</i>
93.	Cells small, 1.5–2.5 μm . in diameter, spherical	<i>Synechocystis</i>
	Cells large, up to 30 μm . by 20 μm ., ellipsoidal to almost cylindrical	<i>Synechococcus</i>

C. DESCRIPTIONS OF GENERA AND SPECIES

PHYLUM SCHIZOPHYTA

CLASS CYANOPHYCEAE

ORDER CHROOCOCCALES

Aphanocapsa Naegeli

Cells spherical distributed throughout homogeneous colonial mucilage; individual cell sheaths not evident; cells often in pairs resulting from recent division.

The nomenclature of Geitler (1932) is followed; Bourrelly (1970) included *Aphanocapsa* in *Microcystis* Kuetzing.

- | | | |
|----|--|---------------------|
| 1. | Cells 3.5–5.0 μm . in diameter, bright blue-green | <i>A. grevillei</i> |
| | Cells 1.5–2.5 μm . in diameter, pale blue-green | <i>A. muscicola</i> |

Aphanocapsa grevillei (Hassall) Rabenhorst

Fig. 2a

Cells bright blue-green, spherical, 3.5–5.0 μm . in diameter, distributed singly and in pairs throughout homogeneous, irregularly shaped, mucilaginous colonies; mucilage hyaline; colonies up to 36 μm . in diameter.

Geitler (1932) described the colonies as spherical or hemi-spherical.

Habitat. Recorded from only two subaerial calcium-rich sites (10 and 47).

Distribution. Antarctica: Ongul Islands, eastern Antarctica, as a terrestrial alga (Akiyama, 1968); Anvers Island, Antarctic Peninsula, in fresh-water pools (Parker and others, 1972). Other records: Europe, in damp soil, on rocks, occasionally in plankton (Geitler, 1932).

Aphanocapsa muscicola (Meneghini) Wille

Fig. 2b

Syn. Aphanocapsa virescens (Hassall) Rabenhorst

Cells pale blue-green, spherical, 1.5–2.5 μm . in diameter, distributed singly and in pairs throughout homogeneous mucilaginous colonies; mucilage hyaline; colonies variously shaped, ranging from almost spherical to irregularly lobed, maximum diameter in field material c. 50 μm ., blue-green colonies forming on BBM agar cultures.

Habitat. Quite widespread in subaerial habitats, being recorded from 33 sites. Frequent amongst wet bryophytes, in the soils below herbaceous vegetation and in sites contaminated with large quantities of bird or seal excreta.

Distribution. Antarctica: no record. Other records: Europe, in most soil and on rocks (Geitler, 1932).

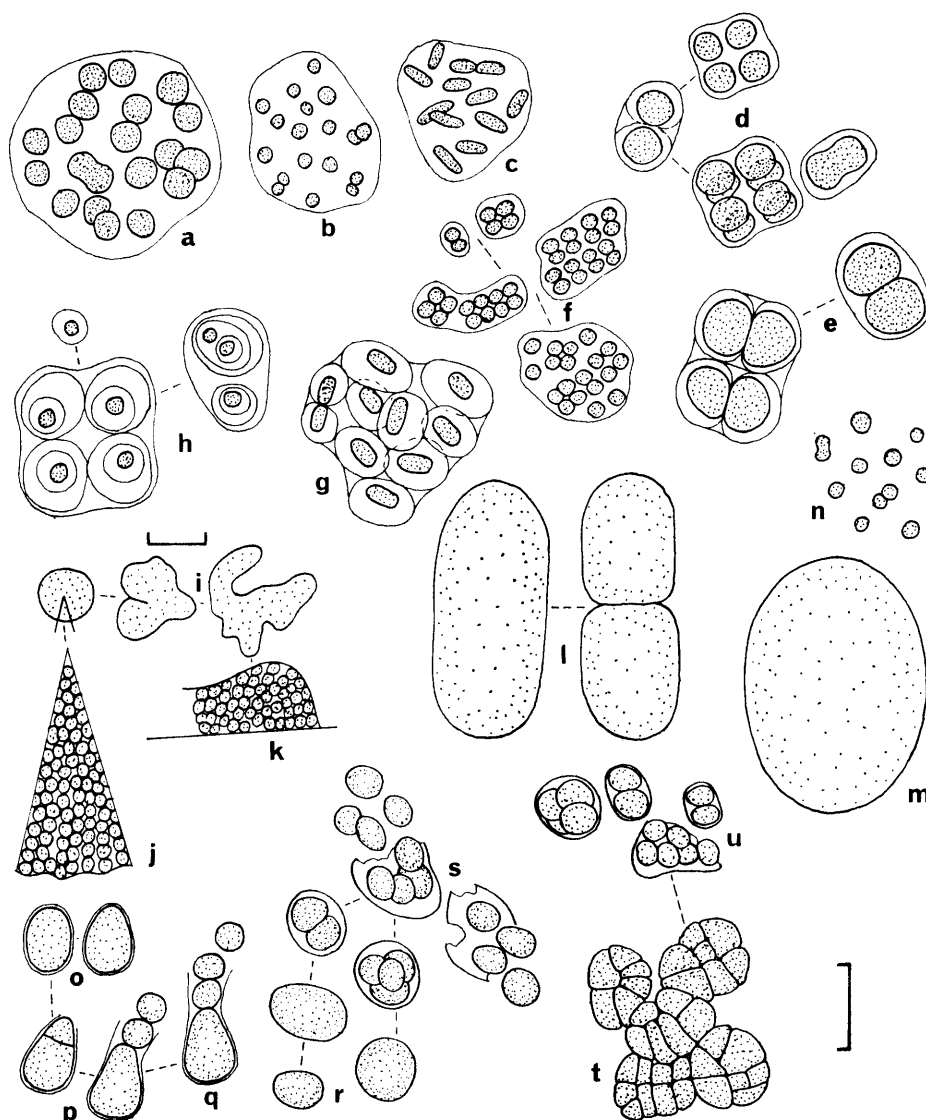


FIGURE 2

a. *Aphanocapsa grevillei* (p. 17); b. *Aphanocapsa muscicola* (p. 17); c. *Aphanothece saxicola* (p. 18); d. *Chroococcus pallidus* (p. 19); e. *Chroococcus minutus* (p. 19); f. *Merismopedia tenuissima* (p. 20); g. *Gloeotheca palea* (p. 20); h. *Gloeocapsa gelatinosa* (p. 20); i-k. *Chlorogloea purpurea* (p. 19); l. *Synechococcus brunneolus* (p. 21); m. *Synechococcus maior* (p. 21); n. *Synechocystis minuscula* (p. 21); o-q. *Chamaesiphon subglobosus* (p. 22); r and s. *Chroococciopsis* sp. A (p. 22); t and u. *Myxosarcina chroococcoides* (p. 22).

The upper scale is 0.1 mm. and refers to i; the lower scale is 10 μm . and refers to a-h and j-u.

Aphanothece Naegeli

Cells cylindrical, distributed throughout homogeneous colonial mucilage; individual cell sheaths not evident.

Distinguished from *Gloeotheca* Naegeli by the presence of individual cell sheaths in that genus.

Aphanothece saxicola Naegeli

Fig. 2c

Cells pale blue-green, cylindrical, 2.5-4.0 μm . by 1.0-1.5 μm ., distributed throughout irregularly shaped mucilaginous colonies with maximum diameter of c. 20 μm ., lying in pairs temporarily after cell division.

Habitat. Rare, recorded from only two subaerial sites, both wet stands of *Drepanocladus uncinatus* (sites 47 and 48).

Distribution. Antarctica: South Orkney Islands, in a fresh-water pool (Fritsch, 1912*b*); Iles Kerguelen, in fresh water (Bourrelly and Manguin, 1954). Other records: Europe, on moist rocks (Geitler, 1932); India, in soil (Mitra, 1951).

Chlorogloea Wille

Cells spherical, closely packed throughout mucilaginous colonies, in vertical section of colonies cells seen to form pseudofilaments usually most pronounced towards outer edges of colonies.

Chlorogloea purpurea Geitler

Fig. 2i-k

Colonies (Fig. 2i) pink-purple, circular or irregularly lobed, raised, *c.* 0·1 mm. in diameter on BBM agar plate cultures; cells closely packed, spherical, 1·0–2·5 μ m. in diameter, embedded in hyaline, homogeneous, firm mucilage, irregularly arranged in centres of colonies but towards periphery radiating as pseudo-filaments (Fig. 2j and k).

In colour and size this alga resembles *C. purpurea* as described by Geitler (1932), although he referred to the colonies as microscopic.

Habitat. Rare, recorded only in penguin guano, subaerial site 13.

Distribution. Antarctica: no record. Other records: Europe, epilithic in the marine environment (Geitler, 1932).

Chroococcus Naegeli

Cells spherical, embedded in homogeneous or faintly stratified mucilage, singly or in small colonies. Colonies may aggregate to form larger masses.

Close to *Gloeocapsa* Kuetzing where, however, the stratifications are more marked and the colonies are generally larger.

- | | | |
|---|-----------|--------------------|
| 1. Cells blue-green, 5–7 μ m. in diameter | | <i>C. pallidus</i> |
| Cells olive-green, 6–8 μ m. in diameter | | <i>C. minutus</i> |

Chroococcus pallidus Naegeli

Fig. 2d

Cells spherical, blue-green, 5–7 μ m. in diameter, contained in hyaline, usually homogeneous, though occasionally faintly stratified, mucilage; colonies usually small containing two, four or eight cells; larger aggregates also occurring.

Habitat. Recorded from five subaerial sites. Amongst wet bryophytes, especially *Calliergon sarmentosum*, and amongst *Cephaloziella varians* (site 59) it formed a thick coating on the surfaces of leaves and stems.

Distribution. Antarctica: Ross Island, in a fresh-water lake (West and West, 1911*b*); Anvers Island, Antarctic Peninsula, in fresh-water pools (Parker and others, 1972). Other records: Europe, on damp rocks (Geitler, 1932).

Chroococcus minutus (Kuetzing) Naegeli

Fig. 2e

Cells olive-green, spherical, 6–8 μ m. in diameter, usually in two-, four- or occasionally eight-cell groups within homogeneous or faintly stratified, hyaline, mucilaginous envelopes.

Geitler (1932) described the cells as light blue-green and the mucilage as non-stratified.

Habitat. Rare, recorded from only one subaerial site, a calcium-rich stand of *Drepanocladus uncinatus* (site 47).

Distribution. Antarctica: South Georgia, in a fresh-water pond (Carlson, 1913); Ross Island, in a fresh-water lake (West and West, 1911*b*; Fritsch, 1917); Anvers Island, Antarctic Peninsula, in fresh-water pools

and a stream (Parker and others, 1972). Other records: United Kingdom, in calcareous soils, only member of the Chroococcales found (Fritsch and John, 1942); India (Mitra, 1951) and Singapore (Johnson, 1969), recorded in soils; France, epilithic on limestone (Fjerdingstad, 1965).

Gloeocapsa Kuetzing

Cells spherical, distributed throughout stratified mucilaginous colonies.

Close to *Chroococcus* Naegeli in which the colonies are generally smaller and less distinctly stratified.

Gloeocapsa gelatinosa Kuetzing

Fig. 2h

Cells spherical, blue-green, 1.5–2.5 μm . in diameter, irregularly arranged throughout stratified mucilaginous colonies; mucilage hyaline; colonies irregularly shaped and consisting of loose aggregates of small mucilaginous capsules containing from one to eight cells.

Habitat. Recorded from eight aerial sites, in crevices in marbles; not found in any subaerial sites.

Distribution. Antarctica: three species have been recorded from the continent and two from Iles Kerguelen, not including *G. gelatinosa*; listed from fresh water by Hirano (1965); Anvers Island, Antarctic Peninsula, in a fresh-water lake (Parker and others, 1972). Other records: Europe, in thermal springs (Geitler, 1932); Switzerland, other epilithic species recorded by Jaag (1945).

Gloeothece Naegeli

Cells cylindrical, distributed throughout stratified mucilaginous colonies.

Distinguished from *Aphanothece* Naegeli by the absence of stratifications in the mucilage in that genus.

Gloeothece palea (Kuetzing) Rabenhorst

Fig. 2g

Cells blue-green, cylindrical, 2.5 μm . wide by 3.5–5.0 μm . long, distributed throughout faintly stratified colonies with yellow-brown mucilage.

Geitler (1932) described the mucilage as homogeneous and the cells as having a slightly larger size range, 2.5–4.5 μm . wide and 1.5–3 times as long as the Signy Island specimens.

Habitat. Rare, recorded only from aerial site 121, a marble outcrop.

Distribution. Antarctica: no record. Other records: Europe, amongst mosses and on damp rocks (Geitler, 1932).

Merismopedia Meyen

Cells spherical, ellipsoidal or cylindrical in homogeneous mucilaginous colonies. Cell division in two planes forming flat colonies in which cells are often regularly arranged in groups of four.

Merismopedia tenuissima Lemmermann

Fig. 2f

Cells blue-green, spherical, 1.0–1.5 μm . in diameter, in small irregularly shaped mucilaginous colonies containing from two to *c.* 30 cells. Cell division in two planes; in small colonies cells clearly arranged in closely packed groups of multiples of two and four; in largest colonies this arrangement becoming indistinct though some groups of two and four cells remaining.

Geitler (1932) illustrated the cells as being more regularly arranged within larger colonies and as occasionally having a stratified mucilage.

Habitat. Recorded from three subaerial sites (10, 27 and 47) and six aerial sites, all calcium-rich.

Distribution. Antarctica: South Orkney Islands, in a fresh-water pool (Fritsch, 1912*b*); Cape Adare, Victoria Land, amongst terrestrial *Prasiola crispa* (Fritsch, 1917). Other records: Europe, in standing water (Geitler, 1932).

Synechococcus Naegeli

Cells solitary, free-living, ellipsoidal to cylindrical, without extensive mucilaginous envelopes, remaining temporarily in pairs after transverse cell division.

- | | | |
|---|-----------|----------------------|
| 1. Cells light-brown, cylindrical, c. 30 μm . by 12 μm . | | <i>S. brunneolus</i> |
| Cells bright-blue-green, ellipsoidal, c. 30 μm . by 21 μm . | | <i>S. maior</i> |

Synechococcus brunneolus Rabenhorst

Fig. 2l

Cells light-brown, cylindrical, c. 30 μm . by 12 μm ., free-living, occurring singly and temporarily in pairs after transverse cell division.

Habitat. Observed once amongst a wet stand of *Drepanocladus uncinatus* in a casual sample from a site not studied in detail.

Distribution. Antarctica: three other fresh-water species have been recorded from Iles Kerguelen and from the South Orkney Islands (Hirano, 1965). Other records: Europe, on moist rocks (Geitler, 1932).

Synechococcus maior Schroeter

Fig. 2m

Syn. Cyanothece maior (Schroeter) Komarek

Cells bright blue-green, broadly ellipsoidal, c. 30 μm . by 21 μm ., chromoplasm lining wall often brownish, although cells retaining their bright blue-green colour.

In a recent publication (Komárek, 1976) *S. maior* was included in a new genus *Cyanothece*, members of the three similar genera *Synechocystis*, *Synechococcus* and *Cyanothece* being characterized by their different modes of cell division.

Habitat. Infrequent, recorded from ten subaerial sites but no aerial sites. Eight occurrences were amongst mosses, including the three calcium-rich *Tortula* spp. sites (26, 27 and 28).

Distribution. Antarctica: Iles Kerguelen, in fresh water (Bourrelly and Manguin, 1954). Other records: Europe, in fresh water (Geitler, 1932); probably of boreo-alpine distribution, in the littoral and benthic flora of lakes and subaerial (Komárek, 1976).

Synechocystis Sauvageau

Cells spherical, solitary, free-living, remaining temporarily in pairs after transverse cell division.

Synechocystis minuscula Voronichin

Fig. 2n

Cells pale blue-green, spherical, 1.5–2.5 μm . in diameter, occurring singly and temporarily in pairs. Recovered only in culture; colonies hemispherical, blue-green, non-mucilaginous on BBM agar.

Habitat. Rare, recorded from only one subaerial site (27) and two aerial sites (121, 122), all calcium-rich.

Distribution. Antarctica: Ongul Islands, eastern Antarctica, a larger species *S. aquatilis* Sauvageau recorded in the terrestrial flora (Akiyama, 1968). Other records: Europe, in a salt lake (Geitler, 1932).

ORDER CHAMAESIPHONALES

Chamaesiphon A. Braun et Grunow

Cells oval to pyriform, fixed at base, ensheathed; sheath, when mature, opening at apex of cell in order to release exospores cut off successively from anterior end of cell.

Chamaesiphon subglobosus (Rostafinski) Lemmermann

Fig. 2o–q

Syn. *Sphaerogonium subglobosum* Rostafinski

Cells blue-green to yellowish, almost pyriform (Fig. 2o), 3–4 μm . by 6–7 μm ., with thin colourless, mucilaginous sheaths, producing small numbers of exospores, usually one or two (Fig. 2p) but occasionally three remaining attached to mother cell (Fig. 2q); recently released exospores approximately spherical, 5 μm . in diameter.

Habitat. Rare, recorded from only two subaerial sites (6 and 53) and forming the dominant vegetation in aerial site 109.

Distribution. Antarctica: Iles Kerguelen, one other species, *C. confervicola* A. Braun, recorded from fresh water (Hirano, 1965). Other records: Europe, in fresh water (Geitler, 1932); Switzerland, an aerial epilithic form (Jaag, 1945).

Chroococidiopsis Geitler

Cells spherical to ellipsoidal, free-living, solitary or in loose aggregates. Vegetative division not occurring, reproduction by formation of endospores.

Chroococidiopsis sp. A

Fig. 2r and s

Cells purple-brown, spherical or ellipsoidal (Fig. 2r), 4–6 μm . by 9–12 μm ., occurring singly or in loose aggregates, releasing two, four, six or eight endospores by irregular rupture of sporangium wall (Fig. 2s); spores spherical to ellipsoidal, 3–6 μm . in diameter.

This alga is most similar to the slightly smaller blue-green alga *C. doonensis* Singh as described by Komárek and Hindák (1975). Most other species produce a considerably larger number of spores.

Habitat. Rare, recorded from one exposed subaerial site (26) of the calcicolous moss *Tortula fuscoviridis*, and one aerial marble site (114).

Distribution. Antarctica: no record. Other records: several aerial species were listed by Komárek and Hindák (1975) from localities in Europe, Asia and the Americas.

ORDER PLEUROCAPSALES

Myxosarcina Printz

Colonies small, fixed, formed by division of cells in three planes; cells irregularly shaped due to mutual adpression, more or less regularly arranged in cubical groups or in lines. Reproduction by vegetative cell division or rarely by endospores.

Myxosarcina chroococcoides Geitler

Fig. 2t and u

Cells yellow-brown, variously shaped due to mutual adpression, up to 12 μm . in diameter, dividing vegetatively to form three-dimensional colonies (Fig. 2t); endospores formed, two, four or larger numbers in each sporangium (Fig. 2u) being released by rupture of sporangium wall.

Geitler (1932) did not describe the formation of endospores but said that it “probably occurs”.

Habitat. Rare, recorded from only one aerial site on coastal rocks (site 111).

Distribution. Antarctica: Anvers Island, Antarctic Peninsula, a similar species *M. concinna* Printz in a fresh-water pool (Parker and others, 1972). Other records: Europe, in marshes and moorland (Geitler, 1932); France, a similar species, *M. spectabilis* Geitler, an aerial epilithic form (Fjerdingstad, 1965).

ORDER HORMOGONALES

Calothrix Agardh

Trichomes single or in small groups, enclosed in homogeneous or lamellate sheaths, terminating with basal heterocyst and also occasionally with intercalary heterocysts, wide at base where cells shorter than wide, often tapering at apex where cells longer than wide, sometimes with false branching.

Calothrix parietina Thuret

Fig. 3a-d

Trichomes blue-green, single (Fig. 3a) or in small groups (Fig. 3c), surrounded by hyaline or yellow-brown stratified sheaths, terminating with basal heterocyst and rarely with intercalary heterocysts (Fig. 3b);

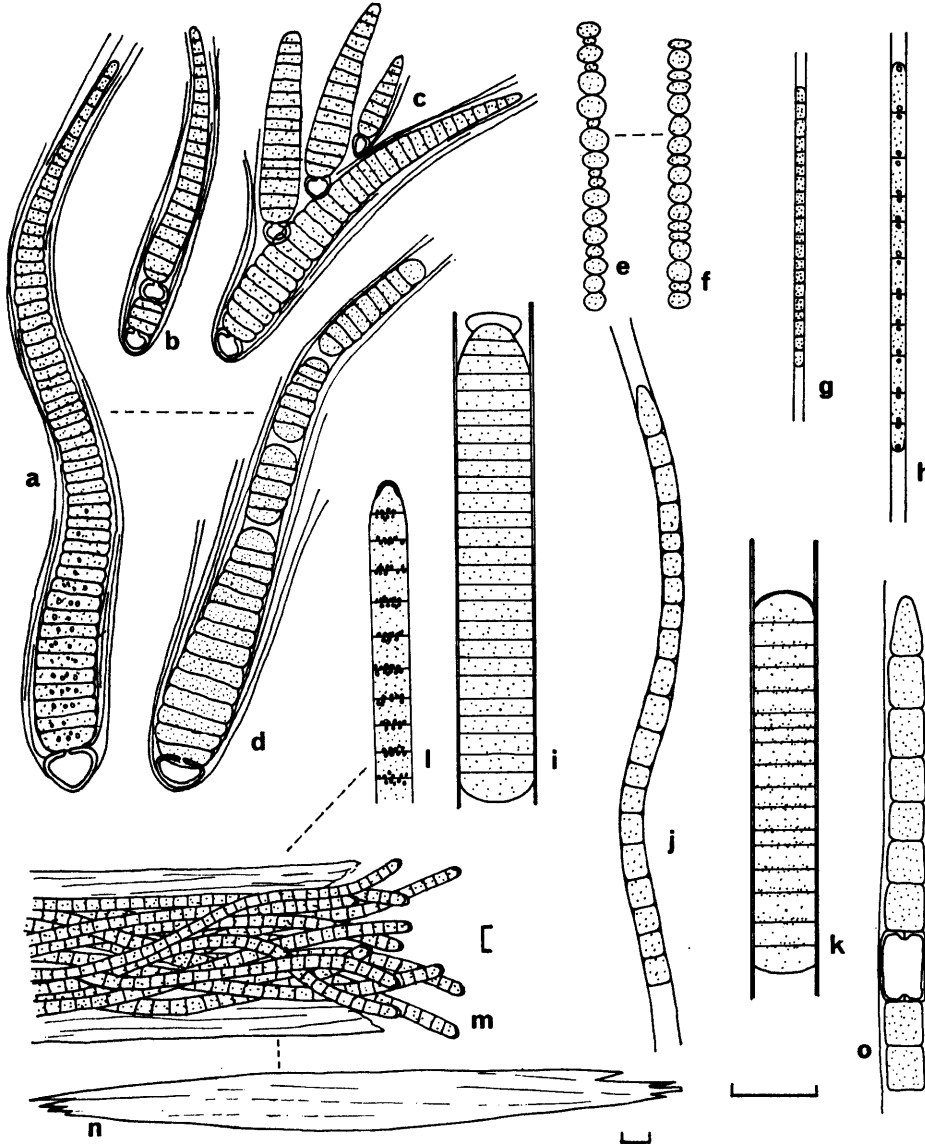


FIGURE 3

a-d. *Calothrix parietina* (p. 23); e and f. *Isocystis pallida* (p. 24); g. *Lyngbya limnetica* (p. 24); h. *Lyngbya perelegans* (p. 25); i. *Lyngbya* sp. A (p. 25); j. *Lyngbya* sp. B (p. 25); k. *Lyngbya* sp. C (p. 25); l-n. *Microcoleus vaginatus* (p. 25); o. *Nodularia* sp. A (p. 26).

The upper scale is 10 μ m. and refers to m; the lower left scale is 0.1 mm. and refers to n; the lower right scale is 10 μ m. and refers to a-l and o.

vegetative cells at base of trichomes 6.0–8.5 μm . wide at apex 2.5 μm . wide; reproduction by hormogone formation (Fig. 3d).

Habitat. Rare, recovered from only one aerial site, a coastal rock outcrop (site 112).

Distribution. Antarctica: seven other species of *Calothrix* listed in fresh water from the continent, South Orkney Islands, South Georgia and Iles Kerguelen by Hirano (1965); Anvers Island, Antarctic Peninsula, in fresh-water pools, an unidentified species (Parker and others, 1972). Other records: Europe, in standing water, on damp earth, in salt water and on salty soils (Geitler, 1932); Denmark, on wet rocks (Petersen, 1935); United Kingdom, an aerial epilithic form (Allen, 1971).

Isocystis Borzi

Trichomes small, solitary or in irregular bundles, without sheaths or heterocysts, occasionally attenuated at apex; cells globular or ellipsoidal; akinetes formed.

Isocystis pallida Voronichin

Fig. 3e and f

Trichomes pale blue-green, single, sheathless; cells globular to ellipsoidal 2.0–3.5 μm . wide by 0.5–2.5 μm . long, often barely touching; akinetes not observed. Cell width sometimes varying irregularly along trichomes (Fig. 3e) and at other times remaining constant (Fig. 3f).

I. pallida is a little-known species and Geitler (1963) doubted whether it was an alga but he suggested that it had been mistaken for a species of the fungal genus *Torulopsidosira*.

Habitat. Rare, recorded from five subaerial sites (4, 42, 60, 64 and 65) with no particular habitat preference.

Distribution. Antarctica: no record. Other records: North America, in thermal spring effluents (Kullberg, 1971).

Lyngbya Agardh

Trichomes cylindrical, unbranched, straight, flexuous or occasionally helically wound, apex sometimes attenuated, contained within more or less firm sheath, single or aggregated to form entangled masses.

Bourrelly (1970) included the genus *Phormidium* Kuetzing here. The two genera are difficult to separate, only differing in the nature of the sheaths which in the latter genus fuse to give confluent mat-like growths, whereas in *Lyngbya* the trichomes and their sheaths tend to remain discrete. Geitler (1932) is followed in distinguishing the two genera, although it is recognized that Drouet (1968) grouped many species of these and of the related genus *Oscillatoria* Vaucher together under a few species each with a large synonymy.

1. Trichomes helically wound	. . . . .	<i>L. sp. B</i>
Trichomes straight or flexuous	. . . . .	2
2. Trichomes 1–2 μm . wide	. . . . .	3
Trichomes 7–8 μm . wide	. . . . .	4
3. Cells 1–2 μm . long, chromoplasm not granular	. . . . .	<i>L. limnetica</i>
Cells 2.5–6.0 μm . long, granule present at both apices of each cell.	. . . . .	<i>L. perelegans</i>
4. Trichomes slightly attenuated at apex	. . . . .	<i>L. sp. A</i>
Trichomes not attenuated at apex	. . . . .	<i>L. sp. C</i>

Lyngbya limnetica Lemmermann

Fig. 3g

Trichomes pale blue-green, straight or flexuous, 1.0 μm . wide, not attenuated, in thin hyaline sheath; 1–2 μm . long, containing chromoplasm without granules and with faint transverse walls; terminal cell rounded and without calyptra.

Geitler (1932) described slightly larger cells, 1–3 μm . long.

Habitat. Infrequent, scattered distribution in 11 subaerial sites.

Distribution. Antarctica: Ross Island, in fresh water (West and West, 1911b). Other records: cosmopolitan in fresh-water plankton and in salt water (Geitler, 1932).

Lyngbya perelegans Lemmermann

Fig. 3h

Trichomes pale blue-green, straight or flexuous, 1.0–1.5 μm . wide, not attenuated, in thin hyaline sheath; cells 2.5–6.0 μm . long, with granule present at both apices; terminal cell rounded and without calyptra.

Habitat. Quite widely distributed in 18 subaerial sites including eight wet moss stands.

Distribution. Antarctica: Iles Kerguelen, in fresh water (Bourrelly and Manguin, 1954). Other records: Europe, on fresh-water plants, also in salt water (Geitler, 1932).

Lyngbya sp. A

Fig. 3i

Trichomes blue-green, straight or flexuous, 8 μm . wide, in thin hyaline sheath 0.5–1.0 μm . thick; cells 2.0–2.5 μm . long with chromoplasm granular; terminal cells slightly attenuated, capped with dead empty cell.

Cannot be identified to species level using Geitler's (1932) key as insufficient material examined.

Habitat. Rare, recorded from four subaerial sites (6, 10, 27 and 61).

Lyngbya sp. B

Fig. 3j

Trichomes blue-green, wound in open spiral of length per winding *c.* 30 μm ., 2.5 μm . wide, slightly constricted at transverse walls, in thin hyaline sheath; cells 2–4 μm . long except for conical, terminal cell 5 μm . long without calyptra.

Cannot be identified to species level using Geitler's (1932) key.

Habitat. Rare, recorded from one subaerial site (27) amongst *Tortula* sp.

Lyngbya sp. C

Fig. 3k

Trichomes blue-green, straight or flexuous, 7.5 μm . wide, not attenuated at apex, in thin hyaline sheath; cells *c.* 2.5 μm . long, terminal cell rounded with calyptra; chromoplasm granular.

Cannot be identified to species level using Geitler's (1932) key.

Habitat. Recorded from eight subaerial sites, including five mineral soils without macroscopic vegetation but no aerial sites.

Microcoleus Desikachary

Trichomes numerous contained within common, wide, usually homogeneous sheath, and lying more or less parallel or wound around one another, attenuated at apex to conical or capitate apices; plant mass cylindrical or fusiform, rarely branched.

Similar to *Schizothrix* Kuetzing where there are generally fewer trichomes within each sheath and false branching is more frequent. Individual trichomes released from the sheath are easily confused with trichomes of *Lyngbya*, *Phormidium* or *Oscillatoria* and the characteristic larger plant mass must be viewed for confidence in identification.

Microcoleus vaginatus (Vaucher) Gomont

Fig. 3l–n

Syn. Oscillatoria vaginata Vaucher*Microcoleus annulatus* Fritsch*Schizothrix polytrichoides* Fritsch

Trichomes (Fig. 3l) blue-green, 5 μm . wide, slightly attenuated at tip, not constricted at transverse walls, terminal cell with calyptra; cells 3–5 μm . long with granules often present along transverse walls; numerous

trichomes enclosed within common, thick, hyaline, stratified sheath (Fig. 3m) forming usually unbranched strands with total width of up to 90 μm . and length of *c.* 2 mm. (Fig. 3n).

Habitat. Recorded from four subaerial sites, all base-rich mineral soils (sites 1, 6, 10 and 11).

Distribution. Antarctica: Victoria Land, in a fresh-water pond (Fritsch, 1917); Iles Kerguelen, in fresh water (Bourrelly and Manguin, 1954). Other records: a widespread soil species perhaps of "universal occurrence" (Drouet, 1937); United Kingdom, in soils rich in calcium (Fritsch and John, 1942; Lund, 1947).

Nodularia Mertens

Trichomes single, unbranched, enclosed in sheath; cells cylindrical or discoidal, often shorter than wide; heterocysts present; reproduction by hormogones or akinetes.

Nodularia sp. A

Fig. 3o

Trichomes blue-green, straight or flexuous, 2.5–3.0 μm . wide, slightly constricted at transverse walls, enclosed in hyaline, non-stratified sheath up to 1 μm . thick; cells 2.0–3.0 μm . long; terminal cell conical; heterocysts rectangular 3.0–3.5 μm . wide by 3.5–4.0 μm . long; akinete formation not observed.

The rectangular heterocysts are similar to those of *N. quadrata* Fritsch, however, the vegetative cells of the present taxon are narrower and longer and are also atypical of most other species of *Nodularia* which have more disc-like cells.

Habitat. Recorded from four subaerial sites, all base-rich mineral soils (sites 1, 2, 6 and 10).

Distribution. Antarctica: Victoria Land, two other species from fresh water (Fritsch, 1917). Other records: United Kingdom (Bristol, 1920), Denmark (Petersen, 1935) both record a single species in soil.

Nostoc Vaucher

Colonies gelatinous, often of large size with definite shape, or microscopic; trichomes flexuous, with no apical differentiation, occasionally with individual sheaths but more frequently these being confluent with general colonial mucilage this being either hyaline or yellow; heterocysts intercalary; reproduction by hormogones or akinetes.

A difficult genus often requiring the presence of akinetes and culture studies such as those of Kantz and Bold (1969) before identifications to the species can be made.

- | | | | |
|----|---|-----------|-----------------------|
| 1. | Thalli macroscopic in field material, mucilaginous, hemispherical colonies or foliose sheets; on agar culture forming flat colonies with lobed margin | | <i>N. commune</i> |
| | Thalli microscopic in field material; on agar culture forming raised, irregularly lobed colonies | | 2 |
| 2. | Colonies on agar culture dark blue-green, up to 3 mm. in diameter | | <i>N. muscorum</i> |
| | Colonies on agar bright blue-green, less than 1 mm. in diameter. | | <i>N. punctiforme</i> |

Nostoc commune Vaucher

Fig. 4f-i

Colonies on moist soil dark blue-green, smooth, shiny, softly gelatinous, hemispherical about 0.5 cm. in diameter (Fig. 4f), on BBM agar culture blue-green, flat with irregularly lobed margin (Fig. 4g), in flushed base-rich habitats blue-green to yellow-brown when moist, blackish when dry, thin sheets, firmly gelatinous with rubbery texture, irregularly shaped and folded, up to 5 cm. in diameter, forming stands up to *c.* 500 cm.²; trichomes irregularly arranged throughout colonies (Fig. 4i), without individual discrete sheaths; colonial mucilage hyaline or yellow; cells 4.0 μm . broad by 2.5–3.0 μm . long (Fig. 4h) with granular contents; heterocysts usually spherical, *c.* 5–6 μm . in diameter; akinetes not observed.

Habitat. Recorded from seven base-rich subaerial sites (1, 10, 26, 27, 47, 49 and 72). Smith (1972) described a *Nostoc* cf. *commune* association which occurs in various mildly base-rich moist habitats. Fogg and Stewart (1968) and Horne (1972) considered that on Signy Island *Nostoc commune* was responsible for appreciable nitrogen fixation in several terrestrial habitats.

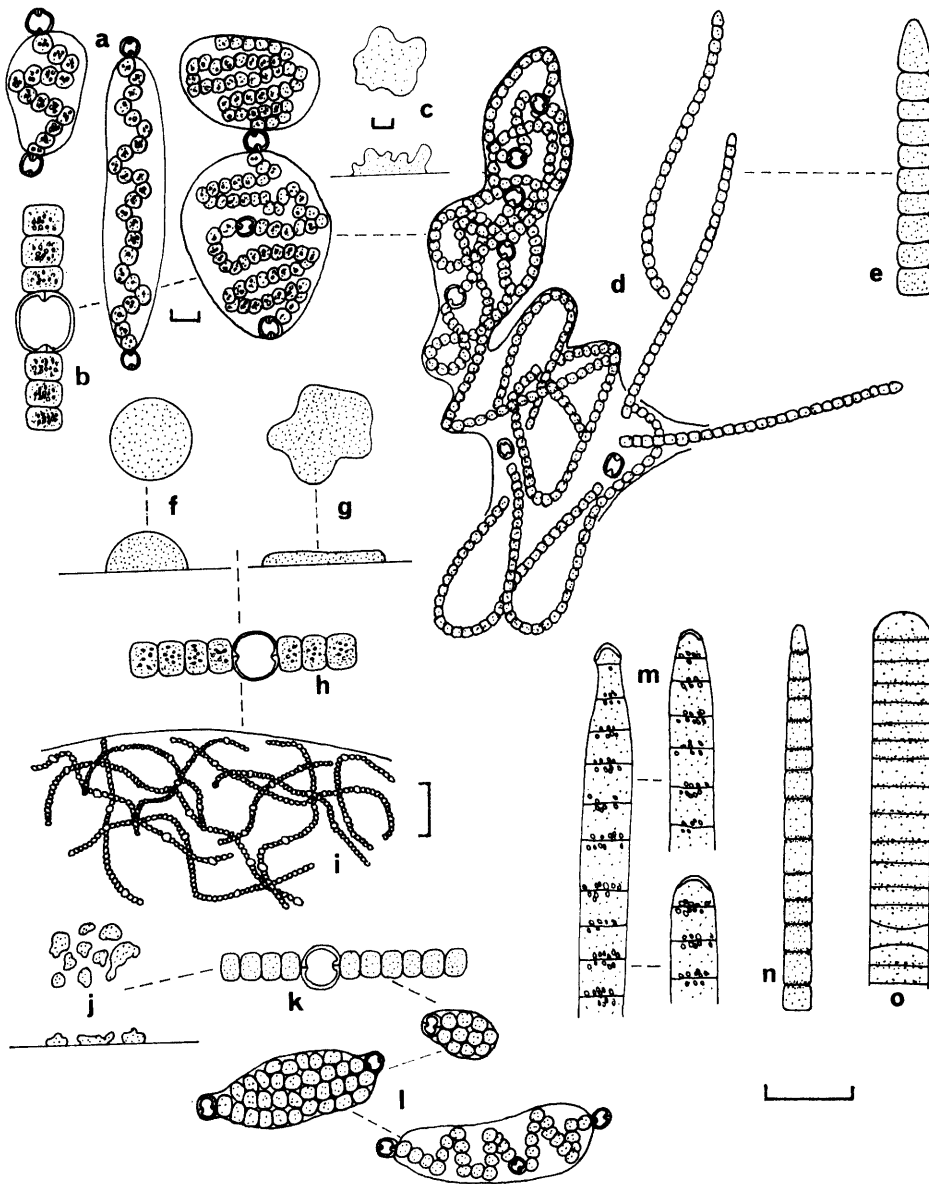


FIGURE 4

a-e. *Nostoc muscorum* (p. 27); f-i. *Nostoc commune* (p. 26); j-l. *Nostoc punctiforme* (p. 28); m. *Oscillatoria amoena* (p. 29); n. *Oscillatoria formosa* (p. 29); o. *Oscillatoria fracta* (p. 29).

The uppermost scale is 1 mm. and refers to c, f, g and j; the upper left scale is 10 μ m. and refers to a, d and l; the centre scale is 30 μ m. and refers to i; the lowermost scale is 10 μ m. and refers to b, e, h, k and m-o.

Distribution. Antarctica: Victoria Land, in soil algal crusts (Holm-Hansen, 1964; Cameron and Devaney, 1970); the Antarctic distribution has been mapped by Koob (1967). Other records: Europe, widespread in moist soil (Geitler, 1932); Iceland and Denmark, amongst mosses and in soil (Petersen, 1928, 1935); United Kingdom, in soil (Lund, 1947); in tropical soils (Durrell, 1964); New Zealand, in soil (Flint, 1968).

Nostoc muscorum Agardh

Fig. 4a-e

Thalli microscopic in field material, dark blue-green, spherical, ellipsoidal and cylindrical to more irregular shapes (Fig. 4a); colonies on BBM agar cultures, dark blue-green raised, irregularly lobed, up to 3 mm. in diameter (Fig. 4c), similar colonies formed in aqueous media; trichomes 4-5 μ m. wide, usually

considerably twisted within hyaline or yellow, firm, outer pellicle; cells barrel-shaped, 3·5–5·0 μm . long, with granular contents (Fig. 4b); heterocysts terminal and intercalary, frequent, almost spherical, c. 7 μm . in diameter. During observations on field material it was noted that motile hormogones are formed by fragmentation of heterocystous thalli at heterocyst positions, heterocyst-free hormogones then escaping through ruptures in outer pellicle (Fig. 4d). Hormogones often with conical terminal cell (Fig. 4e), straight or flexuous.

Desortová (1974) found that *N. muscorum* from soil produced large numbers of akinetes. These were not seen in the Signy Island material. The life cycle in which motile hormogones are released has been described previously in cultures by Lazaroff and Vishniac (1961, 1962).

Habitat. 11 of the 22 subaerial records were amongst wet bryophytes including *Calliergon sarmentosum* carpets at site 42 (SIRS 2), where the ecology of this alga was studied (Broady, 1977b); the alga was absent from *Andreaea* spp. cushions and infrequent amongst *Polytrichum alpestre*–*Chorisodontium aciphyllum* turves (three sites) but frequent in the soils below herbaceous vegetation. Not recorded from the aerial habitat.

Distribution. Antarctica: Iles Kerguelen, in the terrestrial habitat (Bourrelly and Manguin, 1954). Other records: Europe, widespread on damp soils and amongst mosses (Geitler, 1932); Austria, in alpine soils (Reisigl, 1964); U.S.S.R., a predominant species in wet, virgin lands (Fogg and others, 1973), in alpine and tundra soils (Desortová, 1974); also in soils in the United Kingdom (Lund, 1947), U.S.A. (Willson and Forest, 1957), tropical South America (Durrell, 1964), New Zealand (Flint, 1968), Singapore (Johnson, 1969).

Nostoc punctiforme (Kuetzing) Hariot

Fig. 4j–l

Syn. *Nostoc hederulae* Meneghini

Micro-thalli as seen in field material (Fig. 4l) similar in shape to those of *N. muscorum*, trichomes often closely packed resembling masses of individual cells; colonies on BBM agar culture, small, bright blue-green, often less than 1 mm. in diameter (Fig. 4j), irregularly shaped and consisting of aggregations of many small thalli similar to those seen in field material; trichomes bright blue-green, 4–5 μm . wide, twisted and usually closely packed within outer hyaline or yellow pellicle; cells barrel-shaped, 3–4 μm . long (Fig. 4k); akinetes not observed; no motile stage as described for *N. muscorum*.

Habitat. Recorded from 11 subaerial sites and six aerial sites. The latter were all marbles and most of the subaerial sites were also calcium-rich.

Distribution. Antarctica: South Georgia, in a fresh-water pond (Carlson, 1913); Ongul Islands, in the terrestrial habitat (Akiyama, 1968). Other records: Europe, in standing water (Geitler, 1932); Denmark, in the terrestrial habitat but requiring much moisture (Petersen, 1935); Japan, growing amongst terrestrial mosses (Hiramatsu, 1975).

Oscillatoria Vaucher

Trichomes free-living, solitary or in loose aggregates, usually without sheath, straight or flexuous, with or without constrictions at transverse walls which sometimes bear rows of granules, apical region often attenuated, with a characteristic gliding movement during which anterior portion of trichome often appearing to oscillate; cells usually shorter than wide; terminal cell rounded or swollen sometimes bearing distinct calyptra.

Algae of this genus can be confused with those of *Lyngbya*, *Phormidium* and *Microcoleus*. In the former two genera hormogones released from their sheaths could be thought to be species of *Oscillatoria* and in the latter genus trichomes released from the common sheath also resemble species of *Oscillatoria*. Fragmented trichomes of *Oscillatoria* species which normally possess attenuated apices bearing a calyptra may not have developed such features and care must be taken to make identifications from mature individuals. The presence of granules in the chromoplasm may also be a variable character within a species.

1. Trichomes up to 6 μm . wide	2
Trichomes over 6 μm . wide	5
2. Terminal cell with calyptra	3
Terminal cell without calyptra	4

3.	Trichomes 2·5–3·0 μm . wide	<i>O. sp. D</i>
	Trichomes 5 μm . wide	<i>O. amoena</i>
4.	Trichomes 1·2–1·5 μm . wide, apical region hooked	<i>O. subtilissima</i>
	Trichomes 3·5 μm . wide, apical region not hooked	<i>O. formosa</i>
5.	Trichomes over 9 μm . wide	6
	Trichomes 6–9 μm . wide	7
6.	Cells 3–5 μm . long	<i>O. cf. limosa</i>
	Cells 1·5–3·0 μm . long	<i>O. sp. A</i>
7.	Terminal cell without calyptra	<i>O. fracta</i>
	Terminal cell with calyptra	8
8.	Trichomes 7–9 μm . wide, terminal cell bearing filaments of epiphytic bacteria	<i>O. sp. C</i>
	Trichomes 6–7 μm . wide, terminal cell not bearing filaments of epiphytic bacteria	<i>O. sp. B</i>

Oscillatoria amoena Gomont

Fig. 4m

Trichomes blue-green, straight or flexuous, 5 μm . wide, attenuated towards tip; cells 2·5–4·0 μm . long, with small granules present along transverse walls, terminal cell with calyptra and often slightly swollen.

Geitler (1932) described a greater size range with trichome widths of 2·5–5·0 μm .

Habitat. Recorded from 24 subaerial sites. Frequent in the more base- and nutrient-rich sites of the mineral soils without macroscopic vegetation and soils below herbaceous vegetation.

Distribution. Antarctica: Iles Kerguelen, in fresh water (Bourrelly and Manguin, 1954). Other records: Europe, in standing water and on mud (Geitler, 1932).

Oscillatoria formosa Bory

Fig. 4n

Trichomes pale blue-green on moist plate enrichment cultures, on BBM agar cultures yellow-brown, straight or flexuous, slightly attenuated towards tip, slightly constricted at transverse walls; cells 2–6 μm . long, with chromoplasm slightly granular on enrichment cultures but not granular on BBM agar cultures.

O. formosa described by Geitler (1932) is slightly wider (4–6 μm .) but it is otherwise similar to the Signy Island specimens.

Habitat. Recorded from eight subaerial sites, including four base-rich mineral soils (sites 1, 3, 6 and 10).

Distribution. Antarctica: Victoria Land, in fresh water (West and West, 1911*b*). Other records: Europe, in standing water and on mud, widespread (Geitler, 1932); recorded from soils in the United Kingdom (Fritsch and John, 1942), India (Mitra, 1951) and tropical regions of South America (Durrell, 1964).

Oscillatoria fracta Carlson

Fig. 4o

Trichomes blue-green, straight or flexuous, 7 μm . wide; cells 1·5–2·5 μm . long, with granules present along transverse walls; terminal cell rounded, without calyptra.

Geitler (1932) described the trichomes as 100 μm . long and disintegrating into hormogones 10 μm . long. This was not noted in the Signy Island material.

Habitat. Rare, recorded from three subaerial sites (6, 10 and 27) all base-rich.

Distribution. Antarctica: South Shetland Islands, in green snow (Carlson, 1913). Other records: none.

Oscillatoria cf. limosa Agardh

Fig. 5a and b

Trichomes dark blue-green, straight or flexuous, 9–12 μm . wide, not attenuated, occasionally constricted at position of transverse wall between terminal and second cell (Fig. 5b); cells 3–5 μm . long, with granules occasionally present along transverse walls; terminal cell with calyptra.

Habitat. Rare, few specimens observed in the subaerial habitat (sites 53, 58 and 65).

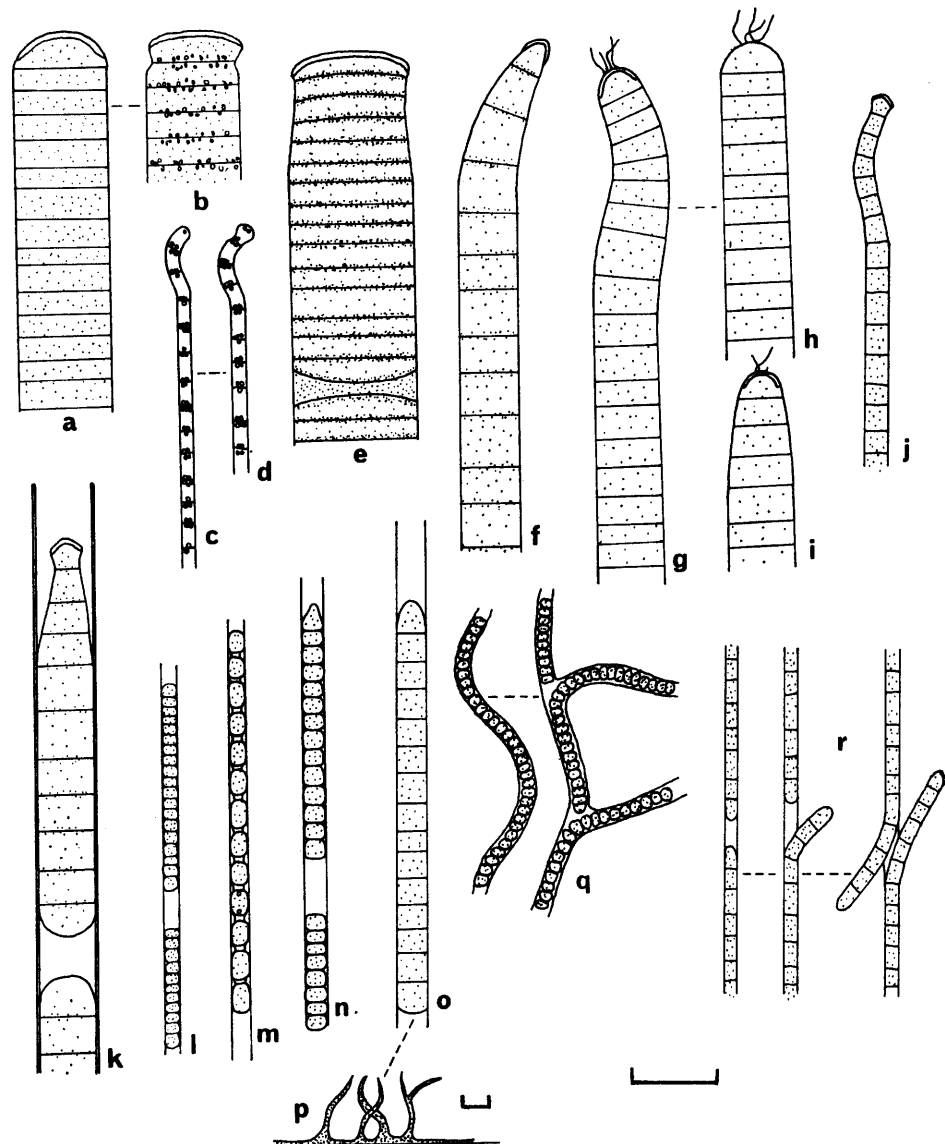


FIGURE 5

a and b. *Oscillatoria* cf. *limosa* (p. 29); c and d. *Oscillatoria subtilissima* (p. 30); e. *Oscillatoria* sp. A (p. 31); f. *Oscillatoria* sp. B (p. 31); g-i. *Oscillatoria* sp. C (p. 31); j. *Oscillatoria* sp. D (p. 31); k. *Phormidium autumnale* (p. 32); l. *Phormidium foveolarum* (p. 32); m. *Phormidium frigidum* (p. 32); n. *Phormidium priestleyi* (p. 32); o and p. *Phormidium* cf. *rubroterricola* (p. 33); q. *Plectonema battersii* (p. 33); r. *Plectonema notatum* (p. 33).

The left-hand scale is 1 mm. and refers to p; the right-hand scale is 10 μ m. and refers to a-o, q and r.

Distribution. Antarctica: Ross Island, in a fresh-water lake (West and West, 1911b). Other records: Europe, widespread in fresh and salt water (Geitler, 1932).

Oscillatoria subtilissima Kuetzing

Fig. 5c and d

Trichomes yellow-brown, straight or flexuous with terminal hook, 1.2-1.5 μ m. wide, not attenuated; cells 2-4 μ m. long, with transverse walls faint and usually bearing from one to three granules; terminal cell rounded, without calyptra, and occasionally slightly swollen (Fig. 5d).

Geitler (1932) did not mention the presence of granules.

Habitat. Recorded from 25 subaerial sites, mostly in the mineral soils without macroscopic vegetation and the soils below herbaceous vegetation. Absent from *Polytrichum alpestre*-*Chorisodontium aciphyllum* turves and most *Andreaea* spp. cushions.

Distribution. Antarctica: South Orkney Islands, in a fresh-water pool (Fritsch, 1912*b*). Other records: Europe, in standing water (Geitler, 1932); Singapore, in soil (Johnson, 1969).

Oscillatoria sp. A

Fig. 5e

Trichomes blue-green, straight or flexuous, 10–15 μm . wide, slightly attenuated towards tip; cells 1.5–3.0 μm . long, with granules along transverse walls; terminal cell slightly swollen with calyptra; bi-concave separation discs often present.

Cannot identify to species level in Geitler (1932).

Habitat. Rare, few specimens observed in subaerial sites 47 and 48.

Oscillatoria sp. B

Fig. 5f

Trichomes pale blue-green, straight or flexuous, 6–7 μm . wide, slightly attenuated towards tip and also slightly hooked; cells 3–6 μm . long, with small granules along some transverse walls; terminal cell with calyptra.

Cannot identify to species level in Geitler (1932) but similar to *O. amoena* Gom.

Habitat. Rare, recorded from three subaerial sites, mineral soils at sites 1, 2 and 34.

Oscillatoria sp. C

Fig. 5g–i

Trichomes pale blue-green, straight or flexuous, 7–9 μm . wide, terminating in several ways, from being without calyptra and not attenuated (Fig. 5h) to being attenuated and with calyptra (Fig. 5i), occasionally with terminal hook (Fig. 5g); cells 2–5 μm . long, with granular chromoplasm but without accumulation of granules along transverse walls; bi-concave cells sometimes present; terminal cell frequently bearing short filaments of epiphytic bacteria.

Cannot identify to species level in Geitler (1932).

Habitat. In two subaerial sites, bird- and seal-contaminated sites 13 and 61 where it sometimes formed dark blue-green, macroscopic surface felts.

Oscillatoria sp. D

Fig. 5j

Trichomes blue-green, straight or flexuous, terminally hooked, 2.5–3.0 μm . wide, slightly attenuated at tip; cells 1.5–2.5 μm . long, with granular contents; terminal cell slightly swollen, with calyptra.

Cannot identify to species level in Geitler (1932).

Habitat. Recorded from nine subaerial sites, only once amongst moss, *Tortula* sp. at site 27.

Phormidium Kuetzing

Trichomes simple, unbranched, similar to those of *Lyngbya* Agardh, straight or flexuous, apex sometimes attenuated; individual sheaths usually indistinct and difficult to demonstrate, where aggregations of trichomes occur sheaths becoming confluent and plant mass appears as felt-like layer.

Bourrelly (1970) included *Phormidium* in *Lyngbya*. Geitler (1932) is followed in distinguishing the two genera. It is easy to confuse individuals of this genus with those of *Lyngbya*, *Oscillatoria* and *Microcoleus*, and Drouet (1968) grouped these together under a few species each with a large synonymy.

1.	Trichomes 3.5–7.0 μm . wide	2
	Trichomes 1.5–2.5 μm . wide	3
2.	Trichomes 7.0 μm . wide	<i>P. autumnale</i>
	Trichomes 3.5 μm . wide	<i>P. cf. rubroterricola</i>
3.	Cells appearing to be separated by thin gelatinous pad	<i>P. frigidum</i>
	Cells directly joined	4
4.	Trichomes 1.5 μm . wide	<i>P. foveolarum</i>
	Trichomes 2.5 μm . wide	<i>P. priestleyi</i>

Phormidium autumnale (Agardh) Gomont

Fig. 5k

Syn. *Oscillatoria autumnalis* Agardh
Phormidium uncinatum Gomont

Trichomes blue-green, straight or flexuous, 7 μm . wide, attenuated; terminal cell slightly swollen, with calyptra; cells 3–6 μm . long, with chromoplasm occasionally granular, sometimes small granules along transverse walls.

Habitat. Frequent in the subaerial sites with 37 occurrences, also in four aerial sites (104, 105, 106 and 112). Largely absent from *Andreaea* spp. cushions and *Polytrichum alpestre*–*Chorisodontium aciphyllum* turves. Particularly characteristic of the mineral soils, the soils below herbaceous vegetation and sites close to birds' nesting areas and seal wallows, sometimes a major component of surface algal felts in the latter. In the aerial habitat recorded from irrigated sites on coastal cliffs close to birds' nests.

Distribution. Antarctica: Ross Island, in fresh water and in the terrestrial habitat (West and West, 1911b; Fritsch, 1917); Jenny Island, Antarctic Peninsula, in fresh water (Gain, 1912); Iles Kerguelen, in fresh water (Bourrelly and Manguin, 1954); the Antarctic distribution of this and other *Phormidium* spp. were mapped by Koob (1967). Other records: Europe, cosmopolitan on damp earth, nitrophilous (Geitler, 1932); United Kingdom, in soil (Bristol, 1920; Fritsch and John, 1942; Lund, 1947); Iceland, Denmark and Greenland, common in soil, nitrophilous (Petersen, 1928, 1932a, 1935).

Phormidium foveolarum Gomont

Fig. 5l

Trichomes blue-green, straight or flexuous, 1.5 μm . wide, not attenuated; cells 1–2 μm . long, slightly constricted at transverse walls; terminal cell without calyptra.

Habitat. Recorded from 29 subaerial sites and three aerial sites (105, 109 and 110). Frequent in mineral soils, soils below herbaceous vegetation and sites close to birds' nesting areas and seal wallows. In the latter it is often a constituent of surface algal felts. The three aerial sites were coastal, irrigated and close to birds' nests.

Distribution. Antarctica: Ongul Islands, eastern Antarctica, in fresh water (Watanabe and others, 1961). Other records: Europe, in damp earth and on rocks and in polluted water (Geitler, 1932); United Kingdom, in soils which were not base deficient (Lund, 1947); also in soils from Denmark and Greenland (Petersen, 1932a, 1935); India (Mitra, 1951) and tropical South America (Durrell, 1964).

Phormidium frigidum Fritsch

Fig. 5m

Trichomes blue-green, straight or flexuous, 1.5–2.0 μm . wide, not attenuated; cells 2.5–3.5 μm . long (occasionally 6 μm .), appearing to be separated by thin gelatinous pads; granule occasionally present at both apices of each cell; terminal cell rounded and without calyptra.

Geitler (1932) described slightly narrower trichomes (up to 1.5 μm . wide) and his illustration showed spaces between the cells but no mention was made of them being joined by a gelatinous pad. This feature is also a characteristic of *Pseudanabaena* Lauterborn.

Habitat. Rare, recorded from two subaerial sites, 4 and 26.

Distribution. Antarctica: Victoria Land, in snow fields (Fritsch, 1917); Haswell Island, in soil (Kol, 1968). Other records: Europe, in fresh water (Geitler, 1932).

Phormidium priestleyi Fritsch

Fig. 5n

Trichomes pale blue-green, straight or flexuous, 2.5 μm . wide, not attenuated, slightly constricted at transverse walls; cells 1.5–2.0 μm . long; terminal cell usually rounded, occasionally conical and up to 3.5 μm . long on BBM agar cultures, without calyptra.

Geitler (1932) described the trichomes as 3 μm . wide and did not describe a conical terminal cell.

Habitat. Recorded from 26 subaerial sites and seven aerial sites. Frequent in mineral soils, soils below

herbaceous vegetation and sites near to birds' nesting areas and seal wallows. The aerial sites are mostly coastal, irrigated, bird-affected sites.

Distribution. Antarctica: Victoria Land, in fresh water (Fritsch, 1917). Other records: none.

Phormidium cf. *rubroterricola* Gardner

Fig. 5o and p

Trichomes blue-green, flexuous, 3.5 μm . wide, not attenuated; cells 3.0–3.5 μm . long; terminal cell rounded without calyptra (Fig. 5o). On BBM agar cultures old growths forming strands growing up from flat growth on agar surface (Fig. 5p).

P. rubroterricola was described by Geitler (1932) as 2.2–2.4 μm . wide and the terminal cell is more pointed than in specimens from Signy Island.

Habitat. Recorded from 21 subaerial sites. Frequent in the soils below herbaceous vegetation, infrequent amongst mosses, absent from *Polytrichum alpestre*–*Chorisodontium aciphyllum* turves and *Andreaea* spp. cushions.

Distribution. Antarctica: no record of *P. rubroterricola*. Other records: Puerto Rico, in soil (Geitler, 1932).

Plectonema Thuret

Trichomes falsely branching, single within more or less thick sheath; branches arising singly or in pairs; heterocysts absent.

This genus can be confused with *Lyngbya*. False branching is sometimes rare and if not seen the trichomes cannot be distinguished from those of *Lyngbya*.

- | | |
|--|---------------------|
| 1. Trichomes 2.5 μm . wide, considerably curved and twisted | <i>P. battersii</i> |
| Trichomes 1.5 μm . wide, straight and flexuous | <i>P. notatum</i> |

Plectonema battersii Gomont

Fig. 5q

Trichomes blue-green, infrequently falsely branching, 2.5 μm . wide, constricted at transverse walls, considerably curved and twisted, in thin hyaline sheath; cells *c.* 1 μm . long.

Petersen (1932a) described a form with copious branching.

Habitat. Recorded from 13 aerial sites, on coastal rocks and particularly frequent on marble outcrops.

Distribution. Antarctica: no record. Other records: Europe, on coastal rocks (Geitler, 1932); in soils from the United Kingdom, (Bristol, 1920) and Denmark (Petersen, 1932a).

Plectonema notatum Schmidle

Fig. 5r

Trichomes blue-green, occasionally falsely branching, 1.5 μm . wide, not constricted at transverse walls which are often faint, in thin hyaline sheath; cells up to 3.5 μm . long.

Geitler (1932) described the presence of one or two granules at the transverse walls and trichomes, 1.7–2.0 μm . wide.

Habitat. Rare, recorded from one subaerial site, amongst *Tortula fuscoviridis* on an exposed marble knoll (site 26).

Distribution. Antarctica: Ross Island, in fresh-water ponds (West and West, 1911b). Other records: Europe, in fresh water (Geitler, 1932).

Pseudanabaena Lauterborn

Trichomes solitary, motile, not ensheathed; cells cylindrical, joined by small gelatinous pads; heterocysts and akinetes rare.

- | | |
|---|--------------------|
| 1. Cells cylindrical, usually containing spherical granule at both apices | <i>P. catenata</i> |
| Cells ellipsoidal, slightly swollen centrally, granules absent | <i>P. tenuis</i> |

Pseudanabaena catenata Lauterborn

Fig. 6a-c

Trichomes blue-green, with slow gliding movement with erratic side-to-side action of tip, straight or flexuous; cells $2.5-3.5 \mu\text{m}$. long, joined by small gelatinous pads, both apices often with small spherical granule (Fig. 6a), occasionally granules considerably enlarged (Fig. 6b); apex of terminal cell containing one, or sometimes two spherical granules or rarely a short, curved bar-shaped granule (Fig. 6c).

Habitat. Recorded from 26 subaerial sites. Frequent in the mineral soils without macroscopic vegetation, the soils below herbaceous vegetation and amongst the wet bryophytes. Absent from amongst *Polytrichum alpestre*-*Chorisodontium aciphyllum* turves.

Distribution. Antarctica: no record. Other records: Europe, widespread on mud (Geitler, 1932); Switzerland, on aerial rock faces (Jaag, 1945).

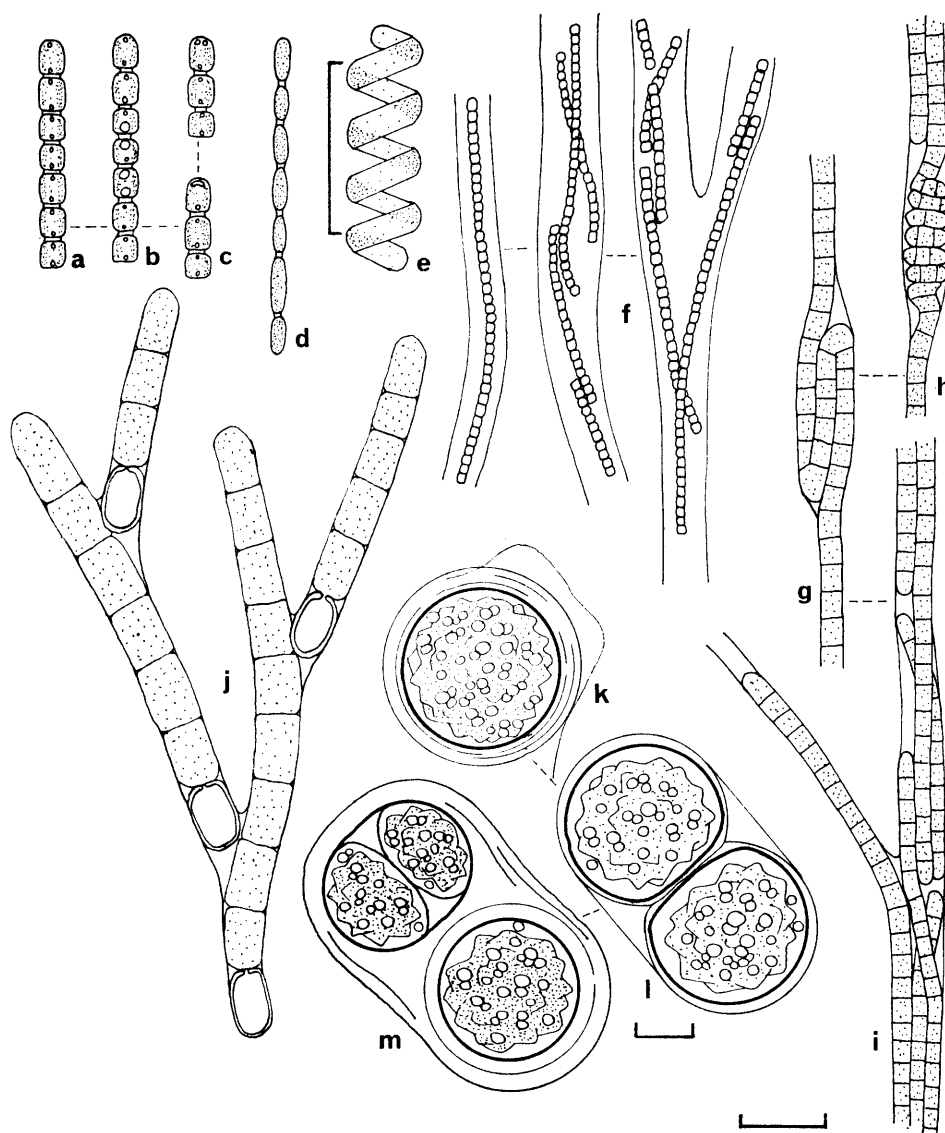


FIGURE 6

a-c. *Pseudanabaena catenata* (p. 34); d. *Pseudanabaena tenuis* (p. 35); e. *Spirulina maior* (p. 35); f. *Schizothrix fragilis* (p. 35); g-i. *Schizothrix* sp. A (p. 35); j. *Tolypothrix tenuis* (p. 36); k-m. *Gloeodinium montanum* (p. 36).

The scales are $10 \mu\text{m}$. The upper scale refers to e, the centre scale to k-m, and the lower scale to a-d and f-j.

Pseudanabaena tenuis Koppe
Fig. 6d

Trichomes pale blue-green, 1.2 μm . wide, showing similar motility to *P. catenata*; cells 1.5–3.5 μm . long, ellipsoidal, slightly swollen centrally, joined by colourless gelatinous pads.

Geitler (1932) described the cells as somewhat longer (6–8 μm .) and no gelatinous pads were illustrated.

Habitat. Rare, recorded from three base-rich subaerial sites (6, 7 and 47).

Distribution. Antarctica: no record. Other records: Europe, on mud (Geitler, 1932).

Schizothrix Kuetzing

Trichomes few in number (cf. *Microcoleus*) enclosed in common sheath, showing false branching of the plant mass.

- | | | | |
|---------------------------------------|-----------|--|--------------------|
| 1. Trichomes 1.5 μm . wide | | | <i>S. fragilis</i> |
| Trichomes 2.5 μm . wide | | | <i>S. sp. A</i> |

Schizothrix fragilis (Kuetzing) Gomont
Fig. 6f

Filamentous yellow-brown growth produced on BBM agar, not observed on moist plate enrichment cultures or in direct microscopic examination of field material. Trichomes 1.5 μm . wide, one to four enclosed in hyaline non-stratified sheaths with frequent false branching, not attenuated at tip, slightly constricted at transverse walls; cells 1.0–1.5 μm . long.

Habitat. Rare, recorded from one subaerial site, in moraine soil at site 3.

Distribution. Antarctica: no record of this species but three other species have been recorded from fresh water (Hirano, 1965; Parker and others, 1972). Other records: Europe, North America, on damp walls, around swamps, in thermal springs (Geitler, 1932).

Schizothrix sp. A
Fig. 6g–i

Trichomes pale blue-green, 2.5 μm . wide, slightly constricted at transverse walls, one to four enclosed in thin, hyaline sheath showing false branching (Fig. 6i), occasional trichomes become bent back upon themselves (Fig. 6g) and may also tightly spiral within restricting sheath (Fig. 6h), not attenuated at tip; cells 2.5–6.0 μm . long; terminal cell rounded.

Cannot identify to species level in Geitler (1932).

Habitat. Rare, recorded from one subaerial site, in moraine soil at site 4.

Spirulina Turpin

Trichomes solitary, not ensheathed, motile, helically wound usually in very regular manner; spiral loosely or tightly coiled; transverse walls often difficult to see.

Bourrelly (1970) included *Spirulina* in *Oscillatoria* but here Geitler (1932) is followed in distinguishing the two genera.

Spirulina maior Kuetzing
Fig. 6e

Trichomes pale blue-green, tightly spiralled, short being only up to 10 μm . long, 1.5 μm . wide, spiral width 2.5 μm ., length of each winding 2.5 μm .; transverse walls not visible at a magnification of 1,000 diameters.

Geitler (1932) described the distance between spiral windings as 2.7–5.0 μm .

Habitat. Rare, recorded from one subaerial site, in mineral soil mixed with guano from a penguin rookery (site 13).

Distribution. Antarctica: no record of this species, although *S. subtilissima* Kuetzing has been found in a fresh-water pond in the South Orkney Islands (Fritsch, 1912*b*). Other records: Europe, Africa, in salt water and brackish water (Geitler, 1932).

Tolypothrix Kuetzing

Trichomes single within more or less thick sheath, falsely branching with branches arising singly; heterocyst with single pore present at base of each branch.

Tolypothrix tenuis Kuetzing

Fig. 6j

Trichomes blue-green, falsely branching; heterocyst with single pore at base of each branch; branches 6 μm . wide at base tapering slightly to 5 μm . at apex, slightly constricted at transverse walls; sheath thin, hyaline and non-stratified; cells 5–11 μm . long.

Geitler (1932) described a somewhat thicker sheath giving a filament width of up to 10 μm .

Habitat. Recorded from five subaerial sites and one aerial site. Four of the subaerial sites were calcium-rich (sites 26, 27, 28 and 47) as was the single aerial site 114.

Distribution. Antarctica: South Georgia, in a fresh-water pond (Carlson, 1913); Iles Kerguelen, in fresh water (Hirano, 1965). Other records: Europe, in fresh water and sometimes on rocks (Geitler, 1932); *T. tenuis* f. *terrestris* Boye Pet. was recorded as a terrestrial alga from Iceland (Petersen, 1928) and the United Kingdom (Fritsch and John, 1942; Lund, 1947).

PHYLUM PYRRHOPHYTA

CLASS DINOPHYCEAE

ORDER DINOCOCCALES

Gloeodinium Klebs

Cells spherical to ellipsoidal, solitary or in small colonies of usually two or four cells surrounded by stratified, mucilaginous envelopes; chromatophores brown, numerous, radially arranged; reproduction by autospores.

Gloeodinium montanum Klebs

Fig. 6k–m

Cells spherical, 27–42 μm . in diameter, single (Fig. 6k) or in small colonies of up to eight cells, contained within thin, stratified, mucilaginous envelopes; chromatophores golden-brown but not clearly observed in Signy Island material because of presence of numerous colourless and pale yellow oil (?) globules and though illustrated as a single chromatophore probably being composed of numerous radially arranged chromatophores as illustrated by Bourrelly (1970). Reproduction by autospores (Fig. 6l and m), sporangium wall rupturing to release two spores.

Habitat. Recorded from two subaerial sites, both amongst *Drepanocladus uncinatus* carpets (sites 47 and 48).

Distribution. Antarctica: no record. Other records: Europe, not uncommon in peat bogs (Schiller, 1937).

PHYLUM CHROMOPHYTA

CLASS CHRYSOPHYCEAE

ORDER STICHOGLOEAE

Unidentified genus of family Stichogloeaceae

Fig. 11l–o

Cells single, free-living, ellipsoidal (Fig. 11l), 8.5–11.0 μm . by 12.0–15.5 μm ., often containing many small spherical globules (Fig. 11m); chromatophores golden-brown, two per cell, U-shaped in apical view

(Fig. 11n) not adherent to wall, each containing pyrenoid-like body. Autospores formed (Fig. 11o), two released by irregular rupture of sporangium wall.

The possession of a distinct cell wall without ornamentation, by coccoid cells, places this alga in the family Stichogloeaceae. Two genera, *Phaeobotrys* Ettl and *Selenophaea* Chodat, have solitary cells lacking a mucilaginous envelope (Bourrelly, 1968) but neither resembles the present alga.

Habitat. Recorded from two aerial sites, abundant on coastal rocks, associated with *Ulothrix zonata* (sites 97 and 100).

Distribution. Antarctica: no record. Other records: members of the Chrysophyceae are infrequent in soils; United Kingdom, unidentified unicellular genera have been found by Fritsch and John (1942) and Lund (1947).

CLASS XANTHOPHYCEAE

ORDER MISCHOCOCCALES

Botrydiopsis Borzi

Cells spherical, solitary, free-living, of variable diameter, up to 80 μm . in large adult cells, multinucleate; chromatophores numerous, discoid or fusiform, lacking pyrenoids. Reproduction by aplanospores or zoospores; zoospores with two unequal flagella.

Botrydiopsis constricta Broady

Figs. 7a-s and 8a-q

Adult cells usually spherical (Fig. 7c, d, f and g), occasionally broadly ellipsoidal (Fig. 7e), single, up to 42 μm . in diameter, majority of cells about 25 μm . in diameter; wall smooth, thin, occasionally with lens-shaped thickenings (Fig. 7k); chromatophores numerous in large cells, usually fusiform, lacking pyrenoids, mostly parietal though some often either project into cell or lie entirely in interior, young cells, up to 10 μm . in diameter, contain few, parietal, plate-like chromatophores (Fig. 7a and b); nuclei numerous in adult cells, central (Fig. 7e); oil globules often present. Occasionally, in old cultures, individual cells surrounded by stratified mucilaginous sheaths (Fig. 7i and j). Reproduction by aplanospores (Fig. 7s), zoospores (Fig. 7l-r) or vegetative division (Fig. 8a-q). Aplanospores usually spherical, 3.5-6.0 μm . in diameter, occasionally ellipsoidal to almost cylindrical, uninucleate, with one or two, rarely three or four, chromatophores. Zoospores, 5-7 μm . by 2-3 μm ., naked, unequally biflagellate, containing single chromatophore with stigma (Fig. 7p and q), usually released in large numbers by rupture of sporangium wall. Vegetative division most frequently seen in old cultures; spherical cells usually greater than 20 μm . in diameter becoming broadly ellipsoidal to almost cylindrical, then constricting and forming transverse wall across constriction thus cutting off two daughter cells of equal or unequal sizes (Fig. 8a-d). In region of constriction, wall often thick and faintly stratified. A thickish bridge of wall material may be present between two daughter cells before their separation (Fig. 8d). A process resembling budding also occurs; daughter-cell initiation commences with formation of thickening of one portion of wall (Fig. 8e), mother cell becomes pyriform (Fig. 8f) and daughter bud then swells, becoming separated from mother cell by deepening constriction (Fig. 8g), transverse wall formation and separation of daughter cells follows.

The occurrence of vegetative division in this alga is the major characteristic separating it from other species of this genus in which no such division has been observed. The zoospores are also characteristic as no other species possesses spores with a stigma and only one chromatophore. This new species has been described in more detail and discussed by Broady (1976).

Habitat. Widely distributed in the subaerial habitat, being recovered from 47 sites. Most frequent amongst the wetter bryophytes, mineral soils without macroscopic vegetation and soils below herbaceous vegetation.

Distribution. Antarctica: Victoria Land, a species of the same genus, *B. antarctica* Kol, described from soil (Kol, 1970); Ongul Islands, *B. arhiza* Borzi recorded in the terrestrial flora (Akiyama, 1968). Other records: *Botrydiopsis* spp. are quite frequent soil algae recorded from the United Kingdom (Fritsch and John, 1942; Lund, 1947), Denmark (Petersen, 1932a) and Austria (Reisigl, 1964).

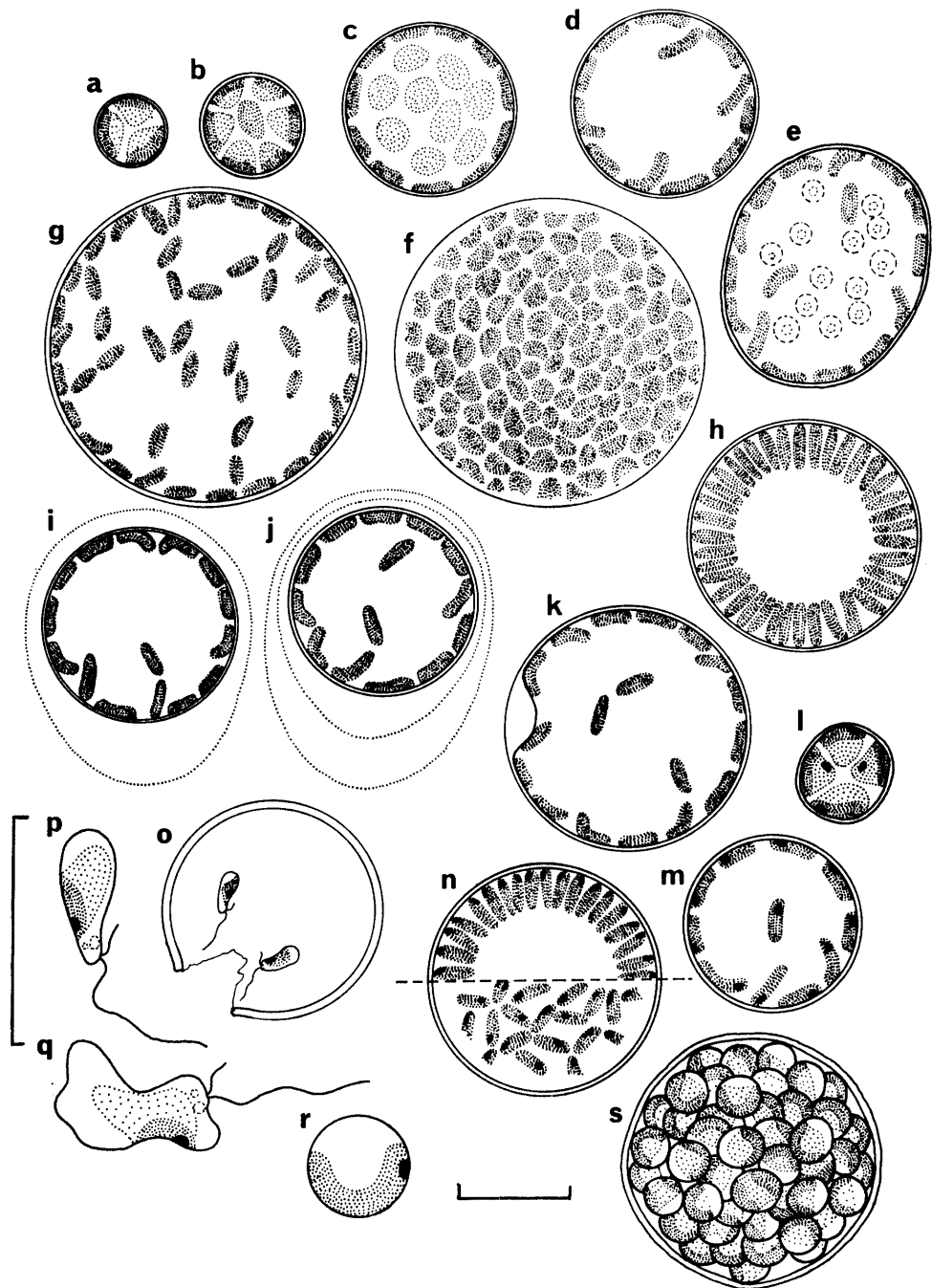


FIGURE 7

Botrydiopsis constricta (p. 37). a and b. Young cells; c-h. Adult cells: e. Showing multinucleate condition; f. Surface view of large cell; g. Optical section of large cell; h. Optical section of cell with radially arranged chromatophores; i and j. Cells with gelatinous envelopes; k. Lens-shaped thickening of cell wall; l-r. Zoospore formation: l-n. Zoosporangia; n. Sporangia in pseudopodia; p. Zoospore actively swimming; q. Settled zoospore putting out pseudopodia; r. Developing zoospore; s. Aplanosporangium.

The scales are 10 μm . The upper scale refers to p-r, the lower scale to a-o and s.

Characiopsis Borzi

Cells solitary, globular, oval or fusiform, attached to substrate by holdfast disc often with more or less long stalk, with one or more parietal chromatophores lacking pyrenoids. Reproduction by unequally biflagellate zoospores or aplanospores.

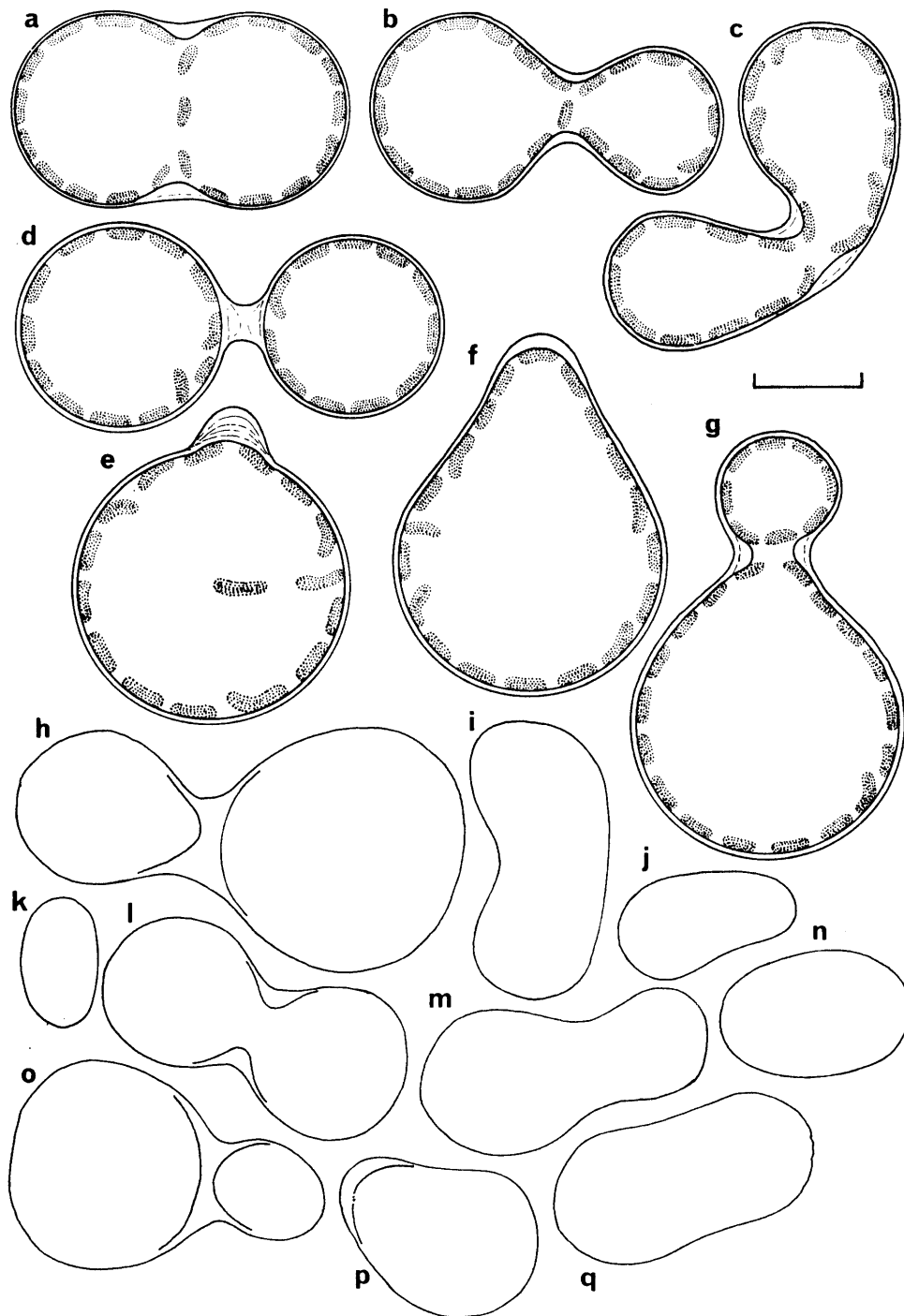


FIGURE 8

Botrydiopsis constricta (p. 37). Vegetative division; a. Early stage of cell division; b and c. Later stages, constriction nearly complete; d. Daughter cells bridged by wall material; e. Early stage of "budding" with cell wall thickening; f. Later stage with cell becoming pyriform; g. Daughter cell almost formed; h-q. *Camera lucida* drawings of cells from a culture showing vegetative division indicating thickened portions of the cell walls.

The scale is 10 μ m.

Characiopsis sp. A

Fig. 9a-d

Cells single, approximately oval, attached to substrate by short stalk terminating in disc-shaped holdfast, adult cells $7.5 \mu\text{m}$. wide by $13\text{--}20 \mu\text{m}$. long with several parietal chromatophores lacking pyrenoids (Fig. 9a); oil globules often present; wall smooth without thickenings except at base where it extends, forming short stalk no more than $3 \mu\text{m}$. long with terminal, brown, holdfast disc, $2\text{--}12 \mu\text{m}$. in diameter, occasionally with brown mucilage surrounding disc. Reproduction by formation of spherical aplanospores, four in each sporangium (Fig. 9b) released by rupture of sporangium wall, these initially without holdfast (Fig. 9c) but this developing as spores increase in size (Fig. 9d); no zoospore formation observed.

This unidentified species is similar to *C. obovoidea* Pascher in cell shape and size except for the lack of even a short stalk to the holdfast in that alga.

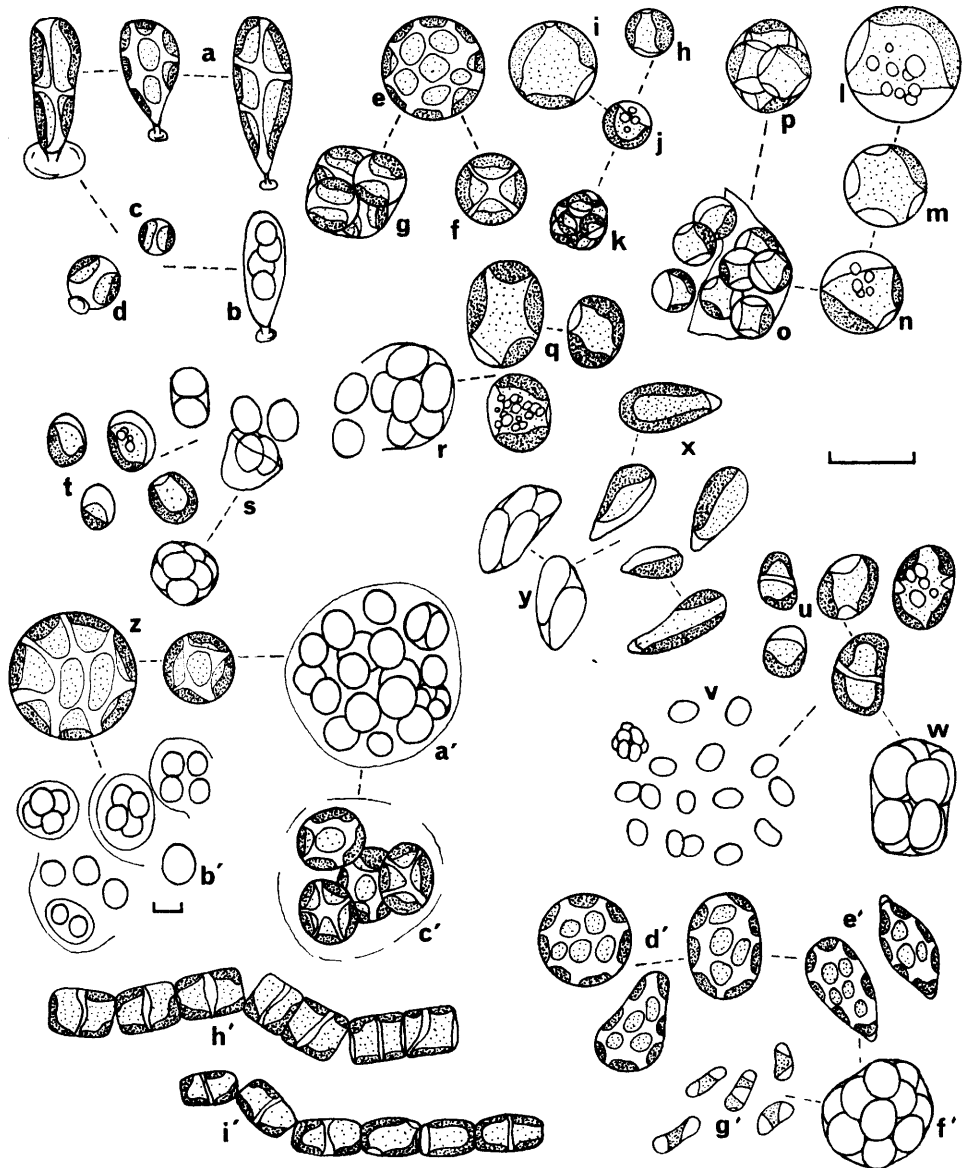


FIGURE 9

a-d. *Characiopsis* sp. A (p. 40); e-g. *Chloridella neglecta* (p. 41); h-k. *Chloridella* sp. A (p. 41); l-p. *Chloridella* sp. B (p. 41); q and r. *Ellipsoidion* sp. A (p. 42); s and t. *Ellipsoidion* cf. *perminimum* (p. 42); u-w. *Gloeobotrys terrestris* (p. 42); x and y. *Monodus subterraneus* (p. 43); z-c'. *Gloeobotrys* sp. A (p. 42); d'-g'. Unidentified genus of the family Pleurochloridaceae (p. 43); h'. *Heterothrix debilis* (p. 44); i'. *Heterothrix exilis* (p. 45).

The scales are $10 \mu\text{m}$. The upper scale refers to a-u, w-z and c'-i', the lower scale to v, a' and b'.

Habitat. Rare, recorded from two subaerial sites, both soils below herbaceous vegetation (sites 64 and 65).
Distribution. Antarctica: Iles Kergulen, two species of *Characiopsis* from fresh water (Hirano, 1965).
 Other records: Denmark, two species in soil (Petersen, 1932a).

Chloridella Pascher

Cells solitary, spherical, free-living, of small size up to 20 μm . in diameter, containing one or several parietal chromatophores usually without pyrenoids, with smooth wall. Reproduction by autospores.

This genus is similar to the chlorophycean genera *Chlorella* and *Muriella* being distinguished by the the absence of starch in *Chloridella*.

- | | |
|--|--------------------|
| 1. Cells with one to four chromatophores | <i>C. neglecta</i> |
| Cells with single chromatophore | 2 |
| 2. Cells mostly 4–5 μm . in diameter, forming eight autospores | <i>C. sp. A</i> |
| Cells up to 15 μm . in diameter, forming four, eight or 16 autospores | <i>C. sp. B</i> |

Chloridella neglecta Pascher

Fig. 9e–g

Cells single, spherical, 3.5–12.0 μm . in diameter (Fig. 9e and f), forming four or eight autospores (Fig. 9g) liberated by gelatinization of sporangium wall, these remaining in loose aggregates for short time after liberation; chromatophores lacking pyrenoids, parietal, discoid, in adult cells four to several, in spores one to four in number.

Pascher (1939) described the formation of two or four autospores in this alga, whilst a form described by Ettl (1968) formed eight autospores.

Habitat. Rare, recorded from two subaerial sites, amongst *Andreaea* sp. cushions at site 16 and *Tortula fuscoviridis* at site 26.

Distribution. Antarctica: no record. Other records: Europe, common in fresh water (Pascher, 1939); Switzerland, in alpine soil (Vischer, 1945); Austria, a form of *C. neglecta* in alpine soil (Reisigl, 1964).

Chloridella sp. A

Fig. 9h–k

Cells spherical, mostly 4–5 μm . in diameter, occasionally reaching 10 μm . (Fig. 9h–j); chromatophore single, parietal, lacking pyrenoid, somewhat lobed covering more than half of wall; several oil globules often present. Reproduction by formation of eight autospores (Fig. 9k).

The similar *C. simplex* Pascher has a single chromatophore but the cells are larger, 12–15 μm . in diameter and only two autospores are formed (Pascher, 1939).

Habitat. A scattered infrequent distribution in 11 subaerial sites.

Chloridella sp. B

Fig. 9l–p

Cells spherical, 3.5–15.0 μm . in diameter, with single, more or less lobed, parietal chromatophore lacking pyrenoid (Fig. 9l–n); several oil globules often present. Reproduction by formation of four (Fig. 9p), eight or 16 autospores, 3.5–6.0 μm . in diameter, released by rupture of sporangium wall (Fig. 9o), occasionally spores still within sporangium may themselves be dividing.

This alga is also similar to *C. simplex* Pascher in possessing a single chromatophore and in cell dimensions. However, it differs in the number of spores produced and in the method of their release which, according to Pascher (1939), is by gelatinization of the cell wall.

Habitat. Rare, recorded from one subaerial site amongst *Andreaea regularis* cushions (site 29).

Ellipsoidion Pascher

Cells ellipsoidal or short cylindrical, solitary, free-living, with small number of parietal chromatophores, with or without pyrenoid, and with smooth wall. Reproduction by autospores or unequally biflagellate zoospores.

1. Cells 3–4 μm . by 3.5–6.0 μm .; two, four or eight autospores formed *E. cf. perminimum*
 Cells 3–9 μm . by 5–12 μm .; four or eight autospores formed *E. sp. A*

Ellipsoidion cf. perminimum Pascher

Fig. 9s and t

Cells ellipsoidal or almost spherical, 3.0–4.0 μm . by 3.5–6.0 μm . (Fig. 9t); chromatophore single, parietal, of variable size covering from less than half to nearly all of wall; oil globules occasionally present. Reproduction by formation of two, four or eight autospores released by irregular rupture of sporangium wall (Fig. 9s); zoospores not observed.

E. perminimum has a smaller chromatophore than the Signy Island specimens, covering a small area of the cell wall and only two or four spores are formed (Pascher, 1939).

Habitat. Rare, recorded from three subaerial sites (sites 5, 30 and 37).

Distribution. Antarctica: no record. Other records: Austria, *E. perminimum* in a calcium-poor alpine soil (Reisigl, 1964).

Ellipsoidion sp. A

Fig. 9q and r

Cells ellipsoidal or almost spherical, 3–9 μm . by 5–12 μm ., with single, lobed, parietal chromatophore (Fig. 9q); often containing oil globules. Reproduction by formation of four or eight autospores released by irregular rupture of sporangium wall (Fig. 9r); zoospores not observed. In aqueous microscopic preparations of material from BBM agar cultures cells tending to remain in large, loose aggregates.

Cannot identify to species level using the keys of Pascher (1939).

Habitat. Recorded from nine subaerial sites including four mineral soils.

Gloeobotrys Pascher

Cells spherical or ellipsoidal, distributed irregularly, or occasionally in groups of two or four cells, throughout homogeneous, mucilaginous colonies, sometimes with faint stratifications caused by remains of sporangium walls; chromatophores few, parietal. Reproduction by autospores or zoospores.

1. Cells ellipsoidal or occasionally reniform, 6–11 μm . by 3.5–6.0 μm *G. terrestris*
 Cells spherical, 6–15 μm . in diameter *G. sp. A*

Gloeobotrys terrestris Reisigl

Fig. 9u–w

Cells ellipsoidal or occasionally reniform, 6–11 μm . by 3.5–6.0 μm ., irregularly arranged throughout soft, hyaline mucilage (Fig. 9v), containing one or two, rarely more, parietal, plate-like chromatophores (Fig. 9u); oil droplets often present; autospores formed (Fig. 9w), eight or 16 released by gelatinization of sporangium wall.

The cells are slightly larger than those described by Reisigl (1964) (4.5 μm . by 6.3 μm . in diameter), who also described no more than two chromatophores.

Habitat. Widely distributed in 39 subaerial sites but rare in *Polytrichum alpestre*–*Chorisodontium aciphyllum* turves.

Distribution. Antarctica: no record. Other records: Austria, in alpine soil (Reisigl, 1964).

Gloeobotrys sp. A

Fig. 9z–c'

Cells spherical, 6–15 μm . in diameter, containing several parietal chromatophores (Fig. 9z), in young colonies removed from BBM agar culture, being quite closely and usually irregularly arranged throughout hyaline, homogeneous mucilage (Fig. 9a'), in older cultures remaining in groups of two, four or eight, usually four, with mucilage faintly stratified (Fig. 9b'). Reproduction by formation of two, four or eight

autospores released, in young cultures, by gelatinization of sporangium wall (Fig. 9c') but in old cultures wall remains persisting.

Pascher (1939) described only one species, *G. chlorinus* Pascher, in which the cells are spherical but considerably smaller (4–5 μm . in diameter) than the Signy Island specimens and containing only two to four chromatophores. Reisinger (1964) described five species of *Gloeobotrys* from soil but none is similar to the present alga. Further observations on cultures of this alga are required.

Habitat. Recorded from ten subaerial sites, usually amongst bryophytes.

Monodus Chodat

Cells solitary, free-living, pyriform, small in size, one apex generally rounded and the other more pointed, containing one or several parietal chromatophores. Reproduction by autospores.

Monodus subterraneus Boye Petersen

Fig. 9x and y

Cells mostly pyriform, occasionally slightly curved, 2.5–5.0 μm . by 4.0–9.5 μm ., often with slight terminal wall thickening at narrower apex, other apex broadly rounded (Fig. 9x); chromatophore single, parietal; autospores, two or less frequently four, released by rupture of sporangium wall (Fig. 9y).

Petersen (1932b) described the production of only two autospores.

Habitat. Recorded from 65 subaerial sites, very widespread occurring amongst all vegetation types, in mineral soils without macroscopic vegetation and in soils below herbaceous vegetation. Particularly high cell numbers were found in the Signy Island terrestrial reference site (SIRS) 1 (site 30) and the ecology of this species at that site has been described in some detail (Broady, 1977a).

Distribution. Antarctica: in the terrestrial flora of the Ongul Islands, eastern Antarctica (Akiyama, 1968) and Haswell Island, near Cape Adare, Victoria Land (Kol, 1968). Other records: in soils of Denmark (Petersen, 1932b, 1935) and Czechoslovakia (Rosa and Lhotsky, 1971).

Unidentified genus of the family Pleurochloridaceae

Fig. 9d'–g'

Cells spherical, ellipsoidal, pyriform or other more irregular shapes, maximum cell diameter 14 μm ., containing several parietal, plate-like chromatophores (Fig. 9d'), in old cultures often with terminal wall thickening, rarely present at both apices (Fig. 9e'). Reproduction by autospores with one to several chromatophores produced in sporangia containing at least ten spores (Fig. 9f'), smallest spores being approximately cylindrical (Fig. 9g') c. 5.0 μm . by 1.5 μm .

Free-living solitary forms were placed in the Pleurochloridaceae by Bourrelly (1968). Several genera reproduce solely by autospores as do the Signy Island specimens; however, the present alga can be excluded from these on the basis of cell shape and chromatophore number. Further observations of cultured material are required.

Habitat. Recorded from 32 subaerial sites, widely distributed in most habitat types but infrequent in the soils below herbaceous vegetation.

ORDER TRIBONEMATALES

Heterococcus Chodat

Filaments uniseriate or multiseriate, sometimes heterotrichous but often reduced to erect filaments alone, branching; cells occasionally in tetrads, with discoid, parietal chromatophores without pyrenoids. Reproduction by zoospores or aplanospores.

Heterococcus chodati Vischer

Fig. 11e–i

Thalli uniseriate or multiseriate branching filaments; cells containing one to several parietal, discoid chromatophores; colonies on BBM agar cultures circular, 1–2 mm. in diameter (Fig. 11h), heterotrichous

consisting of central, rough, green mass on agar surface with radiating, branching filaments penetrating substrate, in young aqueous cultures many unicells occurring (Fig. 11e), ranging from small spherical cells *c.* 4 μm . in diameter, possibly aplanospores or settled zoospores, containing single chromatophore, to more irregular shapes up to 27 μm . in diameter containing many chromatophores sometimes these packed closely together and projecting inwards (Fig. 11f); unicells developing into irregularly branching thalli (Fig. 11g and i). No sporangia observed, although on one occasion a single zoospore was seen.

Habitat. Recorded from 20 subaerial sites. Frequent in calcium- and base-rich sites, sites with some bird or seal contamination, and soils below herbaceous vegetation. Absent from *Polytrichum alpestre*-*Chorisodontium aciphyllum* turves and *Andreaea* spp. cushions.

Distribution. Antarctica: no record. Other records: United Kingdom, in alkaline and chalky soils (Fritsch and John, 1942; Lund, 1947); Switzerland, in alpine soil (Vischer, 1945).

Heterothrix Pascher

Filaments simple, unbranched, uniseriate, consisting of identical cylindrical cells often slightly constricted at transverse walls, often readily fragmenting; cells containing a small number of parietal chromatophores; zoospores and akinetes formed.

On fragmentation of the filaments H-shaped cell wall fragments are not formed as in *Tribonema* Derbes et Solier.

- | | |
|--|----------------------|
| 1. Filaments long, multicellular in young cultures; cells cylindrical containing single chromatophore | <i>H. antarctica</i> |
| Filaments readily fragmenting, up to 20 cells long in young cultures; cells barrel-shaped containing one or two chromatophores | 2 |
| 2. Filaments 3.5–4.0 μm . wide, cells 6.0–9.5 μm . long | <i>H. exilis</i> |
| Filaments 5.0 μm . wide, cells 4.0–7.5 μm . long | <i>H. debilis</i> |

Heterothrix antarctica Broady

Fig. 10a–m

Filaments long, multicellular, flexuous, 3.0–4.5 μm . wide, in young cultures without constrictions at transverse walls (Fig. 10a); cells 3.5–9.0 μm . long in young cultures and up to 18 μm . long in old cultures, containing single parietal, plate-like chromatophore covering about half of wall, in young filaments chromatophore covering length of cell but in old filaments lying in centre of larger cells (Fig. 10b); oil globules often present particularly in old cultures. In old filaments transverse walls becoming concavo-convex and filaments readily fragmenting. Akinetes formed, initially constrictions appearing at transverse walls and short lengths of filament breaking away (Fig. 10c), these splitting into individual vegetative cells and becoming spherical, forming akinetes with sculptured cell wall (Fig. 10d–j) and usually packed with oil globules. Staining of cells with Lugol's iodine solution not revealing presence of starch but golden-brown staining granules apparent throughout chromatophore (Fig. 10m).

This new species has been described and a comparison made with other species of *Heterothrix* by Broady (1976).

Habitat. Recorded from six subaerial sites, five of which were wet mosses (sites 42, 43, 48, 51 and 54), the remaining site being *Tortula* sp. at site 28.

Distribution. Antarctica: two species of *Heterothrix* have been recorded in soils of Victoria Land, namely *H. bristoliana* Pascher (Holm-Hansen, 1964; Kol, 1970) and *H. stichococcoides* Pascher (Kol, 1970). Other records: *Heterothrix* spp. are frequent soil algae (Pascher, 1939).

Heterothrix debilis Vischer

Fig. 9h'

Filaments up to about 20 cells in length, readily fragmenting, 5 μm . wide; cells 4.0–7.5 μm . long, barrel-shaped containing one or two parietal chromatophores. Zoosporulation not observed.

In the absence of zoosporulation this alga was identified by cell size and chromatophore number alone from the description by Pascher (1939).

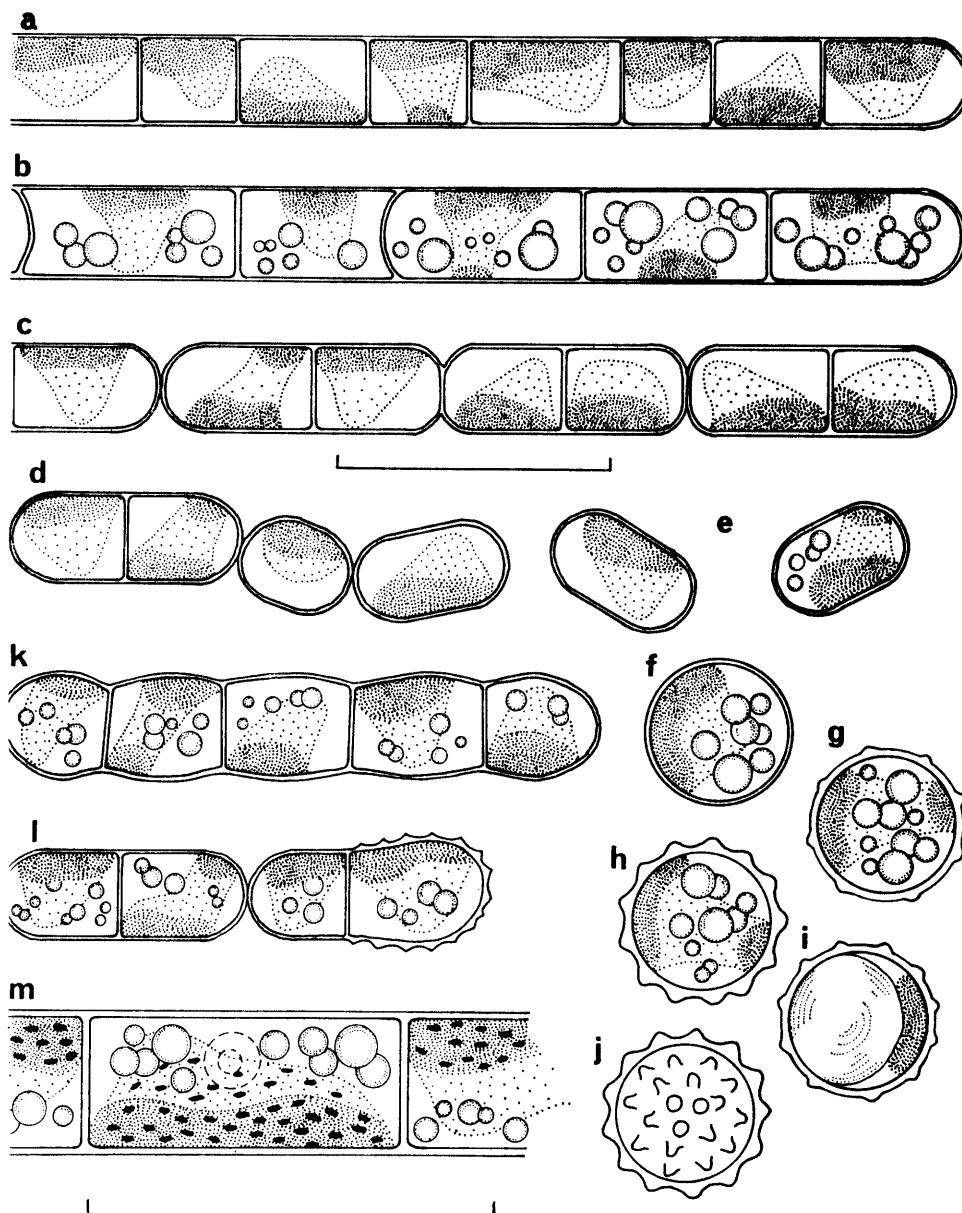


FIGURE 10

Heterothrix antarctica (p. 44). a. Young filament; b. Old filament; c-l. Akinete formation: c. Start of filament fragmentation; d. Later stage of filament fragmentation; e. Single cells; f. Single cells rounded off; g-i. Various sculptured akinetes with oil reserves; j. Surface of akinete; k. Filament prior to fragmentation into single cells; l. Rare akinete formation of cell still attached to a filament; m. Filament treated with Lugol's iodine solution showing distribution of golden-brown staining granules, nucleus and oil globules.

The scales are 10 μm . The upper scale refers to a-l, the lower scale to m.

Habitat. Recorded from 18 subaerial sites, quite frequent in base- and nutrient-rich sites especially soils below herbaceous vegetation, infrequent amongst moss stands.

Distribution. Antarctica: no record. Other records: Austria, in alpine soil (Reisigl, 1964).

Heterothrix exilis Pascher

Fig. 9i'

Filaments from two to about 20 cells in length, readily fragmenting, 3.5-4.0 μm . wide; cells 6.0-9.5 μm . long, barrel-shaped, containing one or two parietal chromatophores. Zoosporulation not observed.

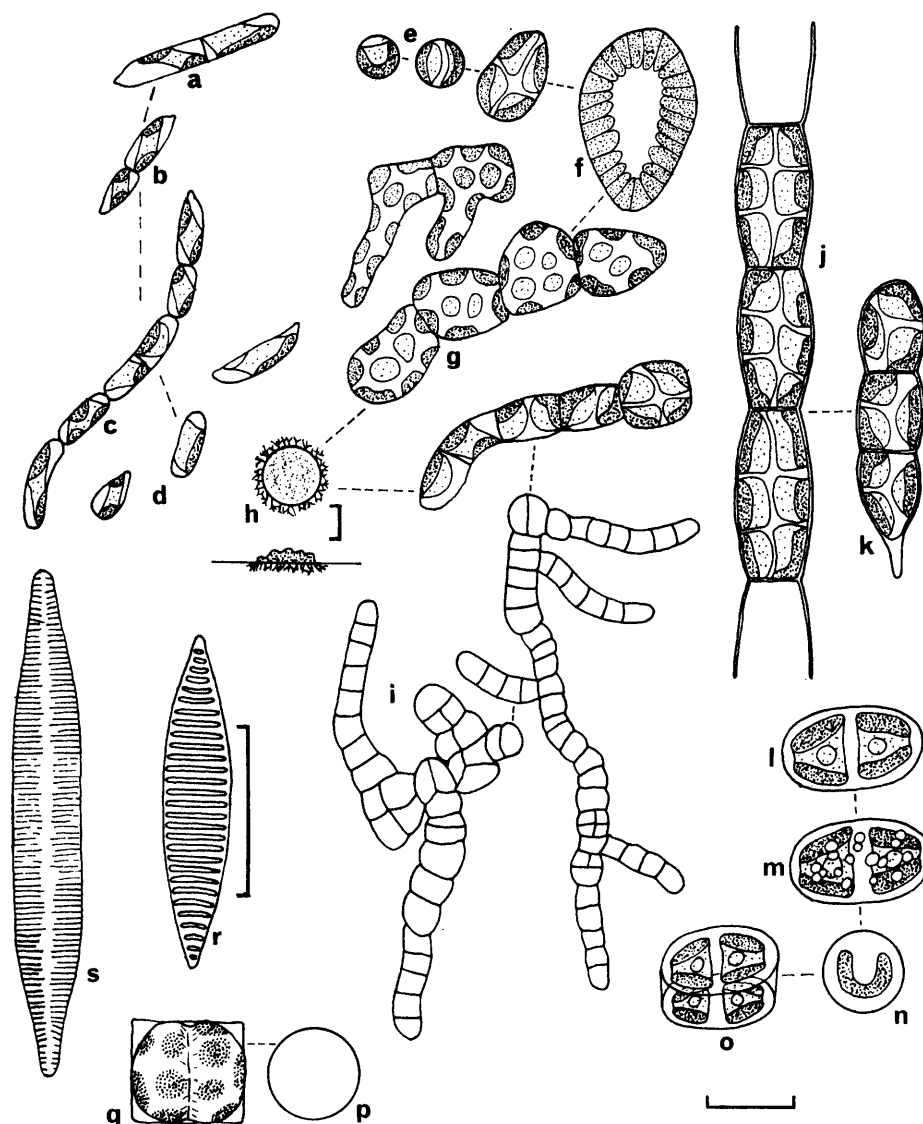


FIGURE 11

a-d. *Heterotrichella gracilis* (p. 47); e-i. *Heterococcus chodati* (p. 43); j-k. *Tribonema vulgare* (p. 47); l-o. Unidentified genus of the family Stichogloeaceae (p. 36); p and q. *Melosira* sp. A (p. 47); r. *Diatoma* sp. A (p. 48); s. *Fragilaria virescens* (p. 48). The upper scale is 1 mm. and refers to h; the centre scale is 10 μ m. and refers to r; the lower scale is 10 μ m. and refers to a-g, i-q and s.

In the absence of zoosporulation this species was identified by cell size and chromatophore number alone from the description by Pascher (1939).

Habitat. Recorded from 29 subaerial sites. Similar distribution to *H. debilis* with occurrences in the more nutrient- and base-rich sites especially the mineral soils without macroscopic vegetation and soils below herbaceous vegetation.

Distribution. Antarctica: no record. Other records: widespread in soils from Europe, (Pascher, 1939), United Kingdom, (Fritsch and John, 1942; Lund, 1947), Austria (Reisigl, 1964), New Zealand (Flint, 1968).

Heterotrichella Reisigl

Filaments simple, unbranched, uniseriate, short and readily fragmenting; cells cylindrical often slightly curved with one or two parietal chromatophores lacking pyrenoids; apical cell of filaments almost conical.

Heterotrichella gracilis Reisigl

Fig. 11a-d

Filaments short, readily fragmenting (Fig. 11b and c), 2.0–4.5 μm . wide; cells 6–12 μm . long, often slightly curved, single cells (Fig. 11d) usually heteropolar, one apex broadly rounded and other bearing short papilla, occasionally both apices papillate, terminal cells of filaments also usually papillate; chromatophore single, parietal, occupying less than half of wall, sometimes in form of half spiral (Fig. 11a).

The filament width is slightly greater than that given by Reisigl (1964) (2.0–2.5 μm . wide) and the larger cells of his illustrations which possess a considerably spiralled chromatophore were not observed.

Habitat. Recorded from 15 subaerial sites including three similar moraine soils (sites 1, 2 and 3). Absent from *Polytrichum alpestre*–*Chorisodontium aciphyllum* turves, otherwise a scattered distribution.

Distribution. Antarctica: no record. Other records: Austria, in calcium-rich alpine soil (Reisigl, 1964).

Tribonema Derbes et Solier

Filaments simple, unbranched, uniseriate, consisting of identical, cylindrical, sometimes barrel-shaped cells, except for terminal cell with short fixation stalk in young filaments; cells containing one or several parietal chromatophores usually without pyrenoids; each cell with wall composed of two equal halves and cell-wall halves of adjacent cells joined at transverse walls forming H-shaped sections, becoming visible when filaments fragment.

The similar genus *Heterothrix* Pascher does not possess H-shaped cell-wall fragments nor do young filaments have a specialized terminal cell with a fixation stalk.

Tribonema vulgare Pascher

Fig. 11j and k

Syn. Tribonema bombycinum f. *tenuis* Hazen*Conferva bombycina* f. *tenuis* Collins

Filaments long, not readily fragmenting, 7.5–10.0 μm . wide; cells 10–22 μm . long, slightly swollen centrally, containing several parietal, discoid chromatophores; terminal cell of young filaments with short fixation stalk (Fig. 11j); broken filaments showing characteristic H-shaped cell-wall fragments of this genus (Fig. 11k). Zoospores not observed.

Habitat. Recorded from 15 subaerial sites. Absent from *Polytrichum alpestre*–*Chorisodontium aciphyllum* turves and *Andreaea* spp. cushions, otherwise quite widely distributed and especially frequent in the soils below herbaceous vegetation.

Distribution. Antarctica: no record of this species, *T. bombycinum* (Agardh) Derbes et Solier recorded by Fritsch (1912b) from fresh water in the South Orkney Islands. Other records: Europe, common in calcium-rich and calcium-poor moorland (Pascher, 1939).

CLASS BACILLARIOPHYCEAE

ORDER COSCINODISCALES

Melosira Agardh

Frustules cylindrical, longer than wide, circular in valve view, single or in chains connected by valve surfaces which often bear radially disposed rows of punctae and peripheral spines; sulcus usually present towards centre of cells at junction of two valves; chromatophores numerous, discoid.

Melosira sp. A

Fig. 11p and q

Frustules 7.5–21.0 μm . in diameter, in girdle view 9.5–25.0 μm . long (Fig. 11q), obvious markings absent and spines around edge of valve lacking (Fig. 11p), single or in short chains; chromatophores numerous, discoid.

Close in size and shape to *M. dickiei* Kuetzing although markings are visible on the valve face of that species (Hustedt, 1930), Signy Island specimens were rarely observed in small quantities and more observations are required on better material before a confident identification can be made.

Habitat. Recorded from four subaerial sites (22, 25, 46 and 59) and two aerial sites (98 and 107) all of which were wet or water flushed.

Distribution. Antarctica: Iles Kerguelen, *M. dickiei* recorded amongst mosses (Bourelly and Manguin, 1954); Hirano (1965) listed five other species from fresh water, including *M. varians* Agardh and *M. sol* Kuetzing from the South Orkney Islands found by Fritsch (1912b). Other records: *M. dickiei* in Europe amongst mosses on wet rocks (Hustedt, 1930).

ORDER DIATOMALES

Diatoma Bory

Frustules forming zig-zag or linear filaments, in girdle view rectangular, in valve view linear to ellipsoidal. Valve traversed by wide costae between which fine punctate striae visible; pseudoraphe in median position, very narrow or obscure.

Diatoma sp. A

Fig. 11r

Frustules rectangular in girdle view, filament formation not observed; valves linear-lanceolate, 3.5–4.0 μm . wide by 14.5–25.0 μm . long, transverse costae obvious but striae very fine.

Possibly a variety of *D. vulgare* Bory.

Habitat. Rare, recorded from one aerial site, on coastal rocks at site 108.

Distribution. Antarctica: six species of *Diatoma* were listed from fresh water by Hirano (1965) including a variety of *D. vulgare*; Deception Island, South Shetland Islands, soil of a cinder cone contained *D. anceps* (Ehrenberg) Grunow (Cameron and Benoit, 1970).

Fragilaria Lyngbye

Frustules forming usually ribbon-like filaments, connected by valve faces. Valves linear, lanceolate or ellipsoidal rarely with undulate margin, curved or tripolar; transverse striae more or less distinct, composed of punctae; pseudoraphe in median position, narrow or broadly lanceolate.

Fragilaria virescens Ralfs

Fig. 11s

Syn. *Fragilaria pectinalis* Ehrenberg
Fragilaria undata f. *constricta* Ehrenberg
Fragilaria aequalis Heiberg
Fragilaria virescens var. *producta* (Lagerstedt) De Toni
Fragilaria aequalis var. *major* Tempere et Peragallo
Diatoma virescens Hassall
Diatoma sulphurescens Agardh
Staurosira equalis Cleve et Mueller

Frustules single or in filaments; valves linear with rostrate apices, 54–100 μm . long by 7.5 μm . wide; transverse striae fine, parallel, slightly radiate towards apices, faint in central region, c. 15 per 10 μm .

No mention is made by Hustedt (1930) or Cleve-Euler (1953) of faint central striae, in their descriptions these are of equal boldness to the other striae.

Habitat. Recorded from five aerial sites (95, 96, 98, 99 and 100), all on coastal rocks irrigated with melt water; in association with *Ulothrix zonata*.

Distribution. Antarctica: in fresh water, Ross Island (West and West, 1911b), Anvers Island, Antarctic Peninsula (Parker and others, 1972); Macquarie Island, in fossil peat (Bunt, 1954). Other records: Europe, in fresh water in mountainous districts (Hustedt, 1930); Iceland, terrestrial but requiring plenty of water (Petersen, 1928); United Kingdom, amongst moss on sandstone rocks (Round, 1957).

ORDER EUNOTIALES

Eunotia Ehrenberg

Frustules single or in filaments, in girdle view rectangular, in valve view asymmetrical to the longitudinal axis with dorsal margin convex and sometimes undulate and ventral margin straight or concave, rarely convex; raphes much reduced, visible at polar nodules; valve surfaces with fine, usually indistinctly punctate, transverse striae parallel throughout most of valve.

- | | | |
|---|-----------|--|
| 1. Valves narrow, 2-3 μm . wide, dorsal margin slightly convex | | <i>E. fallax</i> |
| Valves broad, 7-9 μm . wide, dorsal margin greatly convex | | <i>E. praerupta</i>
var. <i>inflata</i> |

Eunotia fallax A. Cleve
Fig. 12a

Frustules single, in girdle view rectangular, 6 μm . wide, in valve view 2-3 μm . wide by 23-27 μm . long, ventral margin barely concave, dorsal margin slightly convex, apices capitate, transverse striae fine, c. 20 per 10 μm .

Close to *E. exigua* (Brebisson) Grunow but the valve margins are more curved in that species. Hustedt (1930) described only 12-15 striae per 10 μm . in *E. fallax* and Patrick and Reimer (1966) described slightly more, 14-18 per 10 μm . The Signy Island specimens had even more striae.

Habitat. Recorded from 15 subaerial sites. Particularly frequent amongst the wetter bryophytes (9 sites), otherwise scattered and infrequent. Absent from base-rich sites except perhaps for the soil below herbaceous vegetation at site 65.

Distribution. Antarctica: no record of this species. *E. gracilis* Wm Smith was found by Fritsch (1912b) in fresh-water samples from the South Orkney Islands. Other records: Europe, on damp rocks (Hustedt, 1930); North America, often amongst mosses in acid water of low mineral content (Patrick and Reimer, 1966).

Eunotia praerupta var. *inflata* Grunow
Fig. 12b

Frustules single, in girdle view rectangular, in valve view 13 μm . wide by 30-54 μm . long, ventral margin slightly concave, dorsal margin greatly convex, transverse striae c. 15 per 10 μm .

Slightly more striae than described by Hustedt (1930) where there were up to 12 per 10 μm .

Habitat. Rare, recorded from a wet carpet of *Calliergon sarmentosum* (site 45).

Distribution. Antarctica: Iles Kerguelen, amongst mosses (Bourrelly and Manguin, 1954); South Georgia, amongst mosses (Carlson, 1913). Other records: Europe, frequent in mountain springs, ponds and bogs (Hustedt, 1930); North America, in acid cool water associated with moss (Patrick and Reimer, 1966).

ORDER ACHNANTHALES

Achnanthes Bory

Frustules in girdle view rectangular with more or less pronounced central bend making a somewhat U- or V-shape in this view; valve possessing raphe concave and that with pseudoraphe convex; valves lanceolate, linear-lanceolate, linear-ellipsoidal or ellipsoidal; transverse striae patterns on each valve generally similar but may be markedly different, striae finely to coarsely punctate or punctae not apparent with light microscopy; raphe straight or sigmoid, central; pseudoraphe central, sub-marginal or marginal.

- | | | |
|---------------------------------|-----------|---------------------|
| 1. Pseudoraphe marginal | | 2 |
| Pseudoraphe median | | 4 |
| 2. Valve margin undulate | | <i>A. coarctata</i> |
| Valve margin straight or convex | | 3 |

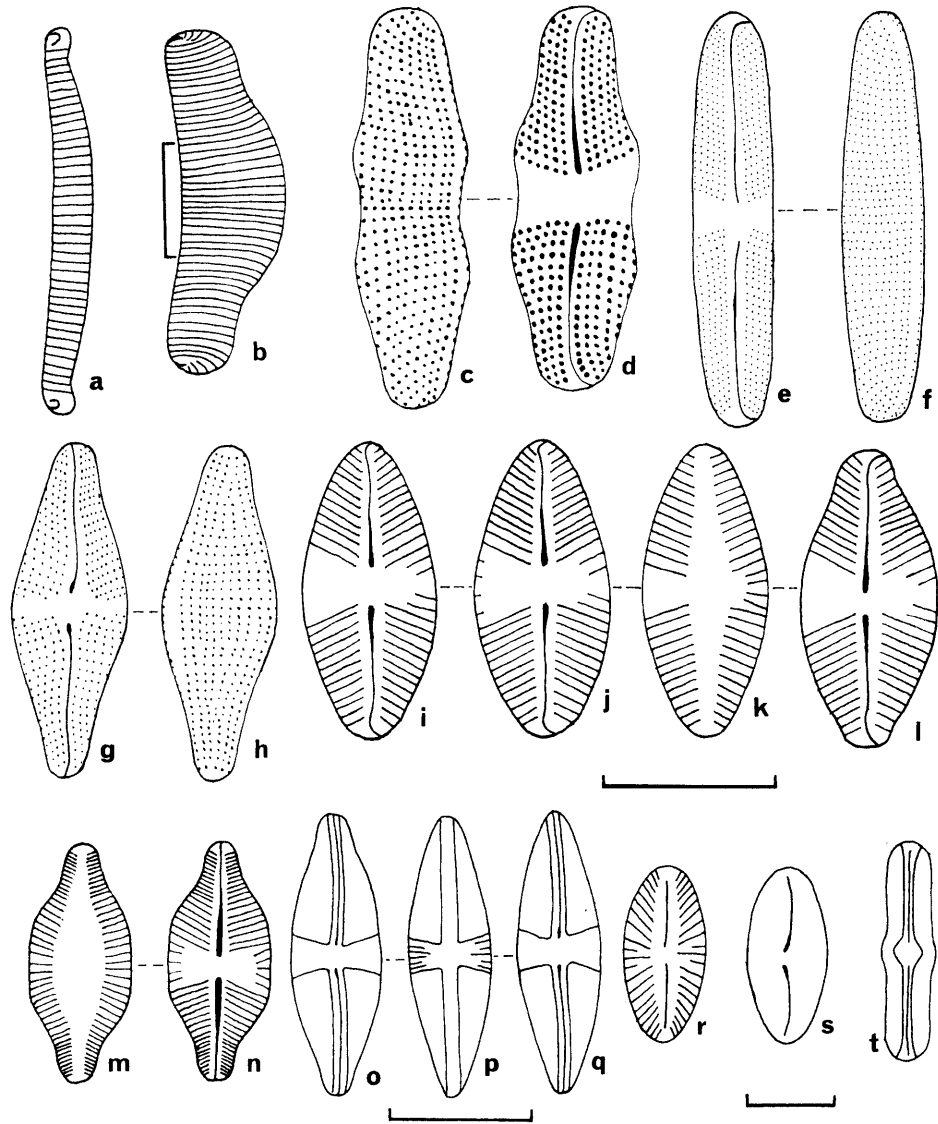


FIGURE 12

a. *Eunotia fallax* (p. 49); b. *Eunotia praerupta* var. *inflata* (p. 49); c and d. *Achnanthes coarctata* (p. 51); e and f. *Achnanthes coarctata* var. *elliptica* (p. 51); g and h. *Achnanthes coarctata* var. *rhomboides* (p. 51); i-l. *Achnanthes lapponica* var. *ninckei* (p. 51); m and n. *Achnanthes montana* (p. 52); o-q. *Achnanthes* sp. A (p. 52); r. *Navicula atomus* (p. 54); s. *Navicula permitis* (p. 55); t. *Navicula perpusilla* (p. 55).

The scales are 10 μ m. The upper scale refers to b-d, g and h; the centre scale refers to a and j-n; the lower left-hand scale refers to o-q; the lower right-hand scale refers to e, f and r-t.

- | | |
|--|---|
| 3. Valves linear-ellipsoidal with almost parallel margins | <i>A. coarctata</i>
var. <i>elliptica</i> |
| Valves ellipsoidal to almost rhomboidal with convex margins | <i>A. coarctata</i>
var. <i>rhomboides</i> |
| 4. Raphe valve with bilateral, central clear area | <i>A. sp. A</i> |
| Raphe valve with unilateral, central clear area or striae occupying central region on both sides | 5 |
| 5. Valves ellipsoidal with broadly rounded rostrate apices, raphe valve with striae in central region on both sides | <i>A. montana</i> |
| Valves ellipsoidal rarely with slightly attenuated rostrate apices, raphe valve with unilateral, central clear area, rarely this containing striae | <i>A. lapponica</i>
var. <i>ninckei</i> |

Achnanthes coarctata (Brebisson) Grunow

Fig. 12c and d

Syn. *Achnanthidium coarctatum* Brebisson

Valves linear-ellipsoidal with undulate margins, 25–29 μm . long by 7–9 μm . wide; striae radiate, c. 16 per 10 μm ., consisting of bold punctae; pseudoraphe marginal to submarginal (Fig. 12c); raphe curved; raphe valve with broad, transverse, central clear area (Fig. 12d).

Hustedt (1930) described fewer striae, 11–14 per 10 μm .

Habitat. Recorded from one mineral soil (site 11) and two moss sites (*Drepanocladus uncinatus* at site 47 and *Tortula* sp. at site 27), all of which were calcium-rich.

Distribution. Antarctica: fresh water record of *A. coarctata* var. *eliminata* f. *antarctica* Peragallo, Antarctic Peninsula (Peragallo, 1921). Other records: Iceland and Denmark, in soil and on rocks (Petersen, 1928, 1935); Austria, frequent in damp, alkaline soils (Brendemühl, 1949); North America, in soil, on rocks and amongst mosses (Patrick and Reimer, 1966).

Achnanthes coarctata var. *elliptica* Krasske

Fig. 12e and f

Valves linear-ellipsoidal with almost parallel margins, 48–53 μm . long by 10–11 μm . wide; striae radiate, c. 10 rows per 10 μm ., punctae clearly visible; pseudoraphe submarginal (Fig. 12f); raphe curved; raphe valve with broad, transverse, central clear area (Fig. 12e).

Hustedt (1930) described this variety as comprising mostly short forms; however, the Signy Island specimens have a length slightly greater than the maximum of the range for the nominate variety of the species (20–48 μm .).

Habitat. Rare, recorded amongst wet *Drepanocladus uncinatus* at site 47 in a calcium-rich area.

Distribution. Antarctica: no record. Other records: United Kingdom, in two calcium-rich soils (Fritsch and John, 1942).

Achnanthes coarctata var. *rhomboides* Tarnavschi et Jitariu

Fig. 12g and h

Frustules forming chains of cells joined by valve faces; valves ellipsoidal to almost rhomboidal with more or less attenuated, broadly rounded apices, 11–17 μm . wide by 31–52 μm . long; striae radiate, c. 14 per 10 μm ., punctae clearly visible; pseudoraphe marginal (Fig. 12h); raphe slightly sigmoid (Fig. 12g); raphe valve with narrow, transverse, central clear area.

A. coarctata var. *rhomboides* illustrated by Tarnavschi and Jitariu (1955) has a similar shape but the valves are smaller (6 μm . by 17 μm .) and there are slightly more rows of punctae, 18–19 per 10 μm .

Habitat. Recorded from four subaerial and four aerial sites. Appears to have a preference for base- and nutrient-rich sites. Sites 29, 67, 70, 105, 106 and 110 probably all received nutrients from nesting birds. The remaining two sites, 111 and 112, are calcium-rich on marbles.

Distribution. Antarctica: no record. Other records: Moldavia, U.S.S.R., amongst *Sphagnum* sp. (Tarnavschi and Jitariu, 1955).

Achnanthes lapponica var. *ninckei* (Guermeur et Manguin) Reimer

Fig. 12i–l

Syn. *Achnanthes ninckei* Guermeur et Manguin

Valves ellipsoidal, 5.0–8.5 μm . wide by 11–21 μm . long (Fig. 12i–k), apices occasionally slightly attenuated and rostrate (Fig. 12l), both valves usually with unilateral, central clear area (Fig. 12i and k), occasionally with faint, short striae occupying this area on raphe valve (Fig. 12j); striae radiate, 20–26 per 10 μm ., punctae cannot be resolved by light microscopy.

Patrick and Reimer (1966) did not describe valves with short striae occupying the central clear area.

Habitat. Recorded from five subaerial sites. Infrequent in water-flushed mosses (sites 40, 42 and 46) and in the soils below herbaceous vegetation (sites 64 and 65).

Distribution. Antarctica: no record. Other records: North America, in fresh water (Patrick and Reimer, 1966).

Achnanthes montana Krasske

Fig. 12m and n

Valves ellipsoidal with broadly rounded rostrate apices, 6–7 μm . wide by 14–18 μm . long; striae radiate, fine, becoming closer together towards valve apices; transverse, central clear area on raphe valve (Fig. 12n) with short striae along both margins; pseudoraphe valve (Fig. 12m) with large, lanceolate, axial clear area.

The Signy Island specimens are longer than those described by Hustedt (1959), in which the length range is 9–14 μm ., and the valves are more rostrate and the central striae shorter.

Habitat. Recorded from four subaerial sites (6, 53, 54 and 65).

Distribution. Antarctica: no record. Other records: Europe, amongst mosses and on damp rocks (Hustedt, 1959).

Achnanthes sp. A

Fig. 12o–q

Valves ellipsoidal (Fig. 12o and p) some with slightly attenuated apices (Fig. 12q), 4.5–6.0 μm . wide by 12–19 μm . long; raphe valve (Fig. 12o and q) with transverse, central clear area; pseudoraphe valve (Fig. 12p) with central area occupied by widely spaced, bolder striae of varying lengths; striae very fine only just resolved on occasional valves by light microscopy; raphe slightly curved.

Cannot be identified to species level using the key of Hustedt (1959).

Habitat. Recorded from two water-flushed subaerial sites, namely mineral soil from a solifluction stripe in glacial detritus (site 6) and amongst *Drepanocladus uncinatus* (site 53).

ORDER NAVICULALES

Hantzschia Grunow

Valves isopolar, slightly curved, with capitate apices and transverse punctate striae; raphe marginal, contained in groove on projecting keel, with readily visible keel punctae connecting it with interior of cell, central nodule often quite clear, raphes of both valves superimposed; frustules in girdle view rectangular, in transverse section in trans-apical plane square.

Hantzschia amphioxys (Ehrenberg) Grunow

Fig. 13a

Syn. Navicula amphioxys Westend.*Eunotia amphioxys* Ehrenberg*Nitzschia amphioxys* (Ehrenberg) W. Smith

Valves lanceolate, slightly curved, with rounded rostrate apices, 6–10 μm . wide by 44–79 μm . long, c. nine keel punctae per 10 μm .; transverse striae fine, punctate, radiate.

Habitat. Recorded from eight subaerial sites, particularly in the base-rich mineral soils without macroscopic vegetation and amongst mosses in base-rich sites (27, 47 and 49).

Distribution. Antarctica: Victoria Land, in fresh-water ponds (West and West, 1911b; Fritsch, 1912c); South Georgia, amongst mosses (Carlson, 1913); Macquarie Island, in soils (Bunt, 1954); Ongul Islands, eastern Antarctica, *H. amphioxys* f. *capitata* Mueller recorded in the terrestrial flora (Akiyama, 1968). Other records: United Kingdom, widespread, particularly in alkaline soils (Lund, 1946), amongst wet mosses (Round, 1957); Austria, especially in alkaline soils (Brendemühl, 1949) also in alpine soil (Reisigl, 1964); New Zealand, widespread in soil (Flint, 1968); many other records world-wide.

Navicula Bory

Valves linear, or lanceolate to ellipsoidal with rounded, pointed or capitate apices; simple raphe present on both valves in axial area extending for length of valve, central and polar nodules clear; transverse striae generally of distinct or indistinct punctae or rarely not resolved by light microscopy.

A genus with many species, sometimes easy to confuse with certain species of *Pinnularia* Ehrenberg.

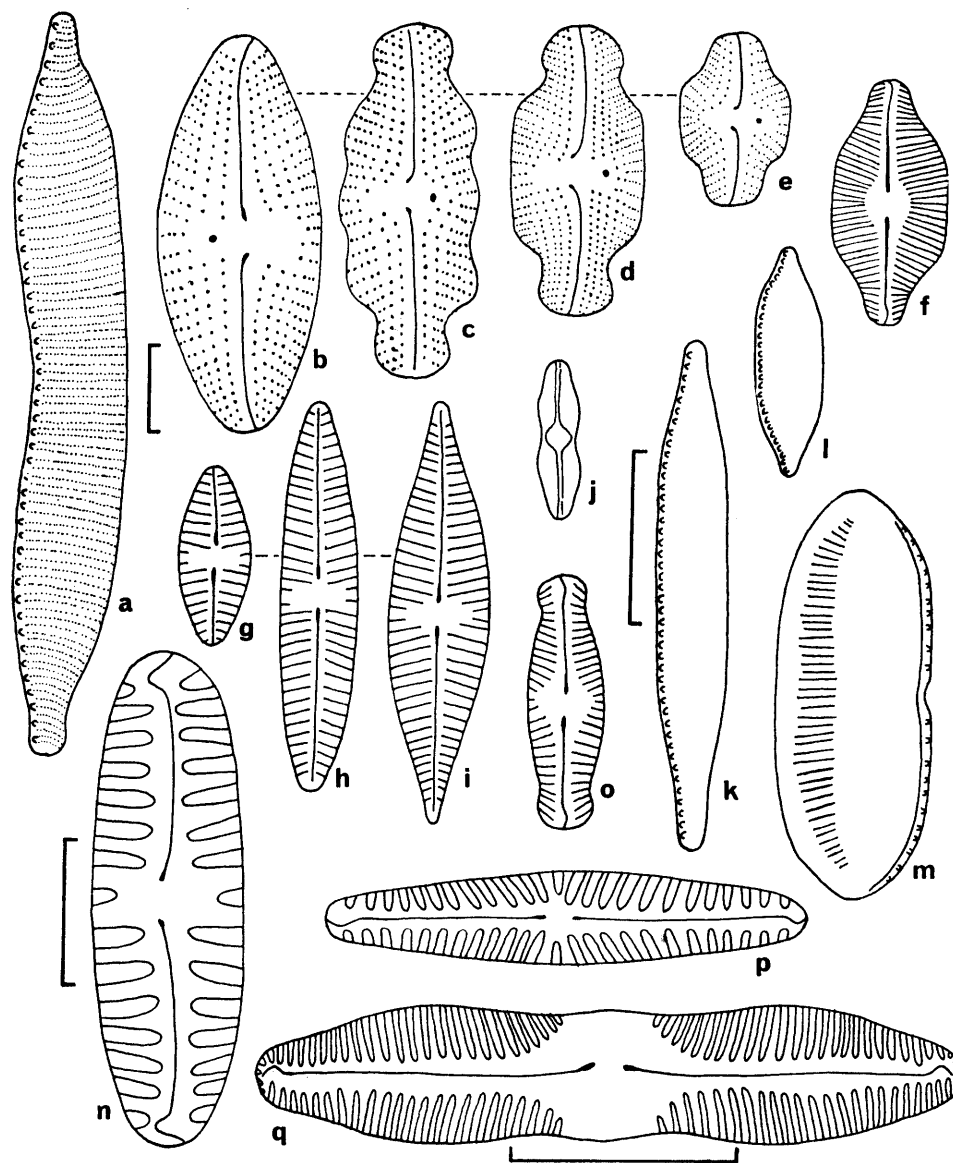


FIGURE 13

a. *Hantzschia amphioxys* (p. 52); b-e. *Navicula mutica* (p. 54); c. *Navicula mutica* var. *nivalis* (p. 54); d. *Navicula mutica* var. *ventricosa* (p. 54); f. *Navicula* sp. A (p. 55); g-i. *Navicula* sp. B (p. 55); j. (?) *Navicula* sp. C (p. 55); k. *Nitzschia palea* (p. 56); l. *Nitzschia fonticola* (p. 56); m. *Nitzschia tryblionella* var. *debilis* (p. 56); n. *Pinnularia borealis* (p. 57); o. *Pinnularia globiceps* var. *krookei* (p. 57); p. *Pinnularia lanceolata* var. *humilis* (p. 57); q. *Pinnularia mesolepta* var. *angusta* (p. 58). The scales are 10 μm . The upper scale refers to a-e; the centre scale refers to f-m and p; the lower left-hand scale refers to n and o; the lower right-hand scale refers to q.

1. Valves with striae distinctly punctate and possessing a single, large, isolated central punctum	<i>N. mutica</i>
Valves with striae not distinctly punctate or striae not resolved by light microscopy, not possessing an isolated punctum	2
2. Valves with central constriction	(?) <i>N. sp. C</i>
Valves without central constriction	3
3. Striae clearly visible	4
Striae not resolved by light microscopy	6
4. Striae 14-17 per 10 μm ., valves with large size range, 3-6 μm . wide by 10-25 μm . long	<i>N. sp. B</i>
Striae 25-30 per 10 μm ., valves without large size range, 4.5-7.0 μm . wide by 9-14 μm . long	5

- | | | |
|----|---|----------------------|
| 5. | Valves with capitate apices; clear central area ellipsoidal | <i>N. sp. A</i> |
| | Valves with broadly rounded apices; clear central area not enlarged | <i>N. atomus</i> |
| 6. | Valves with central swelling | <i>N. perpusilla</i> |
| | Valves without central swelling | <i>N. permitis</i> |

Navicula atomus (Naegeli) Grunow

Fig. 12r

Syn. Synedra atomus Naegeli
Navicula caduca Hustedt
Navicula pseudatomus Lund
Navicula spicoides Fusey

Valves small, ellipsoidal, lightly silicified, 4.5–5.5 μm . wide by 9–11 μm . long; striae radiate, *c.* 25–30 per 10 μm ., central striae irregular in length and more widely spaced; axial clear area narrowly lanceolate. *Habitat.* Recorded from five subaerial sites. Prefers base-rich mineral soils (sites 1, 2, 3 and 10) with an isolated occurrence amongst wet, fairly base-rich *Brachythecium austro-salebrosum* (site 58).

Distribution. Antarctica: no record. Other records: Europe, common in fresh water (Hustedt, 1930); United Kingdom, characteristic of chalk soils (Fritsch and John, 1942), also in wet moss (Round, 1957); Iceland, Denmark and Greenland, in alkaline organic soils and moss (Petersen, 1928, 1935).

Navicula mutica Kuetzing

Fig. 13b–e

Syn. Stauroneis Dumontii Brebisson
Stauroneis polymorpha Lagerstedt
Navicula Semen Ehrenberg
Stauroneis Semen Ehrenberg
Stauroneis Cohnii Rabenhorst

In the present study, distinctions were only occasionally made between the varieties of this species when compiling information on its distribution. The following description groups together several varieties. Valve shape varied but all possessing large unilateral punctum in central area and with radiate, distinctly punctate striae variously shortened in central area. In a sample from a moist epilithic habitat the valve shape varied from small ellipsoidal with broadly rounded rostrate apices (Fig. 13e) to large ellipsoidal with capitate apices (Fig. 13d), 6–10 μm . wide by 10–32 μm . long. A sample from a wet moss habitat had valves ranging from small ellipsoidal with broadly rounded rostrate apices to large, nearly lanceolate, with broadly rounded apices (Fig. 13b), slightly attenuated in the larger forms, 8–10 μm . wide by 15–38 μm . long. A valve with undulate margins (Fig. 13c) was present in soil under a small grass stand.

The form having valves with capitate apices (Fig. 13d) resembles *N. mutica* var. *ventricosa* (Kuetzing) Cleve, the large lanceolate form resembles the nominate variety of the species *N. mutica* var. *mutica* Kuetzing and the form having valves with undulate margins (Fig. 13c) resembles *N. mutica* var. *nivalis* (Ehrenberg) Hustedt. The valves are similar in size and shape to varieties of *N. muticopsis* Van Heurck; although the punctate striae are similar in that species, the unilateral single punctum is not always present (West and West, 1911b).

Habitat. Recorded from 21 subaerial sites and eight aerial sites. Frequent in those sites where there is evidence of nutrient input from birds or seals, namely mineral soils at sites 3, 7, 8, 9 and 13, wet mosses at sites 57 and 58, six of the soils below herbaceous vegetation and seven of the aerial sites. Absent from acid *Polytrichum alpestre*–*Chorisodontium aciphyllum* turves and exposed *Andreaea* spp. cushions.

Distribution. Antarctica: South Orkney Islands, in mud and amongst damp moss (Fritsch, 1912b); Macquarie Island, rare occurrence in soils (Bunt, 1954); listed by Hirano (1965) as a fresh water form on the continent. Other records: Denmark, widespread in soil (Petersen, 1935); United Kingdom, common in basic soils especially those with calcium (Lund, 1946); Austria, particularly in the drier alkaline soils (Brendemühl, 1949); Ireland, on aerial rocks (Schlichting, 1975). *N. mutica* var. *ventricosa* was found by Petersen (1928) on bare ground and amongst mosses in Iceland. *N. mutica* var. *nivalis* was recorded from United Kingdom soils by Fritsch and John (1942).

Navicula permitis Hustedt

Fig. 12s

Valves ellipsoidal, small, 3·5 μm . wide by 8·5–10·0 μm . long, lightly silicified; striae cannot be resolved by light microscopy; raphes slightly curved; axial clear area narrow; large, central clear area absent.

Habitat. Recorded from 13 subaerial sites. Mainly in mineral soils without macroscopic vegetation (eight sites), whilst of the remaining occurrences four were rich in calcium (sites 27, 28, 47 and 70).

Distribution. Antarctica: no record. Other records: Europe, on aerial rocks (Hustedt, 1962).

Navicula perpusilla Grunow

Fig. 12t

Syn. *Synedra perpusilla* Kuetzing*Navicula flotowii* Grunow*Navicula perpusilla* var. *flotowii* (Grunow) Peters

Valves linear with central swelling, 2·5–3·5 μm . wide by 10–13 μm . long; striae cannot be resolved by light microscopy, although occupying distinct areas of valves, central striae short leaving ellipsoidal, central clear area; raphe straight.

Hustedt (1962) illustrated this alga with fine striae. Round (1957) published an illustration almost identical to Fig. 12t.

Habitat. Rare, recorded from two base-rich mineral soils (sites 1 and 6), amongst calcium-rich *Drepanocladus uncinatus* (site 47) and water-flushed *Dicranoweisia grimmiacea* (site 25).

Distribution. Antarctica: no record. Other records: Iceland, amongst mosses (Petersen, 1928); Austria, in the drier soils studied (Brendemühl, 1949); United Kingdom, amongst mosses (Round, 1957).

Navicula sp. A

Fig. 13f

Valves linear with capitate apices, 12–14 μm . long by 6–7 μm . wide; striae readily visible, mostly radiate but becoming convergent at apices, c. 25 per 10 μm ., central striae slightly shorter leaving ellipsoidal, central clear area; raphe straight with hooked apical endings.

Cannot be identified to species level using the keys of Hustedt (1961, 1962, 1966) or Patrick and Reimer (1966).

Habitat. Rare, recorded only from a glacially derived mineral soil (site 6).

Navicula sp. B

Fig. 13g–i

Valves ellipsoidal to lanceolate (Fig. 13g and h), larger forms with cuneate apices (Fig. 13i), 3–6 μm . wide by 10–25 μm . long; striae equally spaced, 14–17 per 10 μm ., slightly radiate; axial clear area narrow; central clear area enlarged because of short central striae; raphes straight.

Similar to *N. cryptocephala* Kuetzing but in that alga the striae become convergent at the apices unlike the present alga where all the striae are radiate. Lund (1946) described *N. cryptocephala* f. *terrestris* from soils in which the apical striae are straight and parallel to only weakly convergent which resembles the present alga more closely.

Habitat. Rare, recorded from one aerial site (99).

(?) *Navicula* sp. C

Fig. 13j

Valves linear with rostrate apices, constricted slightly at centre, 2–3 μm . wide by 8–15 μm . long; striae cannot be resolved by light microscopy although areas occupied by them can be discerned; central clear area ellipsoidal; axial clear area narrow; raphes cannot be resolved.

The valves are similar in shape to those of *N. brekkaensis* f. *bigibba* Hustedt; however, striae and raphes are shown in the illustration provided by Hustedt (1962). Possibly a species of *Achnanthes* Bory; the number of raphes needs to be confirmed.

Habitat. Rare, recorded only from a glacially derived mineral soil from a solifluction stripe (site 6).

Nitzschia Hassall

Frustules solitary or in colonies, in girdle view rectangular, in transverse section in transapical plane rhomboidal; valves of many shapes, linear or ellipsoidal, straight or sigmoid with rounded or capitate apices sometimes attenuated; ornamented with costae or transverse striae, the latter being occasionally clearly punctate, striae sometimes difficult to resolve by light microscopy; raphe contained in groove on projecting keel, usually marginal, occasionally central; keel punctae readily visible.

- | | |
|--|------------------------|
| 1. Valves broad, 9·0–9·5 μm . wide, with broadly rounded to obtusely cuneate apices | <i>N. tryblionella</i> |
| | var. <i>debilis</i> |
| Valves narrow, 3–5 μm . wide, with rostrate apices | 2 |
| 2. Valves 27–30 μm . long | <i>N. palea</i> |
| Valves 11–16 μm . long | <i>N. fonticola</i> |

Nitzschia fonticola Grunow

Fig. 13l

Valves lanceolate with slightly attenuated rostrate apices, 3·5–4·5 μm . wide by 11–16 μm . long, 18 keel punctae per 10 μm ., striae not resolved by light microscopy.

There are fewer keel punctae in the description by Hustedt (1930) (12–15 per 10 μm .) and the striae are described as faint with 28–30 per 10 μm .

Habitat. Rare, recorded from one aerial site (95).

Distribution. Antarctica: no record. Other records: recorded as probably accidental as a terrestrial alga being a more typically fresh-water species in Iceland (Petersen, 1928) and the United Kingdom (Lund, 1946).

Nitzschia palea (Kuetzing) W. Smith

Fig. 13k

Valves lanceolate tapering to rostrate apices, 3–5 μm . wide by 27–30 μm . long; striae not resolved by light microscopy, 17 keel punctae per 10 μm .

Hustedt (1930) and Lund (1946) described the presence of fewer keel punctae (10–15 per 10 μm .) and the striae as faint with 35–40 per 10 μm .

Habitat. Rare, recorded in a mineral soil (site 7) and from an aerial site on coastal cliffs (site 108).

Distribution. Antarctica: Antarctic Peninsula, in fresh water (Peragallo, 1921). Other records: United Kingdom, quite a common soil form (Fritsch and John, 1942; Lund, 1946); Iceland, occasionally as an aerial species but more typical of fresh water (Petersen, 1928).

Nitzschia tryblionella var. *debilis* (Arnott) Mayer

Fig. 13m

Syn. Nitzschia debilis (Arnott) Grunow
Tryblionella debilis Arnott

Valves linear with broadly rounded to obtusely cuneate apices, 9·0–9·5 μm . wide by 23–29 μm . long; striae fine crossing only half of valve surface, *c.* 20 per 10 μm .; slight indentation in centre of keel; keel punctae *c.* 10 per 10 μm .

Habitat. Rare, recorded only in a glacially derived mineral soil from a solifluction stripe (site 6).

Distribution. Antarctica: no record. Other records: United Kingdom, in soils (Fritsch and John, 1942; Lund, 1946); Austria, in wet soils (Brendemühl, 1949).

Pinnularia Ehrenberg

Frustules solitary or rarely in ribbon-like colonies; valves usually linear or linear-lanceolate, apices broadly rounded, rostrate or capitate, margins convex, undulate or straight, large size variation within genus; raphe central, straight or twisting in various ways; axial and central clear areas usually distinct, variable in shape; remaining valve surface ornamented with distinct "costa-like" striae, these being

chambers which open to interior of valve, margins of openings appearing as two parallel lines along valve margin, obscure in small species; chromatophores, two per cell, plate-like.

- | | |
|--|---|
| 1. Valves small, less than 20 μm . long, apices capitate | <i>P. globiceps</i>
var. <i>krookei</i> |
| Valves large, 26–54 μm . long, apices broadly rounded or rostrate | 2 |
| 2. Valves with transverse central clear area | 3 |
| Valves with central area containing striae | 5 |
| 3. Valves 10–12 μm . wide, margins distinctly convex | <i>P. notata</i> var. <i>wulfii</i> |
| Valves 5–9 μm . wide, margins barely convex or triundulate | 4 |
| 4. Valve margins barely convex, striae towards centre of valve as long as other striae | <i>P. molaris</i> |
| Valve margins barely to distinctly triundulate, striae towards centre of valve shorter than other striae except for those towards apices | <i>P. mesolepta</i>
var. <i>angusta</i> |
| 5. Valves linear to linear-ellipsoidal; raphes with large apical hooks | <i>P. borealis</i> |
| Valves lanceolate-ellipsoidal; raphes with small apical hooks | <i>P. lanceolata</i>
var. <i>humilis</i> |

Pinnularia borealis Ehrenberg

Fig. 13n

Syn. *Pinnularia latestriata* Gregory

Pinnularia chilensis Bleisch

Pinnularia hebridensis Gregory

Navicula borealis (Ehrenberg) Kuetzing

Valves linear to linear-ellipsoidal with broadly rounded apices, 9–10 μm . wide by 26–60 μm . long; striae four to six per 10 μm .; raphes slightly curved with large apical hooks and obvious central pores.

The size range of the present alga is smaller than that described by Hustedt (1930) which has dimensions of 28–110 μm . long by 8–18 μm . wide.

Habitat. Recorded from 24 subaerial sites. Particularly frequent in soils below herbaceous vegetation where it occurred in eight of the nine sites, also in eight wet moss sites. Absent from *Polytrichum alpestre-Chorisodontium aciphyllum* turves.

Distribution. Antarctica: South Georgia, amongst moss (Carlson, 1913); Victoria Land, in fresh water (Fritsch, 1917); South Orkney Islands, in mud and amongst mosses (Fritsch, 1912*b*); Macquarie Island, in soils (Bunt, 1954); Iles Kerguelen, in moorland (Bourrelly and Manguin, 1954); Ongul Islands, eastern Antarctica, in the terrestrial habitat (Akiyama, 1968). Other records: Falkland Islands, amongst moss and on rocks (Carlson, 1913); Iceland, Greenland and Denmark, terrestrial, in the latter region abundant amongst mosses (Petersen, 1928, 1935); United Kingdom, frequent in soils but not in large numbers, often amongst mosses (Lund, 1946); Austria, in the drier soils studied (Brendemühl, 1949), in alpine soils (Reisigl, 1964); New Zealand, widespread in soil (Flint, 1968); Czechoslovakia, in soil (Rosa and Lhotsky, 1971); also many other world-wide records.

Pinnularia globiceps var. *krookei* (Grunow) Cleve

Fig. 13o

Valves ellipsoidal with broadly capitate apices, 4–5 μm . wide by 15–19 μm . long; striae fine, *c.* 20 per 10 μm ., towards centre of valve radiate, convergent towards apices; axial clear area narrow, central clear area small.

The size range described by Cleve-Euler (1953) is larger than that of the present alga (8.5–10.0 μm . wide by 34–38 μm . long), although the number of striae is very similar.

Habitat. Recorded from seven subaerial sites. Amongst the mosses *Drepanocladus uncinatus* (site 47), *Calliargon sarmentosum* (site 44) and *Tortula* sp. (site 27) and in four base-rich mineral soils (sites 1, 3, 7 and 10).

Distribution. Antarctica: *P. globiceps* Gregory, in fresh water from Ross Island and Victoria Land (West and West, 1911*b*; Fritsch, 1912*c*). Other records: Sweden, in fresh water (Cleve-Euler, 1953).

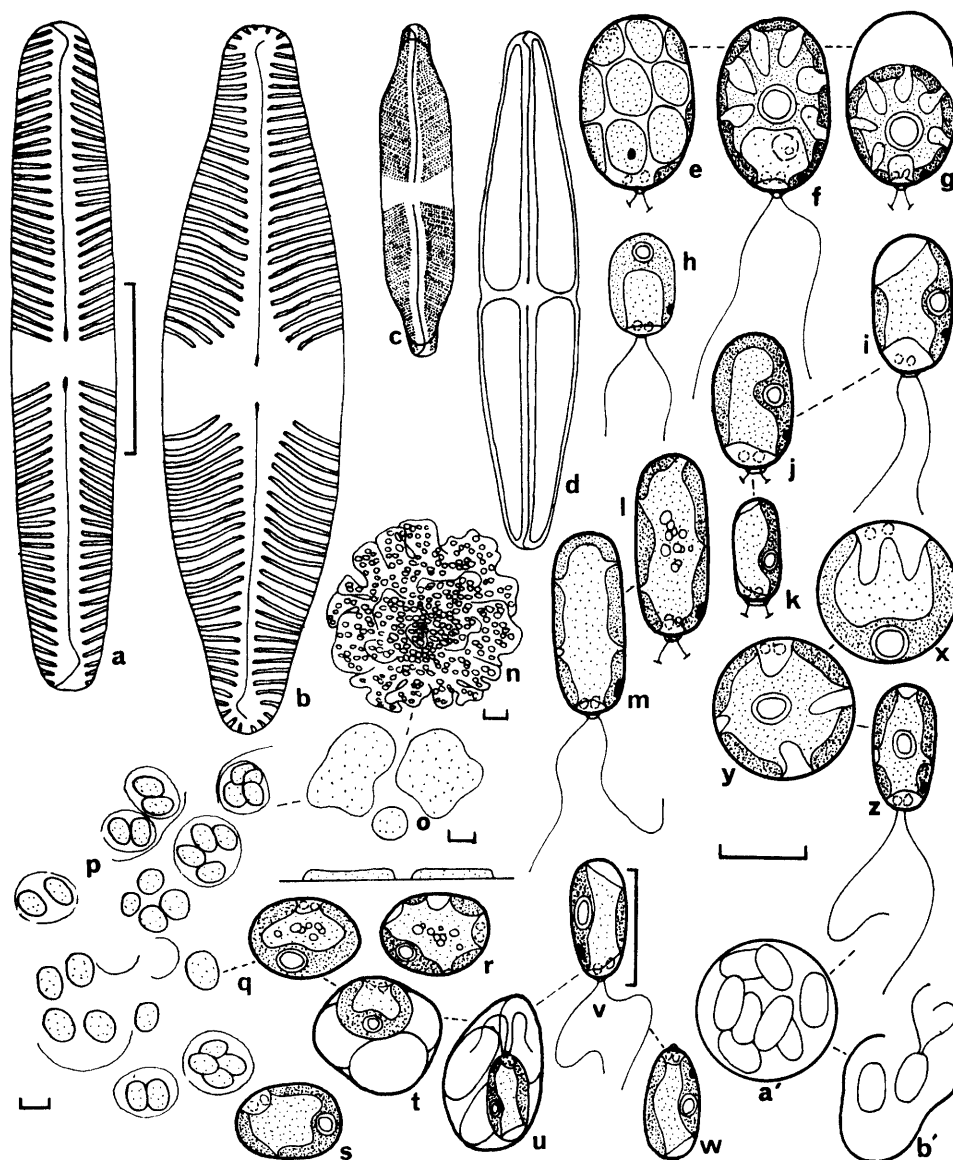


FIGURE 14

a. *Pinnularia molaris* (p. 58); b. *Pinnularia notata* var. *wulfii* (p. 58); c. *Stauroneis* cf. *lapponica* (p. 59); d. *Stauroneis* sp. A (p. 60); e-g. *Chlamydomonas chlorostellata* (p. 60); h. *Chlamydomonas* sp. A (p. 60); i-k. *Chlamydomonas* sp. B (p. 61); l and m. *Chloromonas rosae* (p. 61); n-w. *Chlamydocapsa* sp. A (p. 64); x-b'. *Hypnomonas lobata* (p. 64).
 The upper centre scale is 0.1 mm., the lower centre left-hand scale is 1 mm., and the other scales are 10 μ m. The uppermost scale refers to a, b, d and z; the upper centre scale refers to n; the lower centre left-hand scale refers to o; the lower centre right-hand scale refers to c, e-m and q-b'; the lowermost scale refers to p.

Stauroneis cf. *lapponica* Cleve
 Fig. 14c

Valves linear with broadly rounded, attenuated, rostrate apices, 41 μ m. long by 7.5 μ m. wide; raphes slightly sigmoid; striae finely punctate, strongly radiate, c. 22 per 10 μ m.; pseudosepta present, distinct.

S. lapponica has straight raphes and is slightly shorter and narrower (20-35 μ m. long by 4-7 μ m. wide); the pseudosepta are weak and often barely visible. Few specimens were observed on Signy Island.

Habitat. Recorded from one subaerial site, in soil below *Deschampsia antarctica* at site 61.

Distribution. Antarctica: seven other species of *Stauroneis* are listed in the fresh-water flora (Hirano, 1965). Other records: Europe, *S. lapponica* is reported as an aerial alga (Hustedt, 1959).

Stauroneis sp. A

Fig. 14d

Valves lanceolate-ellipsoidal with slight median constriction, 4.5–6.5 μm . wide by 17–45 μm . long; raphes straight with small terminal hooks; transverse, central clear area narrow; striae cannot be resolved by light microscopy but valve regions containing striae distinctly visible.

Cannot be identified to species level using the keys of Hustedt (1959).

Habitat. Rare, recorded from a single aerial site, on coastal rocks (site 99).

PHYLUM CHLOROPHYTA

CLASS EUCHLOROPHYCEAE

ORDER VOLVOCALES

Chlamydomonas Ehrenberg

Cells single, free-living, motile, oval, ellipsoidal, globular or fusiform sometimes with one or two apical papillae from which two equal flagella arise, in transverse section spherical or slightly ellipsoidal; chromatophore of variable form containing one to several pyrenoids; stigma present or absent; one, two or several contractile vacuoles present; zoospores and motile gametes formed; palmella stages frequent.

- | | |
|---|--------------------------|
| 1. Chromatophore stellate | <i>C. chlorostellata</i> |
| Chromatophore parietal | 2 |
| 2. Pyrenoid in basal position in cup-shaped chromatophore | <i>C. sp. A</i> |
| Pyrenoid in lateral position in variably shaped chromatophore | <i>C. sp. B</i> |

Chlamydomonas chlorostellata Flint and Ettl

Fig. 14e–g

Cells broadly ellipsoidal, 7–24 μm . by 12–30 μm ., spherical in transverse section, with small apical, hemispherical papilla from which two flagella emerge, two contractile vacuoles and single nucleus; chromatophore stellate, with arms usually reaching cell wall forming what appear in surface view to be plate-like parietal chromatophores (Fig. 14e), containing large, distinct, spherical, central pyrenoid (Fig. 14f) and orange-red stigma lying anterior to pyrenoid, in old cultures chromatophore often withdrawn from base of wall (Fig. 14g). Reproduction by zoospores, two or four being released by rupture of sporangium wall. In old agar cultures palmella stage formed in which cells lose flagella, becoming embedded in soft homogeneous mucilage.

Signy Island specimens differed slightly from the description given by Flint and Ettl (1966), the stigma in their isolate is larger, the size range of cells more restricted (11–17 μm . by 18–24 μm .), no palmella stage was described and the terminal papilla is slightly larger.

Habitat. Widely distributed in the subaerial habitat being recorded from 47 sites. Present amongst all the wet bryophytes and in all soils below herbaceous vegetation stands. Notably absent from *Polytrichum alpestre*–*Chorisodontium aciphyllum* turves.

Distribution. Antarctica: no record of this species although five other species of *Chlamydomonas* have been listed in the fresh-water flora (Hirano, 1965), unidentified terrestrial species are recorded from Victoria Land (Holm-Hansen, 1964) and the Ongul Islands, eastern Antarctica (Akiyama, 1968). Other records: New Zealand, in soil (Flint and Ettl, 1966).

Chlamydomonas sp. A

Fig. 14h

Cells ellipsoidal to almost cylindrical in longitudinal section, occasionally with slight apical papilla, 6.0–7.5 μm . by 7.5–12.0 μm ., in transverse section spherical; chromatophore large, cup-shaped, thick at posterior of cell and here containing spherical pyrenoid; stigma distinct, anterior, near to pair of contractile vacuoles; two or four zoospores formed; palmella stage not observed.

Cannot be identified to species level using the keys of Huber-Pestalozzi (1961). Close to *C. reinhardi* Dang, except in that alga the cells are larger, more spherical and four or eight zoospores are formed.

Habitat. Rare, only recorded from one subaerial site where it formed a limited, green, superficial growth on organic mud in a penguin rookery (site 13).

Chlamydomonas sp. B
Fig. 14i-k

Cells ellipsoidal to cylindrical in longitudinal section, 5–12 μm . by 10–18 μm ., spherical in transverse section, with wide flat, apical papilla and two contractile vacuoles; chromatophore parietal, varying in size from covering only half of wall on one side of cell to almost forming parietal cup, containing lateral pyrenoid; two or four zoospores formed.

Cannot be identified to species level using the keys of Huber-Pestalozzi (1961).

Habitat. Rare, recorded from one subaerial site, in a moraine soil (site 4).

Chloromonas Gobi

Description of genus as for *Chlamydomonas* Ehrenberg except that cells do not contain pyrenoid.

- | | |
|--|------------------------|
| 1. Chromatophore parietal plate of varying size | <i>C. rosae</i> |
| Chromatophore parietal, reticulate covering most of wall | <i>C. palmelloides</i> |

Chloromonas rosae Ettl
Fig. 14l and m
Syn. Chlamydomonas rosae Ettl

Cells cylindrical with broadly rounded apices, 5–10 μm . by 12–23 μm ., with wide flattened apical papilla and two flagella, as long as or slightly longer than cells, emerging near to its margins, two contractile vacuoles and single nucleus; chromatophore parietal, variously lobed with anterior stigma; yellow oil globules often present; two or four zoospores formed.

The illustration by Ettl (1970) after Peterfi closely resembles the present alga.

Habitat. Recorded from seven subaerial sites. Restricted to soils below *Deschampsia antarctica* except for one wet moss site (53) of *Drepanocladus uncinatus* which, like the grass sites, was water flushed.

Distribution. Antarctica: no record. Other records: Czechoslovakia, in soil (Ettl, 1970; Rosa and Lhotsky, 1971).

Chloromonas palmelloides Broady
Fig. 15a-g

Cells broadly ellipsoidal (Fig. 15a–d), 9.0–14.5 μm . by 6.0–9.5 μm .; chromatophore parietal, reticulate with single, red, anterior stigma and anterior opening containing two contractile vacuoles; two equal long flagella emerge on either side of hemispherical, apical papilla; nucleus central, often surrounded by many oil globules; zoospores formed, two, four, eight or rarely 16 released by rupture of sporangium wall; palmella stage formed, cells losing flagella, stigma and terminal papilla and occasionally becoming spherical (Fig. 15e and f) with holes in chromatophore becoming branched, narrow slits (Fig. 15e), mucilage soft and faintly stratified, each cell with faintly stratified mucilaginous halo distinct from remainder of mucilage.

Two similar species have been described by Ettl (1970), namely *C. brezoviensis* (Ettl) Gerloff and Ettl and *C. clathrata* Korschikov. However, they can be distinguished from the present species by their different cell size, position of the stigma, shape of the apical papilla and lack of a palmella stage. The original description of this alga was given by Broady (1977b).

Habitat. Recorded from 30 subaerial sites. Absent from the mineral soils without macroscopic vegetation but otherwise frequent and widely distributed.

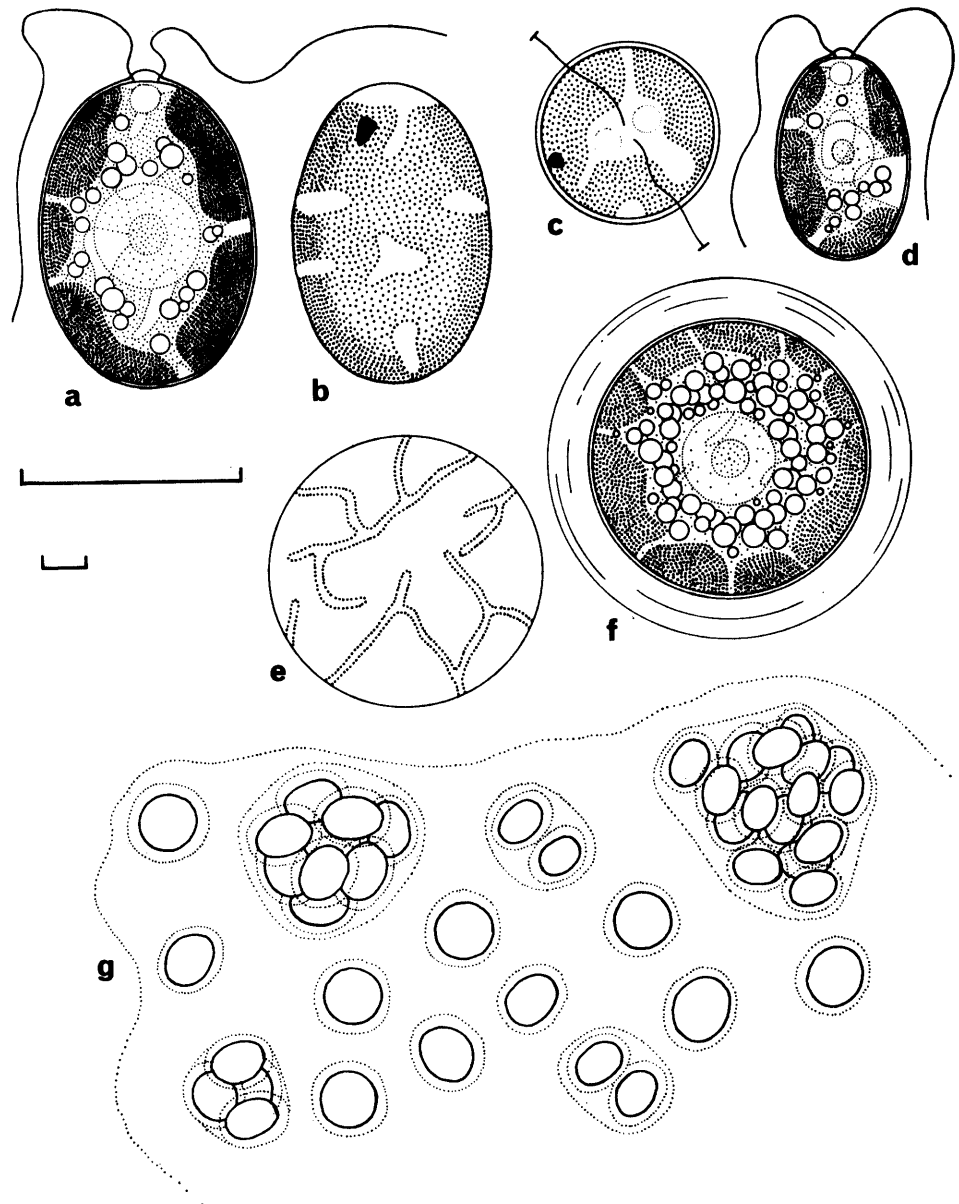


FIGURE 15

Chloromonas palmelloides (p. 61). a. Large adult cell; b. Surface view of chromatophore; c. Apical view; d. Small cell; e. Surface view of cell in palmelloid stage with channels in the chromatophore; f. Optical section through cell from palmella stage showing gelatinous halo; g. Arrangement of cells in palmella stage. The scales are 10 μm . The upper scale refers to a-f, the lower scale to g.

ORDER TETRASPORALES

Chlamydocapsa Fott

Cells chlamydomonad but without flagella and stigma absent or faint, regularly arranged usually in groups of four or eight cells, or more irregularly arranged, in stratified mucilaginous colonies.

- | | |
|--|------------------|
| 1. Cells spherical or subspherical, 7-13 μm . in diameter | <i>C. lobata</i> |
| Cells ellipsoidal, 5-11 μm . by 7.5-12.0 μm ., rarely almost spherical | <i>C. sp. A</i> |

Chlamydocapsa lobata Broady

Fig. 16a-h

Cells spherical or subspherical (Fig. 16a, b and e), 7-13 μm . in diameter, embedded in large irregularly shaped, mucilaginous colonies, in groups of two, four or eight cells or more irregularly arranged (Fig. 16f-h), faint stratifications usually present in hyaline mucilage around individual cells and cell groups, in old cultures each cell with distinct individual mucilaginous halo (Fig. 16g); chromatophore deeply lobed, parietal plate containing one or two basal pyrenoids and with anterior opening containing two persistent contractile vacuoles; nucleus central; oil droplets often present; carotenoids producing orange coloration in old cultures. Zoospores (Fig. 16c) 6.0-8.5 μm . by 3.5-4.5 μm ., ellipsoidal, equally biflagellate, walled,

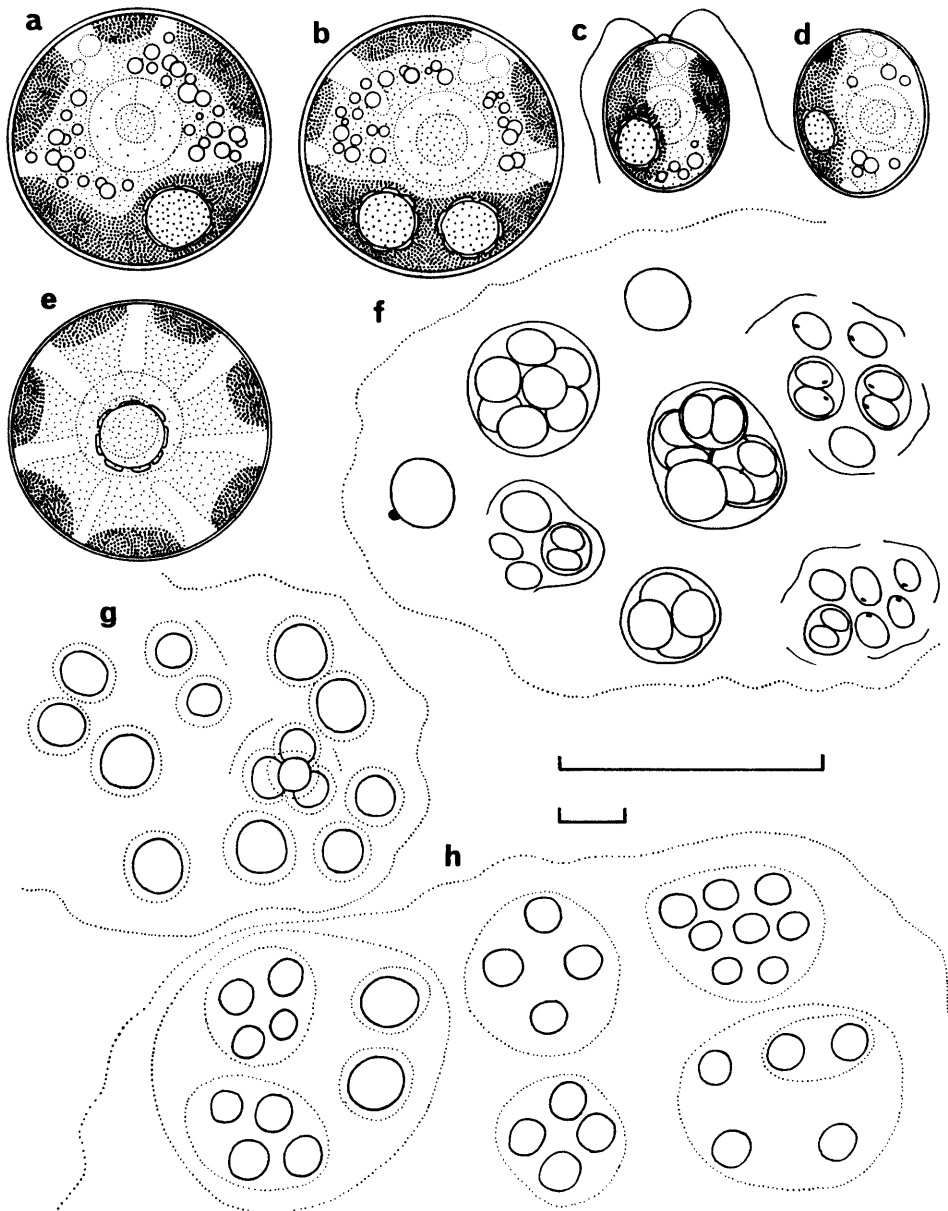


FIGURE 16

Chlamydocapsa lobata (p. 63). a and b. Adult cells; c. Zoospore; d. Autospore with stigma; e. Adult cell with markedly lobed chromatophore; f. Cell arrangement in young cultures; g. Cell arrangement in old cultures, each cell with an individual gelatinous halo; h. Cell arrangement in old culture with cells more regularly grouped.

The scales are 10 μm . The upper scale refers to a-e, the lower scale to f-h.

with single lateral pyrenoid, frequent in young cultures, forming in sporangia containing two, four, eight or 16 spores; spores formed on agar cultures remaining embedded in mucilage until addition of water, as for microscopic preparations, upon which becoming freely motile; often released with stigma but lacking flagella (Fig. 16d and f). Autospores produced in similar numbers to zoospores, frequent in old cultures (Fig. 16g and h), spores being released by partial gelatinization of sporangium wall, occasionally release delayed when spores within sporangium will themselves be dividing (Fig. 16f).

This alga is a member of the Tetrasporales as defined by Fott (1972) due to its possession of persistent contractile vacuoles in the vegetative state, and of walled zoospores produced by a non-motile, unicellular vegetative stage. Broady (1977b) discussed its relationships with similar algae.

Habitat. Recorded from 28 subaerial sites. Widely distributed but especially frequent amongst wet bryophytes (14 occurrences).

Chlamydocapsa sp. A

Fig. 14n-w

Colonies on agar light green, flat, variously lobed and softly mucilaginous (Fig. 14o), in aqueous medium colonies spherical, up to *c.* 0.5 mm. in diameter, addition of Indian ink to aqueous microscopic preparations demonstrating lobed margin of colonies (Fig. 14n); cells often in groups of two, four or eight, although occasionally losing this regular arrangement (Fig. 14p). Adult cells ellipsoidal or occasionally almost spherical, 5–11 $\mu\text{m.}$ by 7.5–12.0 $\mu\text{m.}$ (Fig. 14q-s); chromatophore parietal, cup-shaped, often broadly lobed, containing spherical pyrenoid and with anterior opening containing two persistent contractile vacuoles; oil globules often present. Zoospores ellipsoidal to oval, *c.* 9 $\mu\text{m.}$ by 4 $\mu\text{m.}$, biflagellate, walled, with anterior stigma, lateral pyrenoid and two contractile vacuoles (Fig. 14v), two, four or eight released by irregular rupture of sporangium wall (Fig. 14u), remains of which persist forming faint stratifications in mucilage (Fig. 14p), spores occasionally lacking flagella (Fig. 14w). Autospore formation also occurs (Fig. 14t), two, four or eight spores being released from ruptured sporangium.

This alga is closely related to *Chlamydocapsa lobata* Broady but differs from that species in having mostly ellipsoidal cells. Unialgal cultures of this alga did not survive transport to the United Kingdom and hence a comparison with cultures of the former species could not be made.

Habitat. Recorded from 14 subaerial sites. Mostly amongst wet mosses (seven occurrences) but otherwise a scattered distribution.

Hypnomonas Korschikov

Cells solitary, free-living, spherical or ellipsoidal; chromatophore usually single, parietal, cup-shaped with small apical opening containing two permanent contractile vacuoles, occasionally lobed. Reproduction by walled chlamydomonad zoospores with two equal flagella; sometimes these being released without flagella and stigma and resembling autospores.

Starr (1955) included *Chlorococcum*-type cells with contractile vacuoles in the genus *Chlorococcum* (Meneghini) Starr; however, in the present study Bourrelly (1966) and Fott (1972) are followed in which *Chlorococcum*-type cells with permanent contractile vacuoles are placed in *Hypnomonas* Korschikov.

Hypnomonas lobata Korschikov

Fig. 14x-b'

Syn. Chlorococcum lobatum (Korschikov) Fritsch and John

Cells solitary, free-living, spherical, 6–17 $\mu\text{m.}$ in diameter; chromatophore lobed, parietal with prominent pyrenoid or occasionally two, embedded in thick basal portion (Fig. 14x) and with anterior opening containing two contractile vacuoles. Zoospores chlamydomonad (Fig. 14z), 8.5 $\mu\text{m.}$ by 3.5–5.0 $\mu\text{m.}$, ellipsoidal, with lobed, parietal chromatophore containing lateral pyrenoid and anterior stigma, wall without apical papilla, four or eight released by rupture of sporangium wall (Fig. 14a' and b'), before zoospore formation adult cells containing four or eight chromatophores.

H. lobata illustrated by Fott (1972) had a somewhat more lobed chromatophore.

Habitat. Recorded from six subaerial sites with a scattered distribution (sites 8, 16, 49, 53, 56 and 64).

Distribution. Antarctica: no record. Other records: U.S.S.R. (Korschikov, 1953) and United Kingdom (Fritsch and John, 1942), where it has been isolated from soil.

Signiosphaera Broady

Cells solitary, free-living, spherical or occasionally ellipsoidal, containing parietal, reticulate chromatophore and several contractile vacuoles in peripheral positions. Reproduction by equally biflagellate, walled zoospores or autospores.

This genus was newly described from Signy Island by Broady (1977b) where it was compared with other genera of the family Nautococcaceae as recognized by Fott (1972).

Signiosphaera multinucleatum Broady

Fig. 17a–q

Cells solitary, free-living, spherical (Fig. 17c, d, f and g) and less frequently almost ellipsoidal (Fig. 17e and h), 10–33 μm . in diameter with thin wall in young cultures thickening in old cultures to up to 3 μm . (Fig. 17h and i); adult cells multinucleate with nuclei situated centrally (Fig. 17c and f) and often surrounded by halo of bar-shaped granules; chromatophore parietal, covering wall completely in reticulate network and with several contractile vacuoles distributed in parietal positions in holes in chromatophore, young cells containing minimum of two contractile vacuoles (Fig. 17a and b), more than 12 being present in adult cells 25 μm . in diameter, best viewed in cells from young cultures and in old cultures often ceasing to be contractile. Zoospores (Fig. 17l and m) equally biflagellate, walled, 9.5–12.0 μm . by 3.5–6.0 μm ., wider at anterior than at posterior, containing reticulate chromatophore with anterior bar-shaped stigma, two contractile vacuoles and central nucleus, released by rupture of sporangia (Fig. 17j and k) up to 63 μm . in diameter containing two, four, eight, 16, 32 or 64 spores, produced in large numbers in young cultures. Autospores (Fig. 17p and q) sub-spherical, 5–10 μm . in diameter, produced in similar numbers to zoospores (Fig. 17n and o) mostly in old cultures.

Habitat. Recorded from six subaerial sites, amongst *Andreaea* spp. (sites 14 and 15), *Drepanocladus uncinatus* (sites 48 and 56), in the soil below herbaceous vegetation (site 70) and in soil composed largely of elephant seal faeces with a cover of *Prasiola crispa* (site 61).

ORDER CHLOROCOCCALES

Bracteacoccus Tereg

Cells solitary, free-living, spherical, multinucleate; chromatophores numerous in adult cells, few in young cells, parietal, plate-like, lacking pyrenoids. Reproduction by aplanospores or zoospores, the latter being naked and with two slightly unequal flagella.

Bracteacoccus sp. A

Fig. 18a–g

Cells solitary, free-living, 4–30 μm . in diameter, with numerous, flat, parietal, plate-like chromatophores lacking pyrenoids (Fig. 18a and b) usually distinctly separated but in some cells packed close together and assuming approximately hexagonal shapes (Fig. 18c). Reproduction by zoospores or aplanospores. Zoospores (Fig. 18e) c. 6.0 μm . by 2.5 μm ., pyriform to almost fusiform, naked with single chromatophore containing anterior stigma, forming in large sporangia (Fig. 18d) containing numerous (64?) spores, sporangia rapidly swelling before bursting and liberating spores. Aplanospores (Fig. 18f and g) spherical, 3–4 μm . in diameter, with one or two chromatophores, released in large numbers by rupture of sporangium wall and tending to remain in temporary, large loose aggregates after release (Fig. 18f).

The presence of flagella of unequal length on the zoospores was not observed. The other distinguishing features of the genus *Bracteacoccus*, as summarized by Bischoff and Bold (1963), were observed; however, the Signy Island specimens could not be assigned to any of the species described there in the absence of more detailed culture studies.

Habitat. Rare, recorded from one subaerial site. In soil from a solifluction stripe (site 6).

Distribution. Antarctica: species of *Bracteacoccus* have been recorded in the terrestrial habitat in Victoria Land (Holm-Hansen, 1964) and the Ongul Islands, eastern Antarctica (Akiyama, 1968). Other records:

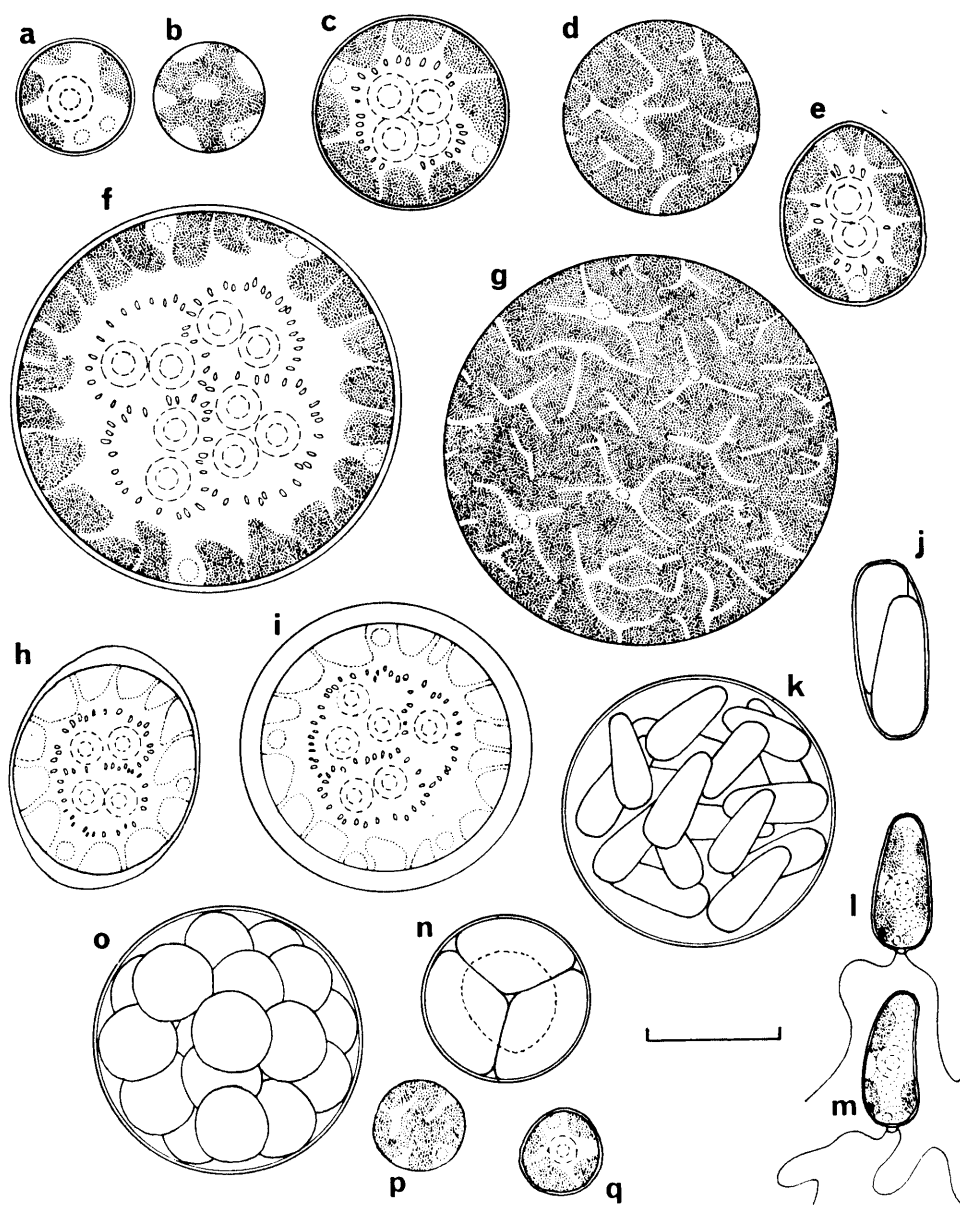


FIGURE 17

Signiosphaera multinucleatum (p. 65). a and b. Young cells in optical section and surface view; c and d. Similar views of larger cells; e. Ellipsoidal cell; f and g. Large adult cells in optical section and surface view; h. Cell from old culture with end walls thickened; i. Cell from old culture with uniformly thickened cell wall; j and k. Zoosporangia; l and m. Zoospores, reniform shape uncommon; n and o. Autosporangia; p and q. Autospores.

The scale is 10 μm .

North America, several new and previously known species are described from soil by Bischoff and Bold (1963); Austria, several species found in soil (Reisigl, 1964); also in soil from Israel (Friedmann and others, 1967) and Czechoslovakia (Desortová, 1974).

Chlorella Beijerinck

Cells solitary, free-living, spherical or ellipsoidal with distinct cell wall; chromatophore parietal cup or plate of variable extent, often with pyrenoid. Reproduction by two, four, eight or 16 autospores released by rupture of sporangium wall.

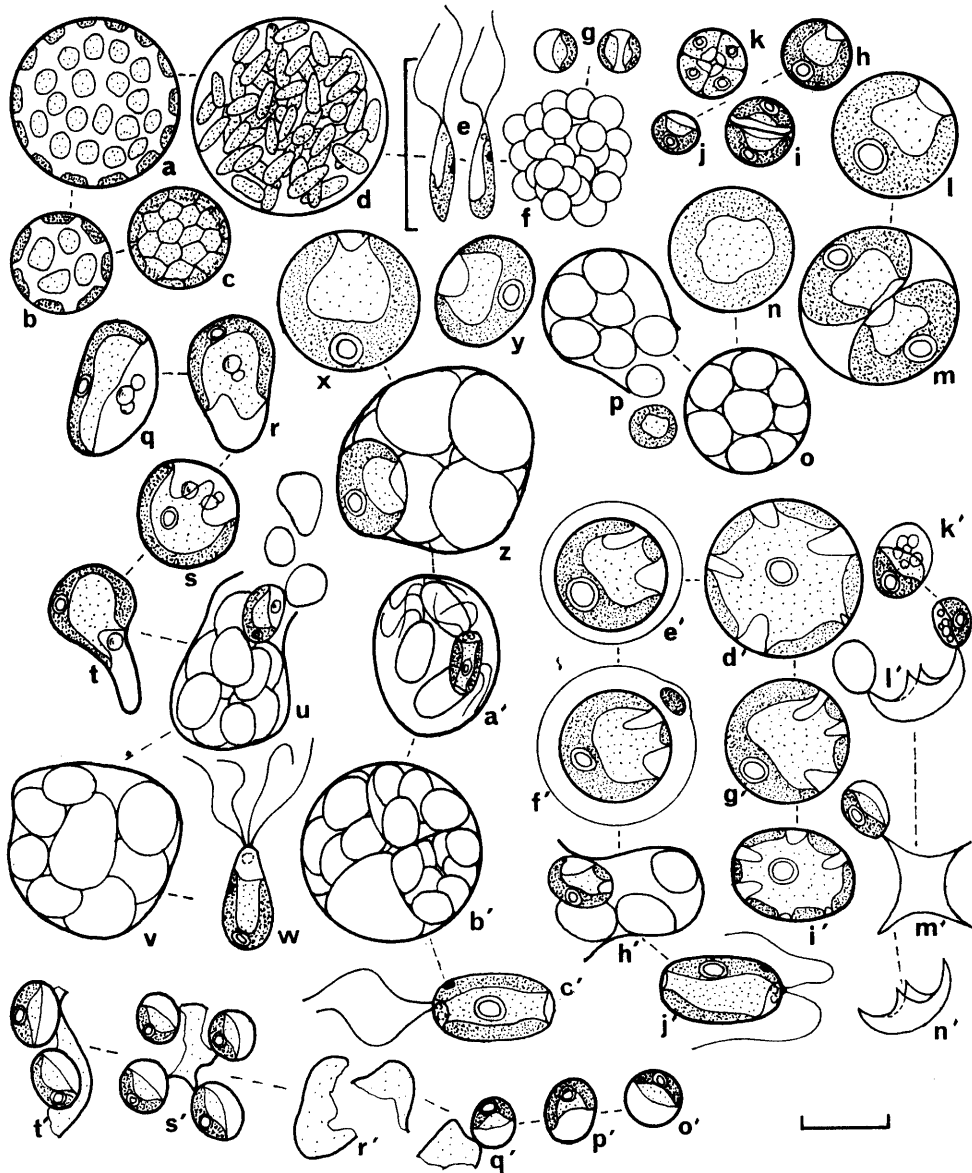


FIGURE 18

a-g. *Bracteacoccus* sp. A (p. 65); h-k. *Chlorella vulgaris* var. *autotrophica* (p. 67); l and m. *Chlorella vulgaris* var. B (p. 68); n-p. *Chlorella homosphaera* (p. 68); q-w. Unidentified genus of the family Chlorococcaceae (p. 68); x-c'. *Chlorococcum humicolum* (p. 70); d'-j'. *Chlorococcum ellipsoideum* (p. 70); k'-n'. *Dictyosphaerium minutum* (p. 72); o'-t'. Unidentified genus of the family (?) Dictyosphaeriaceae (p. 72).

The scales are 10 μm. The upper scale refers to e, w, c' and j'; the lower scale refers to a-d, f-v, x-b', d'-i and k'-t'.

- | | |
|---|--------------------------|
| 1. Chromatophore without pyrenoid | <i>C. homosphaera</i> |
| Chromatophore containing pyrenoid | 2 |
| 2. Cells 3-8 μm. in diameter | <i>C. vulgaris</i> |
| | var. <i>autotrophica</i> |
| Cells 10-21 μm. in diameter | <i>C. vulgaris</i> |
| | var. B |

Chlorella vulgaris var. *autotrophica* (Shihira et Krauss) Fott et Novakova
Fig. 18h-k

Cells solitary showing little tendency to aggregate, spherical, 3-8 μm. in diameter; chromatophore cup-shaped with prominent basal pyrenoid, two or four present immediately prior to spore formation (Fig.

18k and l). Autosporelation occurring, two or four spores being released by rupture of sporangium wall, spores tending to be ellipsoidal (Fig. 18j).

Fott (1967) provided a key for the identification of *Chlorella* species and varieties.

Habitat. Recorded from 31 subaerial sites. Present in all soils below herbaceous vegetation and frequent in mineral soils without macroscopic vegetation. Appears to have requirement for nutrient- and base-rich conditions and grows well where these are supplied by enrichment from birds or seals. Completely absent from *Polytrichum alpestre*-*Chorisodontium aciphyllum* turves, *Andreaea* spp. cushions and many of the wet bryophytes.

Distribution. Antarctica: *C. vulgaris* Beijerinck recorded from Victoria Land, a component of soil algal crusts (Cameron and Devaney, 1970); Deception Island, South Shetland Islands, in soil from cinder cones (Cameron and Benoit, 1970); Anvers Island, Antarctic Peninsula, in fresh water (Parker and others, 1972). Other records: *C. vulgaris* Beijerinck recorded in soils from; United Kingdom (Fritsch and John, 1942; Lund, 1947), tropical South America (Durrell, 1964), India (Mittra, 1951), U.S.S.R. and Czechoslovakia (Desortová, 1974) and as an aerial epilithic alga from Ireland (Schlichting, 1975).

Chlorella vulgaris Beijerinck var. B

Fig. 18l and m

Cells spherical, 10–21 μm . in diameter; chromatophore single, cup-shaped containing prominent basal pyrenoid (Fig. 18l); autospores, two or four released by rupture of sporangium wall (Fig. 18m).

This alga is similar to the previous form except for its greater diameter. The cells are larger than the maximum (10 μm . in diameter) given for *C. vulgaris* by Fott (1967) but all other features identify it as a variety of this species.

Habitat. Rare, recorded from one subaerial site, amongst *Andreaea* spp. from a damp rock crevice (site 24).

Chlorella homosphaera Skuja

Fig. 18n–p

Cells spherical, up to 18 μm . in diameter (Fig. 18n); chromatophore parietal, completely covering wall, lacking pyrenoid. Autospores up to 4 μm . in diameter, eight or 16 released by rupture of sporangium wall (Fig. 18o and p).

The limited description is based on observations on a single colony removed from a BBM agar plate. *C. homosphaera* as described by Skuja (1948) is 3–11 μm . in diameter and a small orifice usually remains in the chromatophore, this was not observed in the Signy Island specimens.

Habitat. Recorded from one wet subaerial site, amongst a carpet of *Calliergon sarmentosum* (site 42).

Distribution. Antarctica: no record. Other records: Swedish Lapland, in fresh-water lakes (Skuja, 1948).

Unidentified genus of the family Chlorococcaceae

Fig. 18q–w

Cells variously shaped (Fig. 18q–t) in culture from spherical, ellipsoidal or pyriform to occasionally bizarre shapes, 10–18 μm . in maximum dimension; chromatophore thin, parietal, more or less lobed with faint pyrenoid; oil globules often present. Reproduction by autospores or zoospores. Autosporangia (Fig. 18u and v) up to 30 μm . long containing up to 16 spores 5–12 μm . in diameter, released by irregular rupture of sporangium wall. Zoospores pyriform, walled, quadriflagellate with parietal chromatophore containing pyrenoid and anterior stigma (Fig. 18w), only observed in one colony removed from BBM agar plate culture, zoosporangia not observed.

This alga cannot be identified to the generic level using the keys of Bourrelly (1966). The two closest genera are *Rhopalocystis* Schussnig and *Fernandinella* Chodat of the family Chlorococcaceae. Both have non-spherical cells, a single chromatophore with a pyrenoid and produce zoospores. However, the zoospores of *Rhopalocystis* are biflagellate and in *Fernandinella* they are naked although similar to those of the Signy Island specimens in possessing four flagella. The latter genus also differs in the formation of compact packets of cells. A culture of this alga did not survive transport to the United Kingdom and, in the absence of further observations, it is difficult to make a critical assessment of its taxonomic position.

Habitat. Rare, only recorded from one subaerial site, in an area where *Chorisodontium aciphyllum* turves were invading a carpet of *Calliergon sarmentosum* (site 41).

Unidentified genus of the order (?) Chlorococcales

Fig. 19a-d

The following notes are from direct microscopic observation of field material since this alga was not cultured. Cells spherical (particularly young cells), ellipsoidal or pyriform, 18-45 μm . in diameter, with thin wall, embedded in stratified, firm mucilage (Fig. 19a) and occurring as thin red encrustations on moist rock surfaces, usually close to seashore. Pyriform cells in particular with marked stratifications in mucilage at narrow pole (Fig. 19c). Cells mostly irregularly arranged but some remaining in two, four or eight cell groups, each group of cells possibly being a result of release of autospores from a single sporangium.

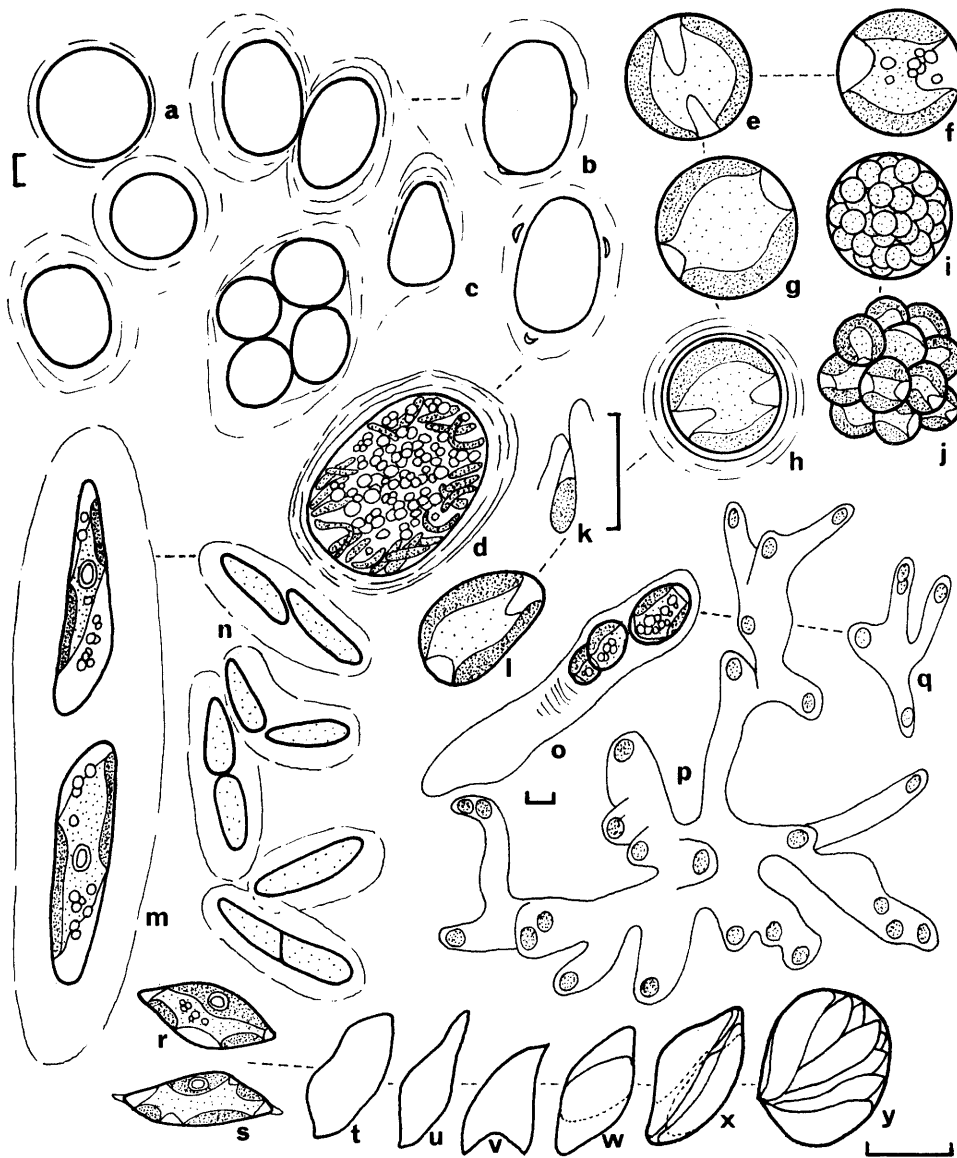


FIGURE 19

a-d. Unidentified genus of the order (?) Chlorococcales (p. 69); e-l. *Myrmecia bisecta* (p. 74); m and n. *Elakatothrix parvula* (p. 72); o-q. Unidentified genus of the family Hormotilaceae (p. 73); r-y. *Monoraphidium braunii* (p. 73). The scales are 10 μm . The uppermost scale refers to a-c; the upper centre scale refers to k; the lower centre scale refers to n, p and q; the lowermost scale refers to d-j, l, m, o and r-y.

Sporangia not observed. Cells often with one or several papilla-like wall thickenings, these becoming detached from wall and forming lunate granules in mucilage (Fig. 19b). Cells usually vivid red due to presence of large numbers of red globules masking internal cell structure and colour of chromatophore, green colour of which being seen in few cells. Chromatophores complex, apparently numerous, spindle shaped, irregularly arranged around periphery of cell, most more or less pointing inwards and some variously bent (Fig. 19d); pyrenoids not observed.

Observations on cultures of this alga are required before further conclusions can be drawn as to its identity.

Habitat. Recorded from three aerial sites, on coastal rocks (sites 98, 99 and 100) associated with *Ulothrix zonata*, *Fragilaria virescens*, and *Plectonema battersii*.

Chlorococcum Meneghini

Cells solitary or in temporary aggregations, never embedded in colonial mucilage, ellipsoidal to spherical with smooth wall sometimes thickening with age, uninucleate or multinucleate; chromatophore a parietal hollow sphere, with or without unilateral opening, with one to many pyrenoids. Asexual reproduction by autospores or zoospores; zoospores equally biflagellate, walled. Sexual reproduction by fusion of motile, biflagellate, walled gametes.

Chlorococcum (Meneghini) Starr includes cells with contractile vacuoles (Starr, 1955). In the present study, Fott (1972) is followed in placing such unicellular algae in the family Nautococcaceae.

- | | |
|--|------------------------|
| 1. Cells tending not to aggregate in loose clumps; chromatophore lobed | <i>C. ellipsoideum</i> |
| Cells forming loose aggregates; chromatophore not lobed | <i>C. humicolum</i> |

Chlorococcum ellipsoideum Deason and Bold

Fig. 18d'-j'

Cells solitary, free-living, 5-24 μm . in diameter in young cultures, reaching 30 μm . in old cultures, adult cells spherical, young cells ellipsoidal, tending not to form aggregations in aqueous microscopic preparations, with lobed, parietal chromatophore containing one, rarely two, prominent pyrenoids (Fig. 18d', g' and i'); wall smooth and thin in young cultures but up to 3 μm . thick in old cultures, occasionally each cell developing thin mucilaginous sheath (Fig. 18e') in old BBM cultures; often with large granule in mucilage (Fig. 18f'). Reproduction by zoospores or autospores. Zoospores (Fig. 18j') ellipsoidal, c. 8.5 μm . by 3.0 μm ., equally biflagellate, walled, with parietal chromatophore, lateral pyrenoid, anterior stigma and small apical papilla, formed in zoosporangia containing up to 32 spores, usually 16 or 32. Autospores ellipsoidal (Fig. 18h') produced in similar numbers to zoospores. Both spore types released by irregular rupture of sporangium wall.

C. ellipsoideum as described by Archibald and Bold (1970) has a similar size range, thickened cell walls in the stationary phase of growth (slightly thicker than the Signy Island specimens, 5-6 μm . wide) and ellipsoidal, young vegetative cells; however, no mucilaginous capsule formation was described there.

Habitat. Recorded from 15 subaerial sites. A scattered distribution, mostly in the mineral soils without macroscopic vegetation (six sites), absent from amongst *Andreaea* spp. cushions and *Polytrichum alpestre-Chorisodontium aciphyllum* turves.

Distribution. Antarctica: no record. Other records: North America, in soil (Deason and Bold, 1960).

Chlorococcum humicolum (Naegeli) Rabenhorst

Fig. 18x-c'

Cells solitary or forming loose aggregates, spherical or ellipsoidal, 6-16 μm . in diameter (Fig. 18x and y); chromatophore large, parietal, cup-shaped with thick basal portion containing distinct pyrenoid. Reproduction by formation of zoospores or autospores; autosporangia with four, eight, 16 or 32 autospores, zoosporangia with four to more than 16 zoospores, both released by rupture of sporangium wall. A zoosporangium was observed in which a primary division into four daughter cells had been made, two of these had then formed four spores each, one eight spores and one had remained as a single cell (Fig. 18b').

Zoospores ellipsoidal, walled, 7.0–8.5 μm . by 4.5 μm ., equally biflagellate with flagella *c.* 9 μm . long and two contractile vacuoles (Fig. 18c'); chromatophore parietal with pyrenoid and faint anterior stigma.

Although it is generally agreed that *C. humicolum* viewed by Nägeli was insufficiently described (Starr, 1955), the present alga is similar to a *Chlorococcum* described by Petersen (1932a) and which he "supposes to belong to *C. humicolum*" and in which the cell size, the method of zoospore and autospore production and the chromatophore are all similar to those in the Signy Island specimens. Starr (1955), in his excellent study of chlorococcalean algae, provided a key to nine species of *Chlorococcum* but the Signy Island specimens cannot be designated to any of these. He regarded *C. humicolum* (Naegeli) Rabenhorst as inadequately described from naturally occurring populations and it is probably best regarded as a form species in the present context.

Habitat. Recorded from 19 subaerial sites. Completely absent only from amongst *Andreaea* spp. cushions and *Polytrichum alpestre*–*Chorisodontium aciphyllum* turves.

Distribution. Antarctica: Deception Island, South Shetland Islands, in soil (Cameron and Benoit, 1970); Anvers Island, Antarctic Peninsula, in fresh water (Parker and others, 1972); *C. humicolum* recorded as a form species from both of the latter locations. Other records: species described as *C. humicolum* have frequently been found in soils, although the validity of the identifications is open to doubt. Many of the *Chlorococcum* species described by Starr (1955) and Archibald and Bold (1970) are soil dwelling.

Chondrosphaera Skuja

Cells spherical embedded in homogeneous or stratified mucilaginous colonies; chromatophore axial, stellate with central pyrenoid. Reproduction by autospores, two, four or eight released by rupture and gelatinization of sporangium wall.

Chondrosphaera is placed in the family Palmellaceae by Fott (1974) together with other palmelloid members of the order Chlorococcales. It is the sole genus in which the cells possess a central star-shaped chromatophore.

Chondrosphaera cf. *lapponica* Skuja

Fig. 23g'–j'

Colonies macroscopic, green, firmly mucilaginous, irregularly shaped up to *c.* 2 cm. in diameter, culture attempts unsuccessful; cells spherical, 5–12 μm . in diameter, in two or four cell groups or irregularly arranged throughout colonies (Fig. 23g'); chromatophore stellate with central pyrenoid (Fig. 23i'); numerous oil globules occasionally present (Fig. 23j'). Autospores formed, two or four liberated by irregular rupture of sporangium wall, fragments of which often persisting in mucilage as faint stratifications (Fig. 23h'), occasionally wall fragments gelatinizing and stratifications then not apparent.

The cell size, chromatophore structure and method of reproduction of *C. lapponica* are similar to the Signy Island specimens; however, it differs in the frequent possession of a tubercular projection from the wall and the mucilage is more markedly stratified.

Habitat. Recorded from two subaerial sites both amongst wet carpets of *Calliergon sarmentosum* (sites 42 and 44). It may be more widespread as microscopic colonies but these could easily have been overlooked especially as the alga did not produce any growth in culture.

Distribution. Antarctica: no record. Other records: Sweden, *C. lapponica* recorded from fresh-water plankton (Skuja, 1964).

Dictyosphaerium Naegeli

Cells spherical to ellipsoidal, oval or reniform with one or several parietal chromatophores with or without pyrenoids. Reproduction by autospores, four or rarely eight released by rupture of sporangium wall into four or eight equal portions or remaining as single cruciform structure, spores remaining loosely attached to wall fragments which are often invested in extensive mucilage forming large colonies. Zoosporulation with formation of naked, equally biflagellate zoospores observed in some species.

Dictyosphaerium minutum Boye Petersen

Fig. 18k'-n'

Cells ellipsoidal, 3-5 μm . by 4-6 μm .; chromatophore parietal with pyrenoid (Fig. 18k'); oil droplets often present; autospores formed, four released by regular rupture of sporangium wall forming cruciform shape (Fig. 18n') to points of which daughter cells often adhering (Fig. 18l' and m').

Petersen (1932a) described this alga as occurring in groups of two to 50 cells with the cell wall remains and the adhering autospores combining loosely together. Lund (1947) stated that colonies of over 200 cells may occur. Both gave illustrations identical to the Signy Island specimens except that in the latter large cell aggregates did not form; however, the culture conditions in which this alga was observed may not have been suitable for the formation of these.

Habitat. Recorded from four subaerial sites. Rarely observed in cultures of two mineral soils (sites 6 and 7), cushions of *Dicranoweisia grimmeacea* (site 25) and *Prasiola crispa* and the underlying soil (site 63).

Distribution. Antarctica: no record. Other records: in soils of Denmark (Petersen, 1932a, 1935) and the United Kingdom (Lund, 1947).

Unidentified genus of the family Dictyosphaeriaceae

Fig. 18o'-t'

Colonies very softly gelatinous, hemispherical on BBM agar cultures; cells spherical to ellipsoidal, 3.5-7.5 μm . by 6 μm . (Fig. 18o' and p'), irregularly arranged throughout colonies; chromatophore parietal, saucer-shaped with indistinct pyrenoid, the latter made more distinct by treatment with Lugol's iodine solution; autospores formed, two and occasionally four released by irregular rupture of sporangium wall (Fig. 18r') about 20 per cent of spores remaining attached to portions of wall (Fig. 18q', s' and t'), either singly, in pairs or rarely in fours, other cells not attached.

The absence of zoospores and vegetative division in unicells embedded in gelatinous colonies places this alga in the Radiococcaceae (Bourrelly, 1966). However, the adherence of cells to portions of the mother cell wall suggests affinities with the Dictyosphaeriaceae.

Habitat. Rare, recorded from only one subaerial site, mineral soil at site 5.

Elakatothrix Wille

Cells fusiform with rounded or pointed apices, rarely cylindrical, colonial, rarely solitary, embedded in homogeneous mucilage with cells being more or less arranged in lines; chromatophore parietal with one or two pyrenoids. Reproduction by transverse cell division.

Elakatothrix parvula (Archer) Hindák

Fig. 19m and n

Cells fusiform to cylindrical with bluntly rounded apices, 25-32 μm . long by 5-7 μm . wide; chromatophore parietal forming wide spiral band making 0.5 to one turn around wall (Fig. 19m) and containing lateral pyrenoid; oil globules frequently present. Cells usually in pairs, though occasionally single or in fours (Fig. 19n), in homogeneous, ellipsoidal, mucilaginous envelopes c. 40-120 μm . long by 20 μm . wide. Vegetative division occurring with formation of oblique transverse wall partitioning off two daughter cells.

The Signy Island specimens did not possess so spiraled a chromatophore as in the description by Hindák (1962) where a 0.75-2 times winding of the chromatophore in adult cells and a 0.5 to single winding in young cells was described.

Habitat. Recorded from four subaerial sites. Rarely observed in mineral soils (sites 6 and 10) and amongst carpets of *Calliargon sarmentosum* (sites 43 and 45).

Distribution. Antarctica: no record. Other records: Hindák (1962) noted that this species occurred in peat moors or bogs and amongst *Sphagnum*.

Unidentified genus of the family Hormotilaceae

Fig. 19o–q

Colonies consisting of branching, homogeneous mucilage containing ellipsoidal cells usually positioned at tips of branches, singly or in pairs (Fig. 19p and q), under phase-contrast microscopy faint transverse markings visible in mucilage (Fig. 19o). Cells $8.5\text{--}10.5\ \mu\text{m}$. by $6\ \mu\text{m}$., internal morphology not clear as alga only observed in field material and on moist enrichment cultures where detail obscured by presence in cells of numerous oil globules; chromatophore parietal. Cells in pairs at tips of some branches possibly resulting from vegetative division, spore formation not observed.

This alga can be placed in the Hormotilaceae (Bourrelly, 1966) because of its chlorococcoid cells present in dendroid colonies. It is closest in appearance to the genera *Hormotila* Borzi and *Hormotilopsis* Trainor et Bold. The only character separating these two genera is the number of flagella possessed by the zoospores, two or four, respectively. *Hormotilopsis* has young spherical vegetative cells with a stigma and contractile vacuoles (Trainor and Bold, 1953; Arce and Bold, 1958); these characters were not seen in the Signy Island specimens. The three or four species of *Hormotila* can be recognized by the cell diameter, from $25\text{--}50\ \mu\text{m}$. (Bourrelly, 1966). The Signy Island specimens had cells well below this range. The generic identity remains in doubt because of the absence of information regarding zoospore and cell morphology. Observations on cultured material are required.

Habitat. Recorded from one subaerial site and five aerial sites all of which were calcium-rich. Present amongst *Tortula fuscoviridis* growing on a marble soil (site 26) and in five of the aerial marble sites.

Monoraphidium Legnerova

Cells solitary, free-living, narrowly or broadly fusiform, occasionally cylindrical, always several times longer than wide, gradually or suddenly tapering towards apices, straight, curved or helically wound; chromatophore parietal covering whole of cell wall in young cells, withdrawn from poles and sides in older cells; pyrenoid present or absent. Reproduction by autospores, two, four, eight or 16 formed by horizontal or slightly oblique partitioning of mother cell, released by entire equatorial or parietal longitudinal rupture of sporangium wall.

This genus has the characteristics of *Ankistrodesmus* Corda as defined by Bourrelly (1966), who included forms with or without gelatinous envelopes. Legnerová (1969) introduced a new genus *Monoraphidium* for solitary forms restricting *Ankistrodesmus* to colonial forms, either with cells joined by a small portion of mucilage or with cells completely enclosed in mucilage.

Monoraphidium braunii (Naegeli in Kuetzing) Legnerova

Fig. 19r–y

Syn. *Raphidium braunii* Naegeli in Kuetzing
Ankistrodesmus braunii (Naegeli) Collins
Ankistrodesmus braunii (Naegeli) Brunnthaler
Raphidium braunii f. *major* Steinecke
Raphidium braunii f. *minor* Steinecke
Ankistrodesmus bernordensis Chodat et Oettli
Ankistrodesmus septatus Chodat et Oettli

Cells solitary, free-living, usually fusiform (Fig. 19r and s), $12\text{--}27\ \mu\text{m}$. by $6\text{--}15\ \mu\text{m}$., but also displaying other more irregular shapes (Fig. 19t–v) in culture; chromatophore parietal filling most of cell, variously lobed, with pyrenoid; apices of occasional cells with papilla-like wall thickenings; orange-red carotenoid pigments present in cells from old cultures. Reproduction by formation of two, four or eight autospores (Fig. 19w–y) released by rupture of sporangium wall.

The Signy Island specimen belongs to *Monoraphidium* because of its solitary nature. *M. braunii* as described by Legnerová (1969) has a slightly larger size range, $13\text{--}52\ \mu\text{m}$. by $1.0\text{--}7.8\ \mu\text{m}$. She noted the plasticity of *M. braunii* in culture and the cell shapes which she illustrated are similar to those seen in the present alga.

Myrmecia Printz

Cells solitary, free-living, spherical; wall thin with or without polar thickening; chromatophore parietal without pyrenoid. Reproduction by autospores or naked biflagellate zoospores.

Myrmecia bisecta Reisingl

Fig. 19e-l

Cells solitary, free-living, spherical, 5–28 μm . in diameter (Fig. 19e–g), occasional cells more irregularly shaped (Fig. 19l), chromatophore bi-lobed, occasionally tri-lobed lacking a pyrenoid; oil globules often present; walls thickening in old cultures, occasionally with stratified mucilage enveloping each cell (Fig. 19h). Autospores formed, four, eight, 16 or more released by rupture of sporangium wall (Fig. 19i and j), smallest spores 2–3 μm . in diameter produced in large numbers, largest 12 μm . in diameter produced in fours, spores tending to remain in temporary clusters after release. Zoospores, c. 9 μm . by 3 μm ., biflagellate, apparently naked (Fig. 19k), rarely formed, sporangia not observed.

Reisingl (1964) provided a detailed description of *M. bisecta*. The cell size and chromatophore structure are identical to the present alga but zoospore production was described in more detail than was seen in the Signy Island specimens.

Habitat. Recorded from 22 subaerial sites. A scattered distribution mostly amongst *Andreaea* spp. cushions, wet moss carpets and in the soils below grass stands.

Distribution. Antarctica: no record. Other records: in alpine soils from Austria (Reisingl, 1964), Czechoslovakia and U.S.S.R. (Desortová, 1974).

Ourococcus Grobety

Cells solitary, free-living, fusiform or filiform, straight or sigmoid; chromatophore parietal with or without pyrenoid. Reproduction by vegetative division with formation of oblique transverse wall, rarely by autosporeulation.

Ourococcus bicaudatus Grobety

Fig. 23a–c

Syn. Keratococcus bicaudatus (A. Braun) Boye Petersen*Dactylococcus bicaudatus* A. Braun*Keratococcus caudatus* Gistl

Cells lunate, fusiform, 10–24 μm . by 2·5–3·5 μm ., with poles extended to form spines, usually of equal length (Fig. 23a); chromatophore parietal covering about half of wall, two just prior to cell division (Fig. 23b); pyrenoid present. Vegetative division with formation of oblique transverse wall (Fig. 23c).

Autosporeulation rarely occurs in this species (Smith, 1950; Bourrelly, 1966) and it was not observed in the Signy Island specimens. Fott (1967) described a strain in which only autosporeulation was seen.

Habitat. Recorded from five subaerial sites. Four occurrences were in the soils below herbaceous vegetation (sites 64, 65, 66 and 71) and one was amongst hummocks of wet *Brachythecium austro-salebrosum* (site 58), which was nutrient enriched as were the former sites.

Distribution. Antarctica: no record. Other records: in soils of the United Kingdom (James, 1935; Fritsch and John, 1942; Lund, 1946), Denmark, Iceland and Greenland (Petersen, 1928, 1932a, 1935), India (Mitra, 1951).

Planktosphaerella Reisingl

Cells solitary, free-living, spherical with thin, smooth wall; chromatophores numerous, parietal, each with pyrenoid in adult cells, in young cells single or few in number. Reproduction by autospores.

Planktosphaerella terrestris Reisingl

Fig. 23d–g

Cells solitary, free-living, spherical, up to 14 μm . in diameter containing numerous parietal, flat, plate-like chromatophores each with pyrenoid (Fig. 23d). Autospores formed, two or four released by rupture

of sporangium wall (Fig. 23f); smallest spores $3.5 \mu\text{m}$. in diameter with single chromatophore, largest $c. 5 \mu\text{m}$. in diameter with up to four chromatophores (Fig. 23e and g).

Reisigl (1964) described the production of two to 32 autospores, a larger number than seen in the Signy Island specimens.

Habitat. Rare, recorded from only two subaerial sites, both mineral soils (sites 5 and 6).

Distribution. Antarctica: no record. Other records: Austria, in alpine soil (Reisigl, 1964).

Pseudochlorella (Lund) Reisigl

Cells solitary, free-living, or in groups of four in communal mucilage, ellipsoidal to sub-spherical; chromatophore parietal, plate-like, band-like or cup-shaped with pyrenoid, often with lobed margin. Reproduction by autospores.

Pseudochlorella subsphaerica Reisigl

Fig. 23h-m

Cells solitary, free-living, ellipsoidal, sub-spherical to oval, or occasionally reniform (Fig. 23h-j), $3.5-7.5 \mu\text{m}$. by $6.0-9.5 \mu\text{m}$.; chromatophore parietal with single pyrenoid; oil globules often present. Autospores formed, four or eight released by irregular rupture of sporangium wall (Fig. 23k-m).

Reisigl (1964) noted the production of only eight autospores.

Habitat. Rare, recorded from one subaerial site, in mineral soil at site 7.

Distribution. Antarctica: no record. Other records: Austria, in an alpine moraine soil (Reisigl, 1964).

Rhopalocystis Schussnig

Cells solitary, free-living, pyriform; chromatophore parietal, extensive, with one or two lateral pyrenoids; nucleus central. Reproduction by autospores or zoospores, not all of mother cell participating in spore production, portion remaining in base of sporangium after spore release.

Rhopalocystis oleifera Schussnig

Fig. 23n-v

Cells approximately pyriform with one apex usually broadly rounded and other often narrowly rounded to almost pointed (Fig. 23n and o), $8.5-25.0 \mu\text{m}$. by $4-12 \mu\text{m}$., usually solitary, free-living, occasionally forming small groups in which cells loosely adhering by narrow apices (Fig. 23s); chromatophore parietal covering large portion of wall, often not quite reaching to narrow apex; pyrenoid prominent, rarely two. Autospores (Fig. 23t) and zoospores (Fig. 23u and v) formed. 16 or 32 (?) zoospores produced but not all of mother cell participating in spore formation, portion always remaining in base of cell after spore release, this then re-growing and gradually refilling empty portion of sporangium (Fig. 23p-r). Zoospores released through approximately circular apical rupture, immediately after release remaining temporarily in soft tenuous mucilage at opening of ruptured sporangium. Zoospores, $c. 6 \mu\text{m}$. by $3 \mu\text{m}$., naked, equally biflagellate, with parietal chromatophore, stigma and two contractile vacuoles. Autosporangia containing seven spores and portion of mother cell remaining at base after spore release through circular apical rupture.

Two species of *Rhopalocystis* have been described, namely *R. oleifera* Schussnig and *R. cucumis* Reisigl. The cell morphology and size of the present alga are similar to the descriptions of the former species by Schussnig (1955) and Täumer (1959). Schussnig illustrated a sporangium wall with a remaining portion of the mother cell at its base unlike Reisigl (1964) where the sporangia of *R. cucumis* are completely emptied on release of the spores. The cells of *R. cucumis* are also unlike the present alga in shape, both poles usually being broadly rounded.

Habitat. Recorded from 19 subaerial sites. Frequent amongst the wet moss carpets (ten occurrences) but absent from the drier *Polytrichum alpestre*-*Chorisodontium aciphyllum* turves and exposed moss-cushion fellfield. Also in mineral soils (sites 1, 2, 4, 5 and 7) and soils under herbaceous vegetation (sites 64, 65 and 69), intolerant of areas grossly contaminated by birds or seals.

Distribution. Antarctica: no record. Other records: East Germany, in fresh-water ponds (Schussnig, 1955).

Scotiella Fritsch

Cells solitary, free-living, ellipsoidal, with wall thickenings forming "wing-like" extensions; chromatophore single, central or parietal with portion crossing cell, containing pyrenoid, or numerous parietal discs, each with pyrenoid. Reproduction by autospores.

Scotiella antarctica Fritsch

Fig. 23y

Cells large, ellipsoidal, c. 60 μm . by 45 μm . with "wing-like" wall extensions; chromatophores not clearly observed due to presence of many oil globules. Reproduction not observed.

Described and illustrated by Fritsch (1912b).

Habitat. Recorded from six subaerial sites, but few cells observed and in these sites probably initially derived from melting of red or yellow snow.

Distribution. Antarctica: South Orkney Islands, common in red and yellow snow samples (Fritsch, 1912b; Fogg, 1967); Anvers Island, Antarctic Peninsula, in fresh water (Parker and others, 1972); the Antarctic distribution was mapped by Koob (1967). Other records: only known from Antarctica.

Sphaerocystis Chodat

Cells spherical to broadly ellipsoidal with smooth, thin wall and single chromatophore containing one to four pyrenoids, embedded in groups of four or eight or more irregularly arranged throughout spherical, ellipsoidal or irregular, homogeneous or faintly stratified mucilaginous colonies. Reproduction by autospores, four, eight, 16 or occasionally larger numbers released by fragmentation or gelatinization of sporangium wall.

Fott (1974) is followed in including this genus in a new family, the Palmogloeaceae, which includes genera of coccoid cells embedded in mucilaginous colonies. Three new species have been described from Signy Island (Broady, 1976).

1. Cells broadly ellipsoidal to sub-spherical; autospores narrowly ellipsoidal to almost cylindrical .
S. oleifera

Cells spherical, occasionally broadly ellipsoidal; autospores broadly spherical to broadly ellipsoidal 2
2. Chromatophore usually bilobed; cells up to 8.5 μm . in diameter *S. bilobata*
 Chromatophore irregularly lobed; cells up to 15 μm . in diameter *S. signiensis*

Sphaerocystis bilobata Broady

Fig. 20a-l

Cells spherical or slightly ellipsoidal, up to 8.5 μm . in diameter, usually 6 μm ., distributed throughout multicellular, irregular, mucilaginous, dark green colonies, in four or eight cell groups (Fig. 20a); mucilage boundary of each cell group often made visible by superficial covering of bacteria and debris. Cells with usually bilobed (Fig. 20b and c), occasionally trilobed (Fig. 20d), parietal chromatophore covering most of wall and containing indistinct pyrenoid between lobes (Fig. 20b and c); oil globules often present (Fig. 20e); nucleus between chromatophore lobes (Fig. 20f). Autospores slightly ellipsoidal (Fig. 20i), 3 μm . by 3.5 μm ., four or eight released, usually by gelatinization of sporangium wall (Fig. 20k) or by its irregular rupture (Fig. 20l) with wall fragments remaining visible around each group of young cells.

The classification scheme for the palmelloid forms of the Chlorococcales suggested by Fott (1974) was used in the determination of the present alga. Its relationships with similar algae, including the following two new species of the same genus from Signy Island, have been discussed by Broady (1976).

Habitat. Recorded from one subaerial site, amongst the wet moss carpets of Signy Island terrestrial reference site 2 (Tilbrook, 1973) (site 42), which consists predominantly of *Calliergon sarmentosum*.

Distribution. Antarctica: the related species *Sphaerocystis schroeteri* Chodat was found by Fritsch (1912b) in yellow snow from the South Orkney Islands, and from fresh water from Anvers Island, Antarctic

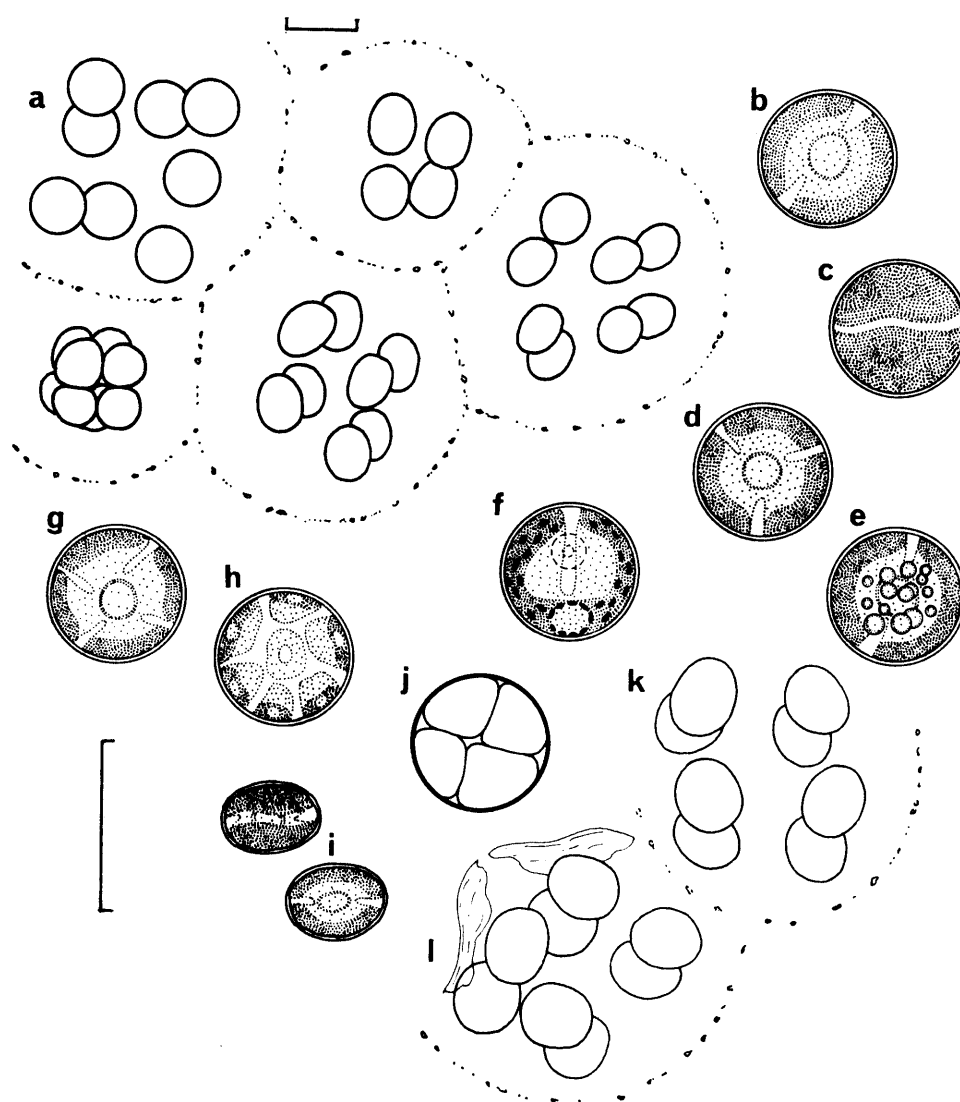


FIGURE 20

Sphaerocystis bilobata (p. 76). a. Cell arrangement in mucilaginous colonies; b. Adult cell with bi-lobed chromatophore; c. Surface view showing narrow gap between the two lobes; d. Tri-lobed chromatophore; e. Oil globules in adult cell; f. Cell stained in Lugol's iodine solution showing starch grains distributed throughout the chromatophore; g, h and j. Autospore formation; i. Autospores; k. Release of spores by gelatinization of cell wall; l. Release of spores by rupture of cell wall. The scales are 10 μm . The upper scale refers to a, the lower scale to b-l.

Peninsula, by Parker and others (1972). Other records: *Sphaerocystis* spp. described by Fott (1974) are mostly planktonic.

Sphaerocystis oleifera Broady

Fig. 21a-j

Cells broadly ellipsoidal to sub-spherical (Fig. 21f-h) up to 11 μm . in diameter, distributed throughout multicellular, irregular, softly mucilaginous, light green colonies in groups of two, four, eight or 16 cells (Fig. 21a), large adult cells occasionally irregularly distributed; occasionally faint, concentric stratifications present in mucilage around cell groups (Fig. 21j). Adult cells with thin, smooth wall, becoming slightly uniformly thicker, up to 1.5 μm . in old cultures; nucleus single; chromatophore green, parietal, broadly lobed with faint pyrenoid. Autospores narrowly ellipsoidal to almost cylindrical (Fig. 21b-e), 7-9 μm . by 3-4 μm ., four or eight, or infrequently two or 16, released by irregular rupture of sporangium wall, fragments of which remaining visible or gelatinizing; chromatophore parietal, variably lobed. Oil globules usually present in both adult cells and autospores (Fig. 21e and g-i).

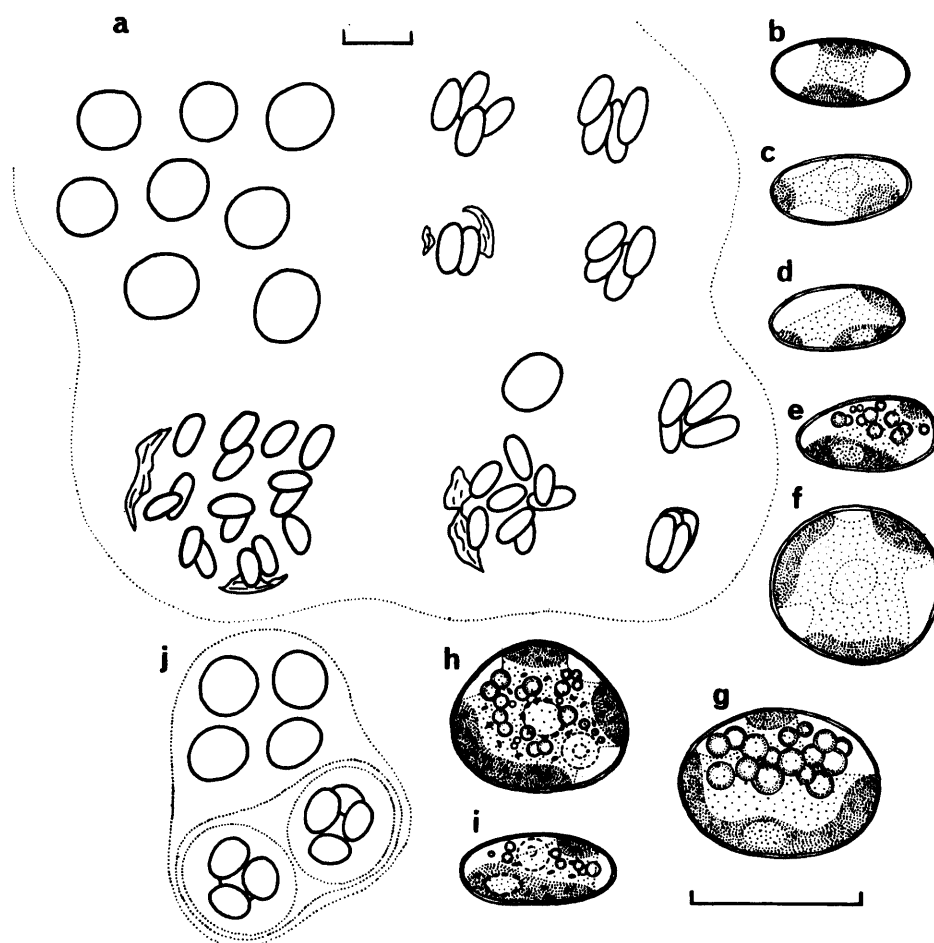


FIGURE 21

Sphaerocystis oleifera (p. 77). a. Cell arrangement in mucilaginous colonies; b-e. Young autospores each with a variously lobed chromatophore; f and g. Adult cells; h and i. Cells stained with Lugol's iodine solution showing starch grains distributed throughout the chromatophores; j. Faint stratifications in the mucilage around the cells.

The scales are 10 μm . The upper scale refers to a and j, the lower scale to b-i.

Habitat. Recorded from 25 subaerial sites. Particularly frequent amongst *Polytrichum alpestre*-*Chorisodontium aciphyllum* turves (nine sites), also amongst wet moss carpets, *Andreaea* spp. cushions and in mineral soils without macroscopic vegetation. Intolerant of nutrient-rich soils below herbaceous vegetation and only in one site which was grossly contaminated by birds or seals namely an eroded *P. alpestre*-*C. aciphyllum* turf (site 39). A major constituent of the algal flora of Signy Island terrestrial reference site (SIRS) 1 (Broady, 1977a).

Sphaerocystis signiensis Broady

Fig. 22a-k

Cells spherical, or rarely broadly ellipsoidal, up to 15 μm . in diameter, distributed throughout multicellular, irregular, softly mucilaginous, dark green colonies occasionally faintly stratified (Fig. 22k), in two, four or rarely eight cell groups, or irregularly arranged (Fig. 22a); chromatophore parietal, usually lobed, containing distinct basal pyrenoid (Fig. 22b-g), two or four chromatophores present prior to spore formation (Fig. 22i and j); nucleus single; oil globules often present. Autospores, spherical or ellipsoidal, 4.5-7.0 μm . in diameter, two, four, or occasionally eight released by irregular rupture of sporangium wall, fragments of which often remaining visible or gelatinizing.

Habitat. Recorded from 21 subaerial sites, predominantly amongst mosses (20 occurrences), especially moss-cushion fellfield, the remaining site (63) consisting of *Prasiola crispa* and the underlying soil from wet flushes.

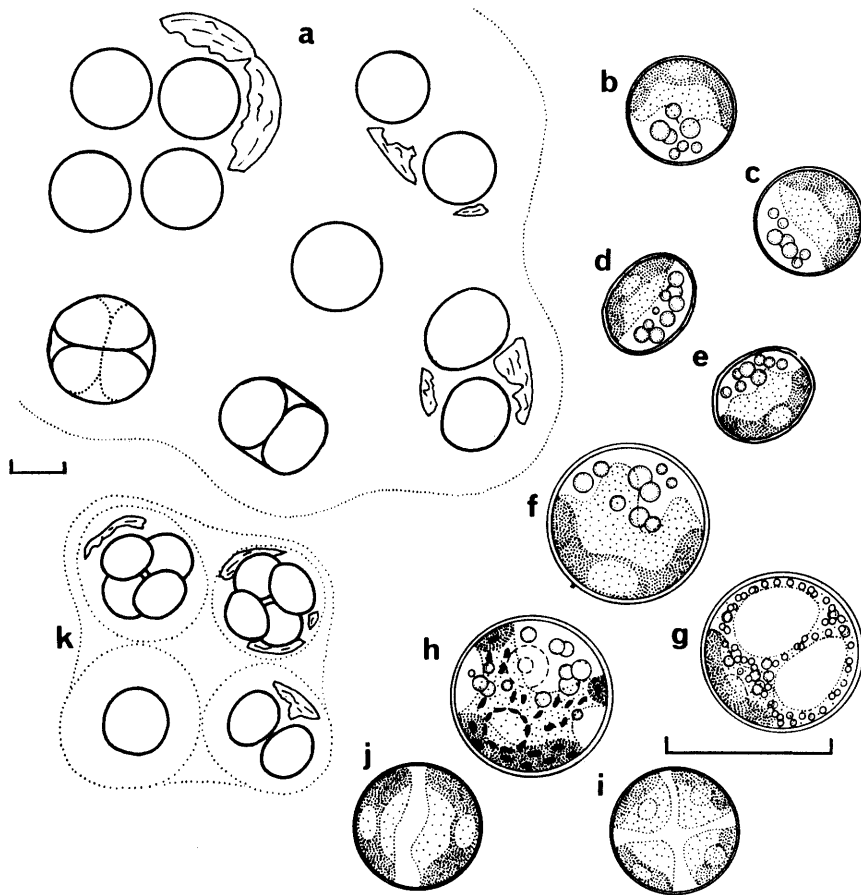


FIGURE 22

Sphaerocystis signiensis (p. 78). a. Distribution of cells in mucilaginous colonies; b-e. Young cells and autospores immediately after release; f and g. Large spherical adult cells; h. Cell stained with Lugol's iodine solution showing general distribution of starch grains throughout chromatophore; i and j. Cells immediately prior to autospore formation; k. Portion of colony with faint stratifications in the mucilage.

The scales are 10 μm . The upper scale refers to a and k, the lower scale to b-j.

Trebouxia Puymaly

Cells solitary, free-living or usually as phycobiont in lichens; chromatophore large, axial, stellate containing central or slightly lateral pyrenoid; nucleus in lateral position. Reproduction by autospores or naked, equally biflagellate zoospores.

(?) *Trebouxia* sp. A

Fig. 23w and x

Cells mostly spherical (Fig. 23w), 8-26 μm . in diameter occasionally with slightly thickened wall about 2.5 μm . wide, with multi-radiate, stellate chromatophore containing central pyrenoid. Some smaller ellipsoidal cells (Fig. 23x), 12 μm . by 8 μm . observed, possibly developing zoospores, sporangia not observed, nor any motile zoospores.

Habitat. Recorded from three subaerial sites. Only a single colony of this alga was observed in culture and it was rarely seen in microscopic examination of field material. It was cultured from amongst a cushion of *Andreaea* sp. sampled from a damp rock crevice (site 16) and was also seen in microscopic observation of soil from below herbaceous vegetation stands (sites 68 and 69). On Signy Island, *Trebouxia* is a common phycobiont in the lichen symbiosis. It is possible that the occasionally observed free-living specimens of this alga were algae dissociated from such symbioses. It is apparent that it is not a successful free-living alga on Signy Island.

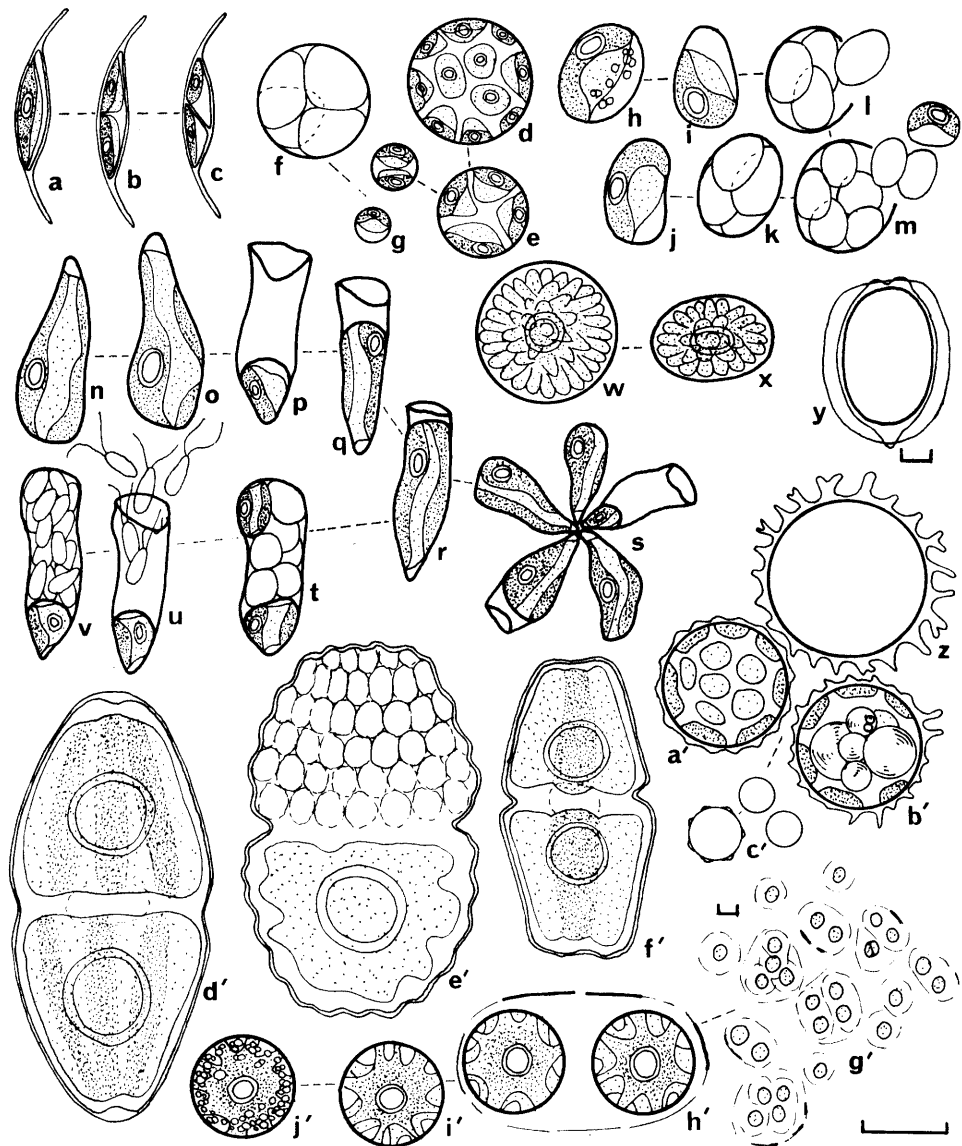


FIGURE 23

a-c. *Ourococcus bicaudatus* (p. 74); d-g. *Planktosphaerella terrestris* (p. 74); h-m. *Pseudochlorella subsphaerica* (p. 75); n-v. *Rhopalocystis oleifera* (p. 75); w and x. (?) *Trebouxia* sp. A (p. 79); y. *Scotiella antarctica* (p. 76); z-c'. *Trochiscia* sp. A (p. 81); d'. *Cosmarium curtum* (p. 93); e'. *Cosmarium notabile* (p. 93); f'. *Cosmarium parvulum* (p. 93); g'-j'. *Chondrosphaera* cf. *lapponica* (p. 71).

The scales are 10 μ m. The upper scale refers to y; the centre scale refers to g'; the lower scale refers to a-x, z-f' and h'-j'.

Distribution. Antarctica: Anvers Island, Antarctic Peninsula, in fresh water (Parker and others, 1972). Other records: Iceland and Denmark, *T. arboricola* Puymaly rarely found in the free-living state but common as gonidia in lichens (Petersen, 1928, 1932a); United Kingdom, *T. arboricola* recorded from two heathland soils (Fritsch and John, 1942).

Trochiscia Kuetzing

Cells solitary, free-living, spherical; wall ornamented with short protuberances; chromatophore star-shaped, lobed with central or lateral pyrenoids or parietal plates each with pyrenoid or structure difficult to discern; oil globules often packing cells. Reproduction by autospores or aplanospores.

This genus contains many doubtful species which may have been misidentified zygospores of desmids or of members of the family Chlamydomonadaceae.

Trochiscia sp. A
Fig. 23z-c'

Cells solitary, free-living, spherical, up to 30 μm . in diameter with variously sculptured wall (Fig. 23z-b'), smaller cells having wall covered with short protuberances (Fig. 23a'), larger cells having longer spines sometimes of unequal lengths (Fig. 23z), occasionally with bifurcated ends; oil globules often present; chromatophore structure often obscured but occasional cells observed with parietal plate-like chromatophores apparently lacking pyrenoids; smallest cells spherical, only 3 μm . in diameter (Fig. 23c') possibly aplanospores.

In the absence of observations on unialgal cultures the species remains undetermined.

Habitat. Recorded from 22 subaerial sites. Frequent amongst wet moss carpets (ten sites) and in soils below herbaceous vegetation (seven sites).

Distribution. Antarctica: South Orkney Islands, four species of *Trochiscia* in fresh water and snow samples (Fritsch, 1912b); Anvers Island, Antarctic Peninsula, several species in fresh water (Parker and others, 1972). Other records: spherical, green unicells with sculptured walls are often found in soils but it is doubtful whether many of these are true *Trochiscia* spp. but are stages in the life cycles of other algae.

CLASS ULOTHRICOPHYCEAE

ORDER ULOTHRICALES

Chlorhormidium Fott

Filaments free-living, unbranched, uniseriate, often readily fragmenting, without mucilaginous sheaths. Cells cylindrical, uninucleate, with single parietal chromatophore covering one-half or more of wall, pyrenoid present. Reproduction by biflagellate zoospores; aplanospores and akinetes also observed.

The nomenclature of Bourrelly (1966) is accepted in the use of the generic name *Chlorhormidium* Fott in preference to the more usual *Hormidium* (Kuetzing) Klebs which is synonymous with a previously described species of orchid.

- | | |
|---|----------------------------|
| 1. Filaments long, multicellular, 8.5-9.0 μm . wide | <i>C. flaccidum</i> |
| Filaments readily fragmenting, up to 15 cells long, or cells single, 4.5-6.0 μm . wide | 2 |
| 2. Filaments up to 15 cells long, 4.5 μm . wide | <i>C. dissectum</i> var. A |
| Filaments of two temporarily joined cells, 6 μm . wide | <i>C. dissectum</i> var. B |

Chlorhormidium dissectum (Chodat) Fott var. A

Fig. 26b and c

Syn. Hormidium dissectum (Gay) Chodat
Stichococcus dissectus Gay

Filaments up to 15 cells in length (Fig. 26b), readily fragmenting into shorter lengths and single cells (Fig. 26c) on BBM agar cultures. Cells 4.5 μm . wide by 7-15 μm . long; chromatophore parietal covering slightly more than half of wall and containing prominent pyrenoid.

Printz (1964) described this alga as having filaments 7-9 μm . wide. The Antarctic material is a small variety.

Habitat. Rare, recorded from one subaerial site, quartz-mica-schist-derived mineral soil at site 5.

Distribution. Antarctica: no record. Other records: Denmark, an aerial alga (Petersen, 1932a); Czechoslovakia, in soil (Rosa and Lhotsky, 1971).

Chlorhormidium dissectum (Chodat) Fott var. B

Fig. 26a

Filaments much reduced on BBM agar culture to pairs of temporarily joined cells. Cells 6 μm . wide by 7-15 μm . long; chromatophore parietal covering more than half of wall and with distinct pyrenoid.

This alga differs from the previous isolate by the slightly wider cells and the lack of filaments longer than two cells. It is slightly narrower than *Hormidium dissectum* described by Printz (1964). It is twice as wide as

H. pseudostichococcus Heering in which the ease of fragmentation is similar to the present alga. The pyrenoid is not prominent in that alga.

Habitat. Rare, recorded from one subaerial site, in mineral soil (site 7) probably contaminated by seals.

Chlorhormidium flaccidum (A. Braun) Fott

Fig. 24k

Syn. *Hormidium flaccidum* A. Braun

Filaments long, multicellular, both in moist plate enrichment cultures and on mineral nutrient agar, width 8.5–9.0 μm . Cells 9.5–20.0 μm long; chromatophore parietal, plate-like, with distinct pyrenoid. Spore formation not observed.

Printz (1964) gave a larger range of width, 5–14 μm ., and described spore formation.

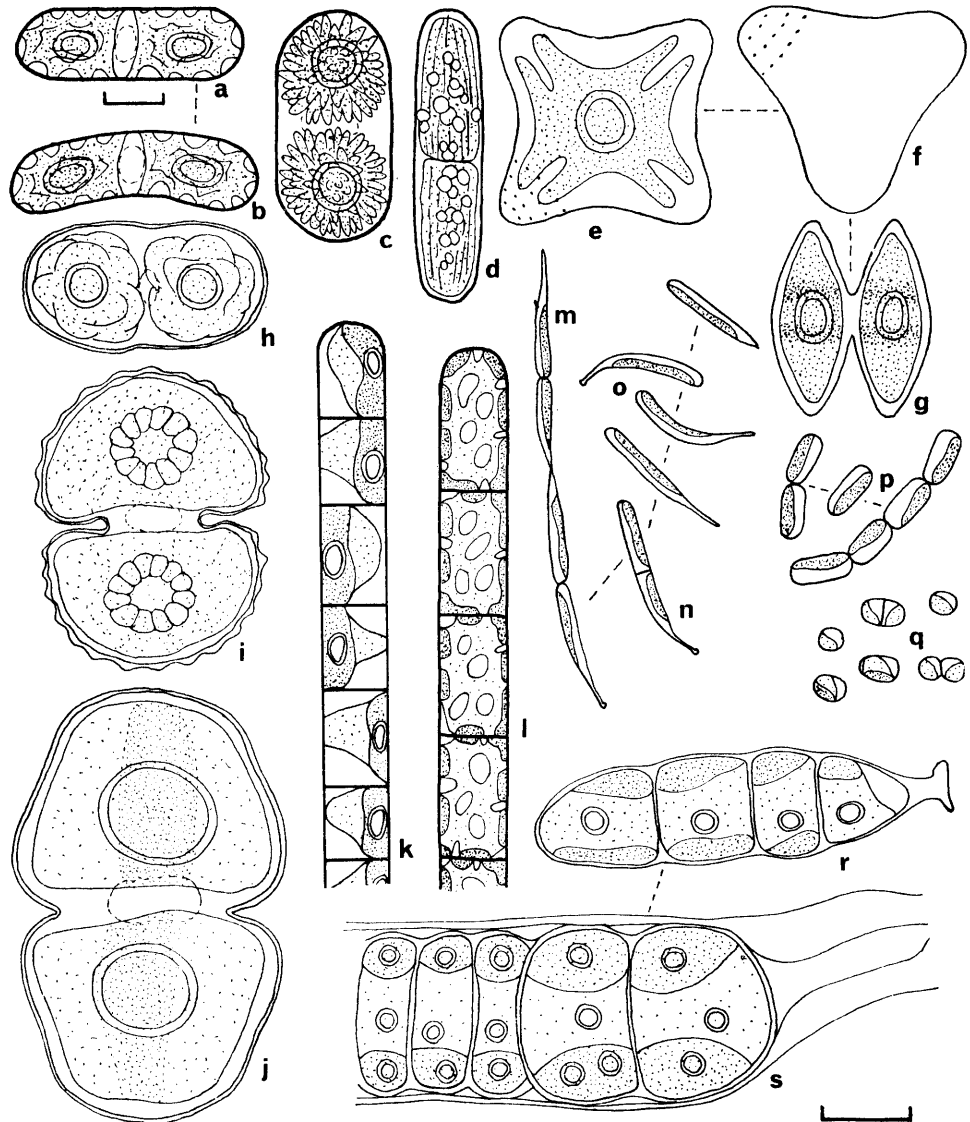


FIGURE 24

a and b. *Cylindrocystis brebissonii* var. *minor* (p. 94); c. *Cylindrocystis crassa* (p. 95); d. *Netrium* sp. A (p. 95); e–g. *Staurastrum muticum* (p. 96); h. *Cosmarium* sp. A (p. 94); i. *Cosmarium undulatum* var. *minutum* (p. 94); j. *Cosmarium* sp. B (p. 94); k. *Chlorhormidium flaccidum* (p. 82); l. *Microspora stagnorum* (p. 83); m–o. *Raphidonemopsis sessilis* var. A (p. 84); p. *Stichococcus bacillaris* (p. 85); q. *Stichococcus minutus* (p. 85); r and s. *Ulothrix zonata* (p. 86).

The scales are 10 μm . The upper scale refers to a–g, the lower scale to h–s.

Habitat. Recorded from 40 subaerial sites. Widespread in sites other than *Polytrichum alpestre*–*Chorisodontium aciphyllum* turves.

Distribution. Antarctica: no record. Other records: a common terrestrial alga on damp soils from Iceland, Denmark and Greenland (Petersen, 1928, 1932a, 1935), United Kingdom (Lund, 1947), Austria (Reisigl, 1964), New Zealand (Flint, 1968) and Czechoslovakia (Rosa and Lhotsky, 1971); also in the aerial habitat; Switzerland (Jaag, 1945), France (Fjerdingstad, 1965), United Kingdom (Allen, 1971).

Fottea Hindak

Cells cylindrical with broadly rounded apices, straight or slightly curved, uninucleate, single or temporarily in pairs, embedded irregularly throughout homogeneous colonial mucilage; chromatophore parietal with or without pyrenoid; colonies multicellular, irregularly shaped. Vegetative cell division by formation of vertical transverse wall; spore formation not observed.

Hindák (1968) compared the genus *Fottea* with similar genera.

Fottea pyrenoidosa Broady

Fig. 25a–j

Colonies softly mucilaginous, on agar dark green and hemispherical, in liquid culture forming small irregular masses (Fig. 25a). Cells cylindrical (Fig. 25b, d and h) usually slightly curved, rarely straight, with broadly rounded apices, length 9–18 μm ., width 6 μm ., spherical in transverse section (Fig. 25c), irregularly arranged throughout homogeneous colonial mucilage as single cells, in pairs or as short filaments of three cells in actively dividing cultures (Fig. 25j); chromatophore parietal, plate-like, encircling more than half of wall but never forming complete sleeve, containing pyrenoid; oil globules often present; nucleus central (Fig. 25i). Vegetative cell division forming two daughter cells (Fig. 25e–g); spore formation not observed.

Broady (1976) compared this new species with the only other described species, *F. cylindrica* Hindak, which does not possess a pyrenoid and has larger cells. The cell shape and colony form of *F. cylindrica* are similar and it was also isolated from soil.

Habitat. Rare, recorded from one subaerial site, in a mineral soil (site 5).

Microspora Thuret

Filaments fixed when young, free-living when adult, unbranched, uniseriate. Cells cylindrical or slightly swollen with parietal, reticulate chromatophore without pyrenoid; walls either obviously composed of H-shaped sections joined at mid-points of cells or requiring staining to make structure apparent, filaments fragmenting readily at these positions. Reproduction by aplanospores, zoospores or akinetes.

Microspora stagnorum (Kuetzing) Lagerheim

Fig. 24l

Syn. Conferva stagnorum Kuetzing
Ulothrix stagnorum Kuetzing

Filaments long, multicellular, 8.5 μm wide; cells 6–18 μm long; H-shaped wall sections not visible without staining with methylene blue, making them apparent in some cells; chromatophore parietal, reticulate, covering all sides of wall. Only one colony observed on BBM agar culture.

Most *Microspora* spp. have a more distinct H-structure to the cell wall (Printz, 1964).

Habitat. Rare, present in one subaerial site, in the soil below *Deschampsia antarctica* at site 64.

Distribution. Antarctica: Iles Kerguelen, three other species of *Microspora* recorded from fresh water (Hirano, 1965). Other records: commonly found in standing water (Printz, 1964); not a common terrestrial genus but this species recorded in soil from Denmark (Petersen, 1932a) and Singapore (Johnson, 1969).

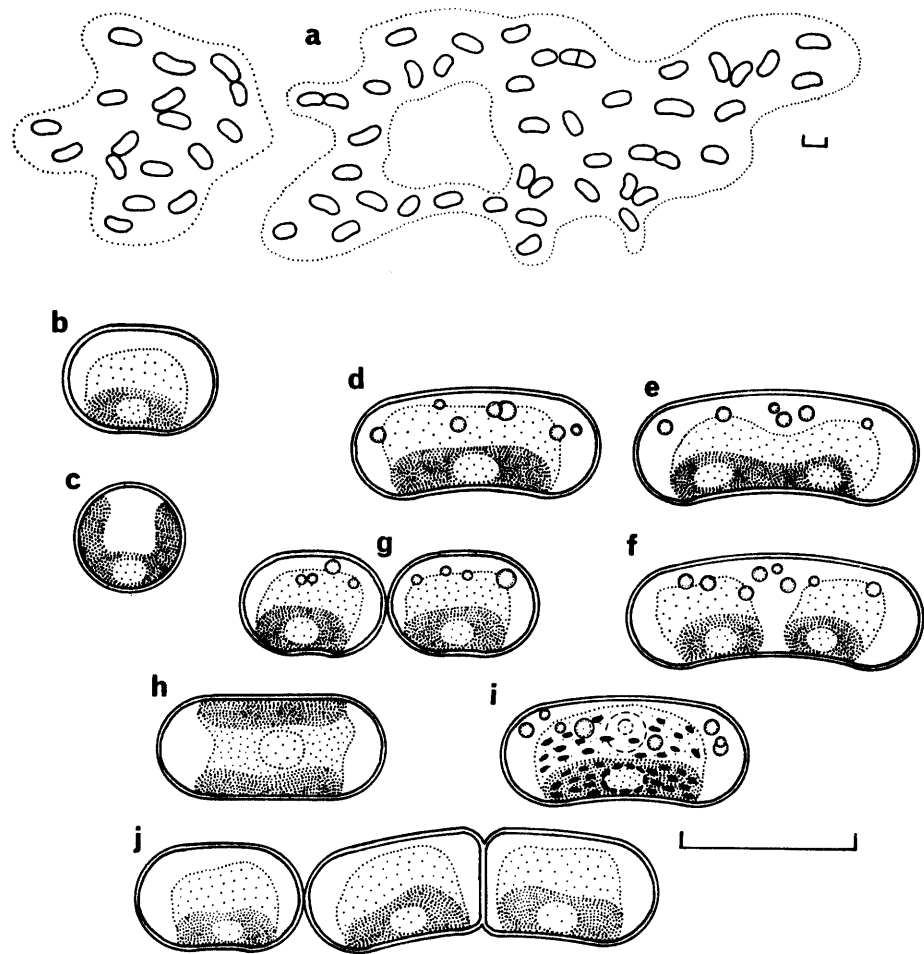


FIGURE 25

Fottea pyrenoidosa (p. 83). a. Arrangement of cells in colonies; b. Small cell; c. Apical view of cell; d. Large adult cell; e-g. Transverse cell division; h. Looking down on to pyrenoid at base of cell demonstrating the straight cells when viewed in this plane; i. Cell stained in Lugol's iodine solution showing the scattered starch granules and central nucleus; j. Rare short filament from an actively dividing culture.

The scales are 10 μm . The upper scale refers to a, the lower scale to b-j.

Raphidonemopsis Deason

Filaments short, readily fragmenting, or cells single. Cells cylindrical to fusiform; basal cell bearing short stalk with small terminal button-like holdfast; chromatophore parietal, plate-like, encircling about half of wall; pyrenoid absent. Reproduction solely by transverse vegetative cell division.

Raphidonema Lagerheim and *Koliella* Hindak are very similar except that their cells do not form holdfasts.

Raphidonemopsis sessilis Deason var. A

Fig. 24m-o

Cells cylindrical, 2 μm . wide by 11.0-14.5 μm . long, straight or slightly curved, single (Fig. 24o) or in readily fragmenting filaments of two to six cells (Fig. 24m and n), tapering to thin stalk at one apex and at other bluntly rounded; terminal holdfast button at tip of stalk in occasional cells from BBM aqueous cultures; chromatophore parietal usually reaching to blunt apex but not down to finely pointed apex; pyrenoid absent.

Deason (1969) described the cells of *R. sessilis* as being acutely pointed at the non-stalked apex. This is the only difference from the present alga in which the cells are bluntly rounded.

Habitat. Recorded from 17 subaerial sites. Amongst wet mosses in nine sites and in four soils below *Deschampsia antarctica*, otherwise infrequent.

Distribution. Antarctica: no record. Other records: North America, isolated from sand dunes (Deason, 1969).

Stichococcus Naegeli

Filaments free-living, short, readily fragmenting or cells single. Cells loosely connected, straight or curved with rounded apices; chromatophore parietal, plate-like, covering one half or less of wall; pyrenoid absent. Reproduction solely by transverse vegetative cell division.

- | | | |
|--|-----------|----------------------|
| 1. Cells cylindrical, in filaments of up to 12 cells | | <i>S. bacillaris</i> |
| Cells spherical to ellipsoidal, temporarily in pairs | | <i>S. minutus</i> |

Stichococcus bacillaris Naegeli *sens. ampl.*

Fig. 24p

Syn. Stichococcus minor Naegeli
Stichococcus membranaefaciens Chodat
Stichococcus dubius Chodat
Stichococcus bacillaris Naegeli *sens. strict.*
Stichococcus chloranthus Rath
Stichococcus pallescens Chodat

Cells cylindrical, 2.5 μm . wide by 3.5–6.5 μm . long, with rounded apices, single and in short readily fragmenting filaments of up to 12 cells; chromatophore parietal; pyrenoid absent.

The longest filaments are slightly longer than those described by Printz (1964) where they consist mostly of from two to four cells.

Habitat. Recorded from 57 subaerial sites. Widespread with no particular habitat preferences but most abundant in nutrient-rich sites (Broady, 1979b).

Distribution. Antarctica: in the terrestrial habitat in Victoria Land (Holm-Hansen, 1964) and Ongul Islands, eastern Antarctica (Akiyama, 1968). Other records: in many soils including ones from Iceland, Denmark and Greenland (Petersen, 1928, 1932a, 1935), United Kingdom (Fritsch and John, 1942; Lund, 1947) and Austria (Reisigl, 1964).

Stichococcus minutus Grintzesco et Peterfi

Fig. 24q

Cells spherical to ellipsoidal, 2.5–3.0 μm . wide by 2.5–4.0 μm . long, single or in temporary pairs formed after vegetative division; chromatophore parietal covering about half of wall; pyrenoid absent.

Printz (1964) described the cells as occurring in chains of up to four cells and the cell length was given as 4–6 μm . *S. minutissimus* Skuja is narrower (1–1.5 μm . wide) and *S. chlorelloides* Grintzesco and Peterfi is broader (3.5–4.0 μm . wide) than the Signy Island specimens though both form similar short chains of cells.

Habitat. Recorded from 12 subaerial sites. Scattered distribution but absent from *Polytrichum alpestre-Chorisodontium aciphyllum* turves and soils below herbaceous vegetation.

Distribution. Antarctica: no record. Other records: Rumania, unspecified habitat (Printz, 1964).

Ulothrix Kuetzing

Filaments fixed when young, often free-living as adults, unbranched, uniseriate, with or without mucilaginous sheaths. Cells cylindrical, often slightly swollen, uninucleate; chromatophore parietal band extending more than half-way round wall, sometimes forming complete ring, with one or several pyrenoids. Reproduction by biflagellate or quadriflagellate zoospores or aplanospores; isogametes produced.

Ulothrix zonata (Weber et Mohr) Kuetzing

Fig. 24r and s

Filaments unbranched, uniseriate, 11–60 μm . wide, with terminal holdfast; cells generally shorter than wide; chromatophore parietal covering more than half of wall; pyrenoid single in cells of youngest filaments (Fig. 24r) but in oldest several occur (Fig. 24s); walls thick and stratified. Aplanospore formation observed but not zoospore formation.

Habitat. Recorded from nine subaerial sites. Present in all the sites where in early summer films of fresh water flowed over coastal rocks which were not in the immediate vicinity of nesting birds.

Distribution. Antarctica: no record. Other records: cosmopolitan in clean fresh water (Printz, 1964); Switzerland, on a wet rock face (Jaag, 1945).

ORDER ULVALES

Prasiococcus Vischer

Groups of cells consisting of four, eight or more often larger numbers, more or less cubically arranged due to vegetative division in three planes, or cells single. Cells ellipsoidal, spherical to sub-spherical; chromatophore axial, stellate with central pyrenoid. Aplanospores formed, released by rupture of sporangium wall.

Prasiococcus calcarius (Boye Petersen) Vischer

Fig. 26h–m

Cells single (Fig. 26k), in small groups (Fig. 26l and m) or in cubical colonies (Fig. 26h–j) formed by vegetative division in three planes, 4–13 μm . in diameter, spherical to sub-spherical but when in groups more irregularly shaped due to mutual adpression; chromatophore axial, stellate; pyrenoid central. Aplanospores formed, 3.5 μm . in diameter, approximately spherical, 16 released by rupture of sporangium wall.

Bourrelly (1966) described the production of two to eight aplanospores only. Belcher (1969) and Lund (1966) provided similar descriptions to the Signy Island specimens.

Habitat. Recorded from ten subaerial sites and 15 aerial sites. Frequent in subaerial sites receiving nutrients from bird or seal excreta and in the aerial habitat as an often major component of the dry green encrustations on exposed rocks.

Distribution. Antarctica: South Sandwich Islands, in samples of the vegetation from around fumaroles (Belcher, 1969). Other records: Lund (1966) provided a thorough review of this alga and stated that it probably has a world-wide distribution. He recorded it on coastal rocks in the United Kingdom and in other aerial situations rich in soluble salts.

Prasiola Agardh

Adult thalli foliose, unistratose, fixed to substrate by short rhizoids. Cells often arranged in groups of four; chromatophore star-shaped with central pyrenoid. Young thalli filamentous, initially uniseriate (“*Hormidium*” stage) then becoming biseriate (“*Schizogonium*” stage) due to cell division in two planes, eventually through further divisions in two planes forming adult foliose thalli.

Prasiola crista (Lightfoot) Meneghini

Fig. 26d and e

Adult thalli foliose, unistratose, formed by division of cells in two planes, cells often remaining in groups of four. Young thalli consisting of uniseriate filaments 9–18 μm . wide with short cells 3–10 μm . long (Fig. 26d). Cell division in two planes producing biseriate (Fig. 26e) and multiseriate filaments before final production of foliose form. Cells with axial, stellate chromatophore with central pyrenoid.

Habitat. Recorded from 26 subaerial and ten aerial sites. Smith (1972), in his classification of the vegetation

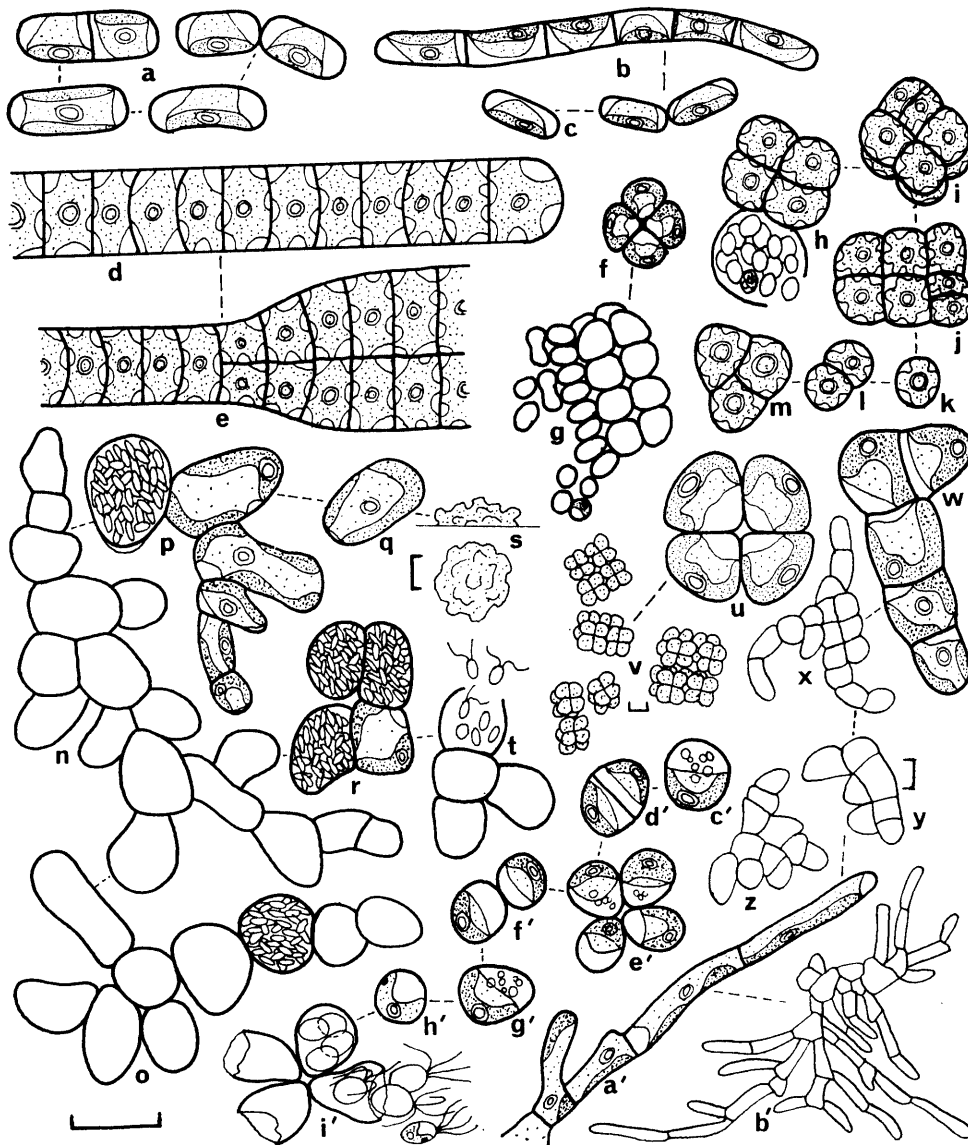


FIGURE 26

a. *Chlorohormidium dissectum* var. B (p. 81); b and c. *Chlorohormidium dissectum* var. A (p. 81); d and e. *Prasiola crispa* (p. 86); f and g. *Chlorosarcinopsis* sp. B (p. 88); h-m. *Prasiococcus calcarius* (p. 86); n-t. *Gongrosira terricola* (p. 89); u and v. *Chlorosarcinopsis* sp. A (p. 88); w-b'. *Desmococcus vulgaris* (p. 88); c'-i'. *Planophila* sp. A (p. 91).

The uppermost scale is 1 mm. and the other scales are 10 µm. The uppermost scale refers to s; the centre left-hand scale refers to v; the centre right-hand scale refers to x-z and b'; the lower scale refers to a-r, t, u, w, a' and c'-i'.

of the South Orkney Islands, described an alga sub-formation in which a *Prasiola crispa* association occurs. It is widespread in many wet habitats on Signy Island, particularly those enriched by bird or seal excreta. In the present study, this is demonstrated by its frequent occurrence in sites receiving nutrients from birds or seals and in the soils below herbaceous vegetation, which were often contaminated by bird excreta. The "*Hormidium*" form was the dominant stage in the aerial sites, although rich growths of the foliose stage were often present in water-flushed rock gullies in the vicinity of nesting birds, a habitat which could also be termed aerial under the present definition of the term.

Distribution. Antarctica: widespread, one of the first algae to be reported from these regions, the early references were provided by Hirano (1965); the Antarctic distribution was mapped by Koob (1967). Other records: a nitrophilous alga forming large growths particularly around the colonies of sea birds (Lund, 1967).

ORDER CHAETOPHORALES

Chlorosarcinopsis Herndon

Cells forming cubical groups by vegetative division in three planes or solitary; chromatophore parietal, cup-shaped or covering wall completely, containing pyrenoid. Zoospores formed, these being biflagellate and naked, also aplanospores and isogametes.

- | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----------|
| 1. Cells 6–10 μm . in diameter | . | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | . | C. sp. A |
| Cells 2.5–5.0 μm . in diameter | . | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | . | C. sp. B |

Chlorosarcinopsis sp. A

Fig. 26u and v

Cells 6–10 μm . in diameter, almost spherical though often distorted due to mutual adpression, forming cubical packets of eight or more cells (Fig. 26v); chromatophore parietal, cup-shaped with pyrenoid (Fig. 26u). Only vegetative division occurring and spore formation not observed.

Chlorosarcinopsis differs from the similar *Chlorosarcina* Vischer in its possession of pyrenoids. *Desmococcus* Brand also forms cubical packets of cells and has a similar parietal chromatophore with a pyrenoid. However, short uniseriate branching filaments are also formed in the latter genus and these have not been seen in the present alga.

Habitat. Rare, recorded from one subaerial site, mineral soil from a solifluction stripe in glacial detritus (site 6).

Distribution. Antarctica: no record. Other records: recent soil studies employing culture techniques have found several species of *Chlorosarcinopsis* especially in arid soils from North America (Chantanachat and Bold, 1962; Bischoff and Bold, 1963) and Israel (Friedman and Ocampo-Paus, 1965).

Chlorosarcinopsis sp. B

Fig. 26f and g

Cells 2.5–5.0 μm . in diameter forming cubical groups (Fig. 26g) often readily fragmenting, single cells and cell pairs being frequent; chromatophore parietal, cup-shaped, with pyrenoid. Only vegetative division occurring and spore formation not observed.

The groups of cells fragmented more readily than those of the previous species.

Habitat. Recorded from 16 subaerial sites. A scattered distribution but absent from *Polytrichum alpestre-Chorisodontium aciphyllum* turves.

Desmococcus Brand

Cubical groups of cells or branching uniseriate filaments, often reduced to few cells, formed by vegetative division in three planes. Cells spherical, sub-spherical or cylindrical; chromatophore parietal with pyrenoid. Reproduction by formation of large quantities of bacilliform aplanospores.

Desmococcus vulgaris Brand

Fig. 26w–b'

Small branching thalli consisting of cells 6.0–9.5 μm . wide (Fig. 26w–z) observed in direct microscopic examination of samples from the field and on BBM agar cultures; in moist plate enrichment culture forming thalli with longer, narrower (3.5 μm . wide) and more profuse branches (Fig. 26a' and b') with cells up to 30 μm . long, material transferred to BBM agar culture developing the former thallus structure. Cells containing parietal chromatophore with pyrenoid; spore formation not observed.

The form with narrow branches is similar to *Pseudo-Pleurococcus printzii* Vischer described by Printz (1964). Bourrelly (1966) described *Desmococcus* as reproducing by aplanospores produced in large quantities from large sporocysts with a sculptured cell wall; however, only vegetative cell division was recorded in the Signy Island specimens.

Habitat. Recorded from four subaerial sites and 27 aerial sites. The subaerial sites were all in exposed situations (sites 11, 12, 15 and 18). It was a common component of dry green rock encrustations in the aerial habitat (19 sites).

Distribution. Antarctica: similar pleurococcooid forms are recorded from the continent, the South Shetland Islands and the South Orkney Islands (Hirano, 1965); Ongul Islands, eastern Antarctica, terrestrial record of *Pseudo-Pleurococcus printzii* (Akiyama, 1968). Other records: Iceland and Denmark, an aerial alga (Petersen, 1928, 1932a); *P.-P. printzii* recorded only in cultures (Printz, 1964).

Gongrosira Kuetzing

Thallus branched, pseudoparenchymatous, consisting of entangled filaments giving rise to short, erect filaments terminating in enlarged cells which form sporangia. Cells with parietal chromatophore containing one or more pyrenoids. Reproduction usually by biflagellate zoospores; aplanospores and akinetes also formed.

The single species found on Signy Island is not typical of the genus as a whole having a more open branching system; this is discussed below.

Gongrosira terricola Bristol

Fig. 26n-t

Syn. Leptosira terricola (Bristol) Printz

Cells forming small irregularly branching thalli (Fig. 26n-p) or initially single (Fig. 26q) on BBM agar culture; colonies almost hemispherical with roughly lobed surface and irregular outline (Fig. 26s). Individual free-living cells spherical or more irregularly shaped, 6-20 μm . in diameter, cells in branching thalli with similar size range; chromatophore parietal, broadly lobed, covering varying areas of wall; pyrenoid spherical. Reproduction by formation of large numbers of biflagellate zoospores in terminal (Fig. 26p) and intercalary (Fig. 26o) sporangia, these occasionally having partially thickened walls; thallus observed with three of four cells having developed into zoosporangia (Fig. 26r); spores released by irregular rupture of sporangium (Fig. 26t). Zoospores oval in lateral view, laterally flattened, 6-12 μm . long, with prominent red stigma usually about mid-way along spore.

Lund (1947) described the formation of aplanospores as well as zoospores although Bristol (1920) did not describe the former in her original description. The zoospores described by Lund are similar to those of the present alga in having the stigma about half-way along the cell. The formation of a basal pseudoparenchymatous disc with radiating filaments, considered as a generic charactersitic of *Gongrosira*, is not strongly developed in this species and Printz (1964) changed *G. terricola* to *Leptosira terricola* because of its similarity to the more open branching system of that genus.

Habitat. Recorded from 11 subaerial sites. Mostly amongst mosses, particularly wet stands (six occurrences), also in mineral soil from a solifluction stripe (site 6).

Distribution. Antarctica: Anvers Island, Antarctic Peninsula, a possible species of *Gongrosira* from fresh water (Parker and others, 1972). Other records: in soils of the United Kingdom (Bristol, 1920; James, 1935; Lund, 1947) and Canada (Lowe and Moyses, 1934).

Hazenia Bold

Thallus consisting of irregularly branching filaments contained in wide, homogeneous, mucilaginous tubes; filaments uniseriate or partially multiseriate with conical terminal cells. Cells sub-spherical to cylindrical, containing parietal chromatophore with pyrenoid. Biflagellate isogametes formed.

The Signy Island specimen is only tentatively placed in this genus in the absence of more detailed observations on unialgal cultures.

(?) *Hazenia* sp. A

Fig. 27d-m

Thallus form varying on BBM agar cultures; young cultures containing single cells (Fig. 27d and f) and small irregularly branched or unbranched filaments; unicells almost spherical, 7-10 μm . in diameter, to

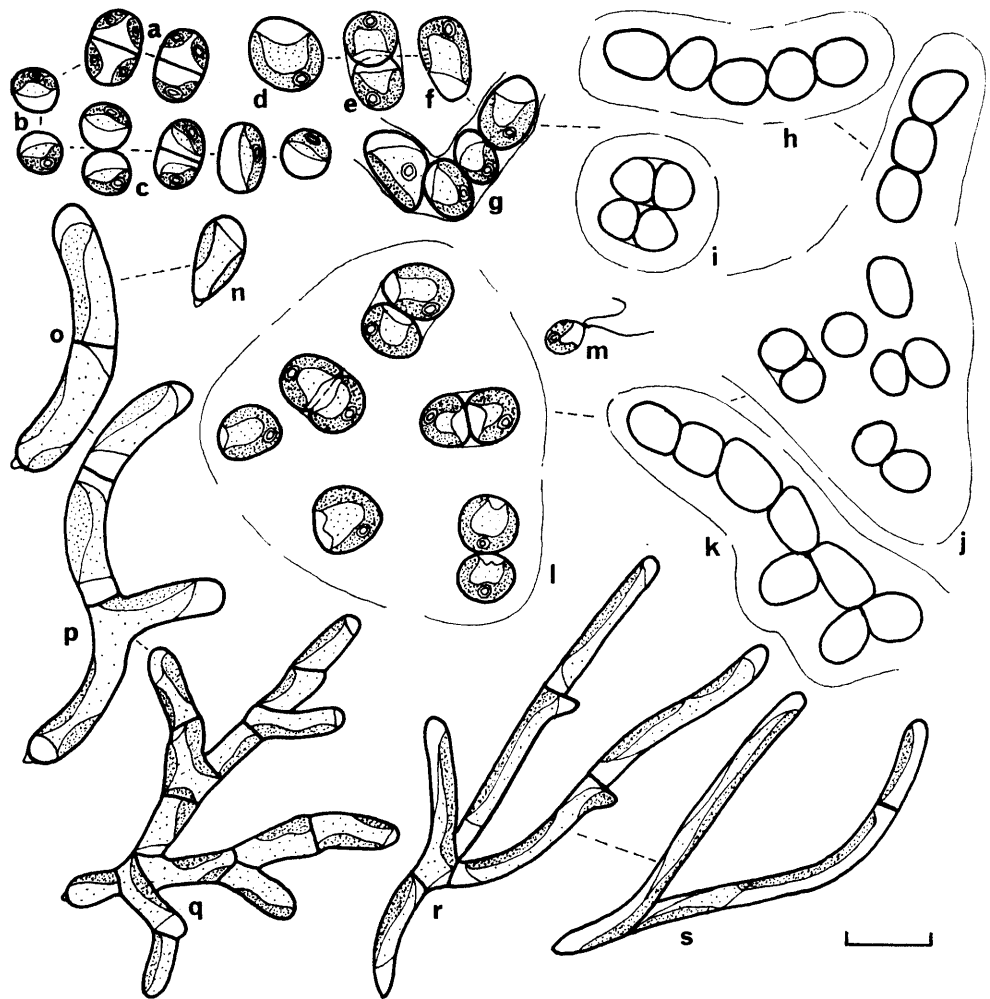


FIGURE 27

a-c. (?) *Planophila* sp. B (p. 92); d-m. (?) *Hazenia* sp. A (p. 89); n-q. *Microthamnion kuetzingianum* (p. 91); r and s. *Microthamnion strictissimum* (p. 91).

The scale is 10 μ m.

almost ellipsoidal, 11 μ m. by 7 μ m., with extensive parietal chromatophore containing single or occasionally two prominent pyrenoids; filaments appearing to be surrounded by thin sheath, possibly of dried mucilage (Fig. 27g); older cultures seen with all cells embedded in non-stratified mucilaginous envelopes up to 20 μ m. wide (Fig. 27h-l) cells being either distributed throughout mucilage as discrete single cells, cell pairs or occasionally in four or cubical eight cell groups, or as irregularly branching filaments or non-branching filaments these often only rudimentary with cells barely touching. Biflagellate zoospores (Fig. 27m) observed on one occasion but not sporangia from which spores released.

Bourrelly (1966) described *Hazenia* as the only genus possessing branching filaments which do not terminate in hair-like processes and are embedded in mucilaginous envelopes. The only described species, *H. mirabilis* Bold, forms branching filaments in mucilaginous sheaths, similar to the Signy Island specimens. However, these are considerably wider, 120-150 μ m. wide, and the filamentous nature of the thalli is more striking than in the present alga (Bold, 1958). No stages were described by Bold in which the cells are only covered by a thin sheath, or where the filaments are rudimentary or non-existent, with the cells single or in pairs within the mucilage. *H. mirabilis* produces similar biflagellate spores but unlike the present alga these perform an isogamous fusion.

Habitat. Recorded from six subaerial sites. A scattered distribution (sites 3, 16, 45, 47, 53 and 65).

Distribution. Antarctica: no record. Other records: North America, *H. mirabilis* isolated from fresh water (Bold, 1958).

Microthamnion Naegeli

Filaments uniseriate, richly and irregularly branching, branches about same diameter as main axis, fixed to substrate by basal cell, with conical terminal cells, mucilage absent. Cells cylindrical, with parietal chromatophore lacking pyrenoid, at bases of branches often V-shaped due to lack of wall formation at position of initiation of branch. Terminal or intercalary sporocysts formed, releasing biflagellate zoospores.

- | | |
|--|-------------------------|
| 1. Filaments 5 μm . wide; cells 10–20 μm . long | <i>M. kuetzingianum</i> |
| Filaments 2.5–3.0 μm . wide; cells 10–40 μm . long | <i>M. strictissimum</i> |

Microthamnion kuetzingianum Naegeli

Fig. 27n–q

Filaments irregularly and richly branching (Fig. 27q), 5 μm . wide with cells 10–20 μm . long, forming small compact thalli in culture. In direct microscopic examination of moss shoots thalli rarely consisting of more than three or four cells with one or two branches (Fig. 27n–p). Young thalli with basal cell slightly terminally thickened. Cells containing parietal chromatophore lacking pyrenoid. Biflagellate zoospores formed but these rarely seen in culture and never in material collected from field.

Habitat. Recorded from 16 subaerial sites. Mostly amongst mosses (11 sites), particularly wet carpets (eight sites). Absent from mineral soils without macroscopic vegetation and sites contaminated by bird or seal excreta.

Distribution. Antarctica: no record. Other records: cosmopolitan in fresh water (Printz, 1964); Denmark, a rare terrestrial form probably requiring plenty of moisture (Petersen, 1932a); Canada, in uncultivated soils (Lowe and Moyses, 1934); Ellesmere Island, amongst wet mosses (Croasdale, 1973).

Microthamnion strictissimum Rabenhorst

Fig. 27r and s

Filaments irregularly branching, 2.5–3.0 μm . wide, with cells 10–40 μm . long containing parietal chromatophore lacking pyrenoid. In particularly long cells, chromatophore does not occupy full length of cell being restricted to middle portion.

The present alga has slightly narrower filaments than the 3–4 μm . width described for this species by Printz (1964). The thalli are not so richly branched as those of *M. kuetzingianum*.

Habitat. Rare, recorded from one subaerial site, in a moraine soil at site 4.

Distribution. Antarctica: Iles Kerguelen, amongst mosses (Bourrelly and Manguin, 1954). Other records: a common fresh-water algae (Printz, 1964).

Planophila Gerneck

Cells spherical, single or forming flat aggregates one cell thick due to vegetative division in two planes; chromatophore parietal, cup-shaped containing one or two pyrenoids. Zoospores with four flagella formed.

Both of the Signy Island specimens can only be tentatively placed in this genus due in one case to the failure to produce the characteristic thallus form and in the other to the lack of zoospore formation; however, both taxa demonstrated vegetative cell division.

- | | |
|---|---------------------|
| 1. Cells 6.0–8.5 μm . in diameter; tending to aggregate in culture | <i>P.</i> sp. A |
| Cells 4–6 μm . in diameter; not tending to aggregate in culture | (?) <i>P.</i> sp. B |

Planophila sp. A

Fig. 26c'–i'

Cells spherical to ellipsoidal, 6.0–8.5 μm . in diameter; chromatophore cup-shaped covering about half of wall and containing distinct basal pyrenoid; oil globules often present (Fig. 26g'). Vegetative cell division occurring with products usually remaining together as irregular clumps of two to several cells in culture (Fig. 26e' and f'). Zoospores quadriflagellate, almost globular, walled, with cup-shaped chromatophore, pyrenoid and stigma, forming in fours and released by rupture of sporangium wall (Fig. 26i'),

remaining motile for only short period, losing flagella on cessation of motility but retaining stigma for longer periods (Fig. 26h'). In 2 months old BBM agar cultures non-motile cells each with red stigma were present but neither zoospores nor sporangia were observed.

Bourrelly (1966) described the formation of flat thalli consisting of a single layer of cells but the present alga in culture formed irregular masses of cells. Vegetative cell division in the Signy Island specimens produced two and then four adhering cells; however, this was not followed by division in a third plane to form cubical packets of eight cells as in *Chlorosarcinopsis* Herndon. This suggests that the irregular aggregates of cells obtained in culture were the result of the clumping of cells capable of division in only two planes which in other growth conditions might form flat thalli.

Habitat. Recorded from 24 subaerial sites. Frequent in the mineral soils without macroscopic vegetation and in the soils below herbaceous vegetation, absent from *Polytrichum alpestre*-*Chorisodontium aciphyllum* turves and *Andreaea* spp. cushions.

Distribution. Antarctica: no record. Other records: Austria, two species of *Planophila* described from alpine soils (Reisigl, 1964).

(?) *Planophila* sp. B

Fig. 27a-c

Cells spherical to ellipsoidal, 4-6 μ m. in diameter (Fig. 27b), mostly single when on BBM agar culture but often two remaining attached after vegetative cell division (Fig. 27c), occasionally division in second plane commences before separation of first two daughter cells (Fig. 27a); spore formation not observed; chromatophore parietal, saucer-shaped containing distinct basal pyrenoid.

The failure of the Signy Island specimens to form flat thalli by the adherence of the cells may be due to the culture conditions under which this alga was examined. This alga is most similar to *Chloroplana* Hollerbach and *Planophila* Gerneck, in both of which the globular cells have a parietal chromatophore with a pyrenoid, the distinguishing feature being the number of flagella on the zoospores, two in *Chloroplana* and four in *Planophila*. In the absence of zoosporulation in the present alga it is tentatively placed in *Planophila*.

Habitat. Recorded from four subaerial sites, in mineral soils at sites 11 and 12 and amongst *Andreaea* spp. cushions at sites 15 and 18.

CLASS ZYGOPHYCEAE

ORDER ZYGNEMATALES

Cosmarium Corda

Cells solitary with distinct median constriction separating two half cells, these not being lobed and not bearing spines; apical view usually ellipsoidal, rarely circular or reniform; wall smooth or variously ornamented; chromatophore single or several in each half cell, each containing one or several chromatophores.

1. Cell wall smooth	2
Cell wall with several small undulations	5
2. Cell wall with apical thickenings	<i>C. curtum</i>
Cell wall without apical thickenings	3
3. Median constriction barely visible	<i>C. sp. A</i>
Median constriction distinct though not deep	4
4. Cells 36 μ m. by 19 μ m. with apical wall slightly concave	<i>C. parvulum</i>
Cells 53 μ m. by 32 μ m. with apical wall slightly convex	<i>C. sp. B</i>
5. Median constriction deep and narrow; half cells semi-circular	<i>C. undulatum</i>
	var. <i>minutum</i>
Median constriction distinct but not deep and narrow; half cells rhomboidal	<i>C. notabile</i>

Cosmarium curtum (Brebisson) Ralfs

Fig. 23d'

Syn. Actinotaenium curtum (Brebisson) Teiling
Penium curtum Brebisson
Calocylindrus curtus (Brebisson) Kirchner
 Further synonymy given by Krieger and Gerloff (1969)

Cells almost ellipsoidal in frontal view, 54 $\mu\text{m.}$ by 25 $\mu\text{m.}$, apical and profile views not obtained in limited material observed; median constriction slight; walls smooth with thickened, rounded apices; chromatophore, one per half cell, axial, with *c.* eight ribs and containing spherical pyrenoid.

The cells are slightly larger than the nominate variety of the species (33–45 $\mu\text{m.}$ by 16–24 $\mu\text{m.}$) but smaller than *C. curtum* var. *attenuatum* (Brebisson) Maskell (58–87 $\mu\text{m.}$ by 20–30 $\mu\text{m.}$) (Krieger and Gerloff, 1969). *Habitat.* Recorded from three base-rich subaerial sites; in mineral soil from a solifluction stripe (site 6) and amongst two moss stands on calcium-rich ground, *Drepanocladus uncinatus* (site 34) and *Tortula* sp. (site 52).

Distribution. Antarctica: listed in the fresh-water flora of the continent (Hirano, 1965). Other records: Arctic, common as a fresh-water species but also on damp earth, rocks and amongst mosses (Krieger and Gerloff, 1969); Ellesmere Island, in fresh water (Croasdale, 1973).

Cosmarium notabile De Bary

Fig. 23e'

Syn. Cosmarium notabile f. *minor* Wille
Penium notabile (De Bary) Gay
 Further synonymy given by Krieger and Gerloff (1965)

Cells in frontal view 30–44 $\mu\text{m.}$ by 21–32 $\mu\text{m.}$, each half cell being almost trapezium-shaped, apical and profile views not observed; chromatophores, one per half cell, central with spherical pyrenoid; side and apical walls straight to slightly convex with undulations, five along each side and four along apical edge.

The finely punctate cell wall described by Krieger and Gerloff (1965) was not observed.

Habitat. Recorded from six subaerial sites. In the same three base-rich sites as *Cosmarium curtum* and in three additional sites (44, 48 and 69) not noted to be base-rich.

Distribution. Antarctica: no record. Other records: Europe, widespread in ponds in mountainous and alpine regions, also on wet rocks (Krieger and Gerloff, 1965).

Cosmarium parvulum Brebisson

Fig. 23f'

Syn. Cosmarium obcuneatum West f. *West*
Actinotaenium obcuneatum (West) Teiling

Cells in frontal view 36 $\mu\text{m.}$ by 19 $\mu\text{m.}$, apical and profile views not observed; side walls straight and apices with slight depression; each half cell containing axial chromatophore with four ribs and spherical pyrenoid.

This alga falls within the size range of the nominate variety of the species described by Krieger and Gerloff (1969) (25–49 $\mu\text{m.}$ by 13–22 $\mu\text{m.}$), the other varieties being considerably smaller. However, the nominate variety does not possess the slight depression in the terminal walls which occurs in *C. parvulum* var. *excavatum* Insam et Krieger and in the Signy Island specimens. The present alga lies between var. *excavatum* and the nominate variety.

Habitat. Rare, recorded from one subaerial site, in a mineral soil from a solifluction stripe (site 6).

Distribution. Antarctica: no record. Other records: scattered distribution in Europe, Arctic, Asia, North America and South America, frequent amongst *Sphagnum* (Krieger and Gerloff, 1969).

Cosmarium undulatum var. *minutum* Wittrock

Fig. 24i

Syn. *Cosmarium crenatum* var. *alpinum* Raciborski
Cosmarium crenatum var. *minutum* Raciborski
Cosmarium undulatum f. *minor* West et West
Euastrum undulatum f. *minor* Gay
Cosmarium alpinum (Raciborski) De Toni
Cosmarium blanjinense Pevalek
Cosmarium undulatum f. *minima* Gutwinski

Cells in frontal view *c.* 36 $\mu\text{m.}$ by 29 $\mu\text{m.}$, apical and profile views not observed; each half cell semi-circular with wall having 15 slight undulations, containing central chromatophore with distinct, spherical pyrenoid; median constriction deep and narrow.

Krieger and Gerloff (1962) described this alga as having slightly fewer, 12–14, undulations round each half-cell wall.

Habitat. Rare, recorded from one subaerial site, amongst a calcium-rich *Drepanocladus uncinatus* carpet at site 47.

Distribution. Antarctica: Jenny Island, Antarctic Peninsula, fresh water (Gain, 1912). Other records: cosmopolitan, recorded amongst *Drepanocladus* and in other terrestrial habitats (Krieger and Gerloff, 1962); Ellesmere Island, another variety recorded from amongst moss (Croasdale, 1973).

Cosmarium sp. A

Fig. 24h

Cells almost cylindrical, 27–48 $\mu\text{m.}$ by 15–25 $\mu\text{m.}$; median constriction barely visible; wall smooth; each half cell containing axial lobed chromatophore with central spherical pyrenoid.

This alga is similar to *C. subglobosum* Nordstedt but it is slightly narrower, and the punctate wall and chromatophore with obvious radial lobes described by Krieger and Gerloff (1969) were not observed.

Habitat. Recorded from two base-rich subaerial sites (6 and 47).

Cosmarium sp. B

Fig. 24j

Cells *c.* 53 $\mu\text{m.}$ by 32 $\mu\text{m.}$, each half cell being almost trapezium-shaped with broadly rounded apex and slightly concave sides; median constriction not deep, open; chromatophores, one in each half cell, axial, four-ribbed with large, spherical pyrenoid; wall covered with fine punctae.

This alga is similar with respect to shape, size and punctate cell wall to *C. holmiense* var. *hibernicum* (W. West) Schmidle described by Krieger and Gerloff (1965). However, the median constriction of the present alga is neither so deep nor so narrow. The nominate variety of the species has nine-ribbed chromatophores compared to the four-ribbed of the Signy Island specimens.

Habitat. Recorded from four subaerial sites. Amongst water-flushed *Drepanocladus uncinatus* carpet (site 53) and base-rich sites 6, 10 and 47.

Cylindrocystis Meneghini

Cells cylindrical with broadly rounded apices or rarely ellipsoidal; wall smooth without median constriction and pores; chromatophores axial, one in each half cell, star-shaped with central pyrenoid.

- | | |
|---|-----------------------|
| 1. Cells 12 $\mu\text{m.}$ wide; pyrenoid ellipsoidal | <i>C. brebissonii</i> |
| | var. <i>minor</i> |
| Cells 21–24 $\mu\text{m.}$ wide; pyrenoid spherical. | <i>C. crassa</i> |

Cylindrocystis brebissonii var. *minor* West et West

Fig. 24a and b

Cells cylindrical, usually straight with broadly rounded apices (Fig. 24a), 30–57 $\mu\text{m.}$ by 12 $\mu\text{m.}$, occasionally slightly curved (Fig. 24b), single, free-living or irregularly arranged throughout colonies with homogeneous mucilage; chromatophores axial each with central, ellipsoidal pyrenoid.

The cell size range is slightly greater than the 27–41 μm . long cells described by West and West (1904). The curved cells resemble *C. brebissonii* var. *curvata* Rabanus described by Krieger (1937), although in that variety the cells are 22 μm . wide.

Habitat. Recorded from 18 subaerial sites. A scattered distribution in sites other than *Polytrichum alpestre-Chorisodontium aciphyllum* turves and those grossly contaminated by bird or seal excreta.

Distribution. Antarctica: Iles Kerguelen, terrestrial (Bourelly and Manguin, 1954); South Orkney Islands, *C. brebissonii* Meneghini in fresh water (Fritsch, 1912a). Other records: *C. brebissonii* Meneghini is quite frequent in the terrestrial habitats in Denmark (Petersen, 1935), United Kingdom (Fritsch and John, 1942; Lund, 1947) and Austria (Reisigl, 1964); Ellesmere Island, *C. brebissonii* var. *minor* recorded amongst mosses (Croasdale, 1973).

Cylindrocystis crassa De Bary

Fig. 24c

Cylindrical cells with broadly rounded apices, 39–74 μm . by 21–24 μm ., with two axial, multi-radiate, stellate chromatophores, each with large central, spherical pyrenoid.

The length range is larger than the 22–46 μm . described by West and West (1904). The alga closely resembles the illustration by Skuja (1964). No zygospores were seen in the Signy Island specimens.

Habitat. Recorded from 15 subaerial sites. Frequent in the soils below herbaceous vegetation (five sites), otherwise a scattered distribution except for its absence from sites grossly contaminated by birds or seals.

Distribution. Antarctica: recorded in the fresh-water habitat in the South Orkney Islands (Fritsch, 1912b) and Jenny Island, Antarctic Peninsula (Gain, 1912). Other records: Ellesmere Island, amongst mosses (Croasdale, 1973).

Netrium Itzsigsohn et Rothe

Cells ellipsoidal, rarely cylindrical, with rounded apices; wall smooth without median constriction and pores; chromatophores axial, one in each half cell, with radiating longitudinal plates, usually deeply notched along margins and nearly filling cell, each with pyrenoid elongated along longitudinal axis.

Only a few poor specimens were seen in a single Signy Island sample and the alga is only tentatively placed in this genus.

Netrium sp. A

Fig. 24d

Cells cylindrical, 48 μm . by 12 μm ., with broadly rounded apices; chromatophores axial, one in each half of cell, their structure was largely masked by granules and globules; pyrenoids not observed.

This alga resembles *N. oblongum* var. *cylindricum* West et West, although the cells observed were even smaller than this small variety of the typical form. The margins of the chromatophores of the Signy Island material were noted not to be deeply notched as are those of *N. oblongum*.

Habitat. Rare, recorded from one subaerial site, in mineral soil from a solifluction stripe (site 6).

Distribution. Antarctica: Iles Kerguelen, *N. digitus* (Ehrenberg) Itzsigsohn et Rothe amongst mosses (Bourelly and Manguin, 1954). Other records: Denmark, the latter species recorded in the terrestrial habitat (Petersen, 1932a); United Kingdom, *N. oblongum* var. *cylindricum* recorded as often abundant in the boggy portions of upland moors (West and West, 1904).

Staurastrum Meyen

Cells solitary with median constriction more or less distinct, in apical view with at least three radiating processes more or less developed or triangular or polygonal, in frontal view each half cell almost fusiform; wall smooth or variously ornamented with wart-like processes or spines; chromatophores central, usually one in each half cell, with central pyrenoid, and in apical view two lobes passing into each radiating process.

Staurastrum muticum Brebisson

Fig. 24e-g

Cells in apical view *c.* 36 μm . wide with three or four short, broadly rounded radiating processes (Fig. 24e and f); wall smooth covered with rows of fine punctae; each half cell almost fusiform in frontal view (Fig. 24g) containing central lobed chromatophore with spherical pyrenoid.

No mention is made by West and West (1911*a*) of this species having a punctate cell wall, although other characters in their description are similar to the Signy Island specimens.

Habitat. Rare, recorded from one subaerial site, amongst *Tortula* sp. on a marble substratum (site 27).

Distribution. Antarctica: Iles Kerguelen, in fresh water (Hirano, 1965). Other records: a widely distributed fresh-water species along margins of lakes and pools (West and West, 1911*a*); Ellesmere Island, amongst mosses (Croasdale, 1973).

D. GLOSSARY

akinete: thick-walled, non-motile spore formed singly from a vegetative cell, containing concentrations of food reserves.

apical view: referring to cells of desmids, cells viewed in the plane containing the two shortest axes.

aplanospore: non-motile asexual spore, one or more formed in each mother cell, from which it differs in shape, e.g. spores of *Bracteacoccus* sp. A.

attenuated: narrowing or tapering towards the ends, e.g. trichomes of *Phormidium autumnale*.

autospore: non-motile asexual spore, one or more formed in each mother cell which it resembles in shape and internal structure, e.g. spores of *Monodus subterraneus*.

axial: referring to chromatophore position, in the centre of the cell.

axial clear area: region bordering the raphe slits in pennate diatoms which is free from striae.

bifurcate: branch or spine forking into two.

biseriate: referring to filaments, composed of two rows or series of cells.

calyptra: thickened membrane over the tip of the terminal cell of trichomes of some filamentous Cyanophyceae.

capitate: swollen at one or both ends, e.g. valves of *Pinnularia globiceps* var. *krookei*.

central clear area: region in the centre of the valves of pennate diatoms which is free from striae, sometimes enlarged to a broad transverse strip, e.g. *Stauroneis* spp.

central nodule: thickening or prominent clear area at the centre of a valve of a pennate diatom, where the raphe, if present, is interrupted.

chlamydomonad: with a similar structure to cells of *Chlamydomonas* being equally biflagellate, walled and with two contractile vacuoles.

chromatophore: organelle in eukaryotic cells containing pigments involved in photosynthesis.

chromoplasm: in cells of the Cyanophyceae the portion of the cell contents containing pigments involved in photosynthesis.

contractile vacuole: membrane-bounded cavity in the cytoplasm showing a pulsating action, involved with the water balance of the cell.

convergent striae: striae directed towards the nearest apex of a pennate diatom valve.

costa: rib-like thickening of a diatom frustule.

cruciform: cross-shaped.

cuneate: wedge-shaped.

dorsal margin: convex margin of a lunate diatom.

endospore: spore formed within a cell in the Cyanophyceae, e.g. spores of *Chroococcidiopsis* sp. A.

exospore: spore cut off from the tip of the protoplast, e.g. spores of *Chamaesiphon subglobosus*.

epilithic: growing on the surface of rocks.

epiphytic: growing on the surface of plants.

false-branching: branches not formed by the lateral division of a cell but by the breaking of a filament and the displacement of a portion to one side followed by its further growth, e.g. *Plectonema* spp.

filiform: thread-like.

- flagellum*: whip-like locomotory cell appendage.
- foliose*: leaf- or sheet-like.
- free-living*: referring to cells or filaments which are not attached to a substratum or to cells which are not components of usually mucilaginous colonies.
- frontal view*: referring to cells of desmids, cells viewed in the plane containing the two longest axes.
- frustule*: siliceous wall of diatoms, composed of two valves.
- fusiform*: spindle-shaped; widest in the middle, elongated and tapering towards each end.
- girdle view*: appearance of a diatom when viewed looking perpendicularly on to the girdle or connecting band joining two valves.
- gonidium*: algal cell in a lichen thallus.
- half cell*: one of the two symmetrical halves of which desmid cells are constructed.
- heterocyst*: specialized cell in some filamentous Cyanophyceae, with hyaline contents, usually slightly larger than vegetative cells and with a pore at one or both apices, e.g. as possessed by *Nostoc* spp.
- heteropolar*: with dissimilar apices.
- heterotrichous*: filamentous thallus consisting of two parts, a prostrate system attached to a substratum giving rise to a projecting or erect system.
- holdfast*: extension of a cell wall attaching a thallus to a substratum.
- hormogone*: short section broken away from a mature trichome, a means of vegetative reproduction in some Cyanophyceae.
- hyaline*: colourless, transparent.
- intercalary*: appearing or inserted between, rather than terminal, as between cells in a filament, e.g. heterocysts in *Nostoc* spp.
- isogamous*: uniting gametes of similar size and form.
- isopolar*: with identical apices.
- keel*: longitudinal extension of a diatom valve running along the whole length of the valve, e.g. as possessed by *Nitzschia* spp.
- keel punctae*: structures appearing as dots or punctae in the light microscope; arranged, more or less regularly, along the keel of certain diatoms, e.g. *Hantzschia amphioxys*.
- lanceolate*: lance-shaped; long and narrow, widest in the middle and tapering towards the apices.
- linear*: referring to the shape of diatom valves, with parallel margins.
- lunate*: crescent or half-moon shaped.
- marginal*: referring to the raphe position of certain diatoms, along the edge of the valve, e.g. raphe of *Hantzschia amphioxys*.
- median plane*: the plane passing through the centre of an object.
- mother cell*: the cell from which daughter cells are formed by its division, either vegetatively or internally with the formation of spores.
- mucilage*: gelatinous material often secreted by cells and often persisting to form an enclosing sheath or capsule or combining cells into colonies.
- multiseriate*: referring to filaments, composed of several rows or series of cells.
- naked*: without a rigid outer wall, e.g. zoospores of *Botrydiopsis constricta*.
- palmella stage*: temporary condition of usually motile unicells in which motility is lost and cells become embedded in mucilaginous colonies.
- papilla*: small nipple-like swelling.
- parenchyma*: compact groups of cells formed by cell division in two or three planes, not derived by the close adpression of filaments as in pseudoparenchyma.
- parietal*: lying against the cell wall.
- pennate*: diatoms which are bilaterally symmetrical about the longitudinal axis and which possess raphes or pseudoraphes.
- phycobiont*: algal partner in the lichen symbiosis.
- polar nodule*: thickening or prominent clear area at the apex of a valve of a pennate diatom where raphe, if present, ends.
- profile view*: referring to cells of desmids, cells viewed from the side in the plane containing the longest and the shortest axis.
- pseudofilamentous*: incidental arrangement of unconnected cells in a linear series.

- pseudoparenchyma*: compact groups of cells formed by the adpression of branching filaments.
- pseudoraphe*: clear axial area along the centre of a pennate diatom valve devoid of a raphe slit.
- pseudoseptum*: siliceous plate projecting from the valve ends towards the centre.
- punctae*: pores in the valve surface seen as rows of dots in the light microscope.
- pyrenoid*: proteinaceous body often embedded in chromatophores, involved with the storage of carbohydrates.
- pyriform*: pear-shaped.
- radiate striae*: striae directed towards the centre of a pennate diatom valve.
- raphe*: complex of slits and nodules running along the valves of some pennate diatoms, used in motility.
- reniform*: kidney-shaped.
- reticulate*: arranged in a network.
- rhomboïd*: oblique equilateral parallelogram.
- rostrate*: possessing a beak-like process.
- separation disc*: modified, bi-concave cell in trichomes of some of the Nostocaceae at the position at which fragmentation occurs with the formation of hormogones.
- sigmoid*: curved to the shape of a letter S.
- sporangium*: cell in which spores are produced.
- stellate*: star-shaped, central mass with several radiating arms.
- stigma*: light sensitive organelle, usually red, often on the chromatophore.
- striae*: rows of punctae visible as isolated dots or not resolvable as individual dots.
- submarginal*: referring to the raphe or pseudoraphe position of certain diatoms, close to the edge of the valve.
- sulcus*: thickened ring of silica on the inside of the valve mantle particularly in *Melosira*.
- thallus*: unicellular or multicellular plant body of primitive plants in which there is little or no differentiation of cells and never differentiation into stem, leaf and root.
- transapical plane*: referring to the symmetry of pennate diatom cells, the plane which lies perpendicular to the valve face and contains the two shortest axes.
- trichome*: a single row of cells without the investing sheath in Cyanophyceae.
- undulate*: wave-like.
- uniseriate*: referring to filaments, composed of a single row or series of cells.
- unistratose*: composed of one layer of cells, e.g. foliose thallus of *Prasiola crispa*.
- valve*: each of the two halves of a diatom frustule, fitting together like the halves of a Petri dish.
- valve view*: appearance of a diatom when viewed looking perpendicularly on to the surface of a valve.
- vegetative cell division*: reproduction by formation of a wall across a mother cell producing daughter cells incorporating portions of the mother cell wall, not internal spore formation where daughter cells form completely new walls.
- ventral margin*: concave margin of a lunate diatom.
- zoospore*: motile, asexual spore, e.g. motile spores of *Chlorococcum* spp.
- zygospore*: thick-walled resting spore resulting from the union of gametes.

VI. COMPARISON OF THE THREE TECHNIQUES USED FOR RECOVERY OF ALGAE

BEFORE comparing the distribution patterns of the algae, it is first necessary to examine critically the three techniques used for analysis of the samples as some sites were not examined by all of these. It is possible that a proportion of the algal flora of these sites was overlooked.

Material from all subaerial sites was examined by direct microscopic examination and culture in mineral salts medium. 33 sites were additionally examined by moist plate enrichment culture (Table IV). Samples from the aerial sites were studied solely by direct microscopic examination. The total numbers of taxa of each class of algae recovered by each method of sample examination are given in Table III. Each method is considered below and the validity of making comparisons between the floras of different sites is assessed.

TABLE III
NUMBERS OF TAXA OF EACH CLASS OF ALGAE RECOVERED
BY EACH METHOD OF SAMPLE EXAMINATION

Class	Total number of taxa	Number of taxa recovered by each technique		
		D	M	C
Cyanophyceae	49	25	34	17
Dinophyceae	1	1	1	0
Chrysophyceae	1	1	1	0
Xanthophyceae	17	1	7	15
Bacillariophyceae	30	28	22	5
Euchlorophyceae	34	9	9	27
Ulothricophyceae	20	7	9	16
Zygophyceae	10	2	10	0
TOTAL	162	74	93	80

D—Direct microscopic examination; M—Moist plate enrichment culture; C—Culture in mineral salts medium (BBM).

1. Direct microscopic examination

The taxa which were identified tended to have distinctive vegetative features which could be seen without resorting to culture techniques. The Cyanophyceae could often be identified by the morphology of the vegetative cells or trichomes and the Bacillariophyceae from the acid-cleared frustules, hence the high recovery of members of these classes (Table III). When internal cell structure or life-cycle information was required, as was frequently the case with the Xanthophyceae, Euchlorophyceae and Ulothricophyceae, direct microscopic examination was unsuitable and low numbers were recovered. Members of these classes were often either unhealthy, with disorganized cell contents, or were filled with storage granules, particularly oil, which masked many of the internal cell characters necessary for identification, and only rarely were they observed in the process of spore formation.

When algae were present in only low numbers, they were unlikely to be seen during direct microscopic examination and were even more inconspicuous if they were small and pale. This technique therefore favoured algae which occurred locally in high numbers. Cells with typical healthy features could often be seen amongst such concentrations. In the aerial habitat *Ulothrix zonata*, *Prasiococcus calcarius*, *Desmococcus vulgaris* and *Prasiola crispa* were found in large numbers in certain sites and were satisfactorily identified by this technique. Similarly, the only two members of the Zygophyceae recognized were the two most frequently occurring in the subaerial sites, *Cylindrocystis brebissonii* var. *minor* and *C. crassa*. Although the other species had distinctively shaped vegetative cells, they were never present in sufficient numbers to be revealed by direct microscopic examination.

2. Moist plate enrichment culture

This technique proved to be the most successful and recovered 93 taxa (Table III), although only 33 of the 72 subaerial sites were treated in this way. Members of the Cyanophyceae and Bacillariophyceae were again the predominant forms recognized and all the species of Zygophyceae were recovered.

This method relies on stimulating the growth of algae in the sample when it is moistened and then incubated in warm light conditions. Material from the cultures was examined on several occasions over a period of 6 months in order that slowly growing algae would have an opportunity to increase in numbers and also to detect possible successions of algae. The growths often became visible to the naked eye and consisted of surface films of mixed algal species.

Algae initially in low numbers which would probably be overlooked during direct microscopic examination were recovered, as demonstrated by the identification of all ten species of Zygothryx. Also, 16 members of the Hormogonales, which were not found during direct microscopic examination, were seen on the moist plates. Nine of these were narrow, pale inconspicuous forms which would have been difficult to discern amongst the large quantities of detritus present during direct microscopic examination.

Living cells of diatoms were more frequent in enrichment cultures than in directly examined field material. Only when it could be confirmed that acid-cleared frustules were actually derived from living cells were the diatom species recorded as present.

Although growths of Euchlorophyceae, Ulothricophyceae and Xanthophyceae were stimulated, the numbers identified did not increase greatly over the numbers identified by direct examination (Table III). Despite healthy vegetative cells being frequent, often a confident identification could not be made as life-cycle information was lacking, and usually this could not be obtained from the mixed growths of algae on the enrichment plates.

3. Culture in mineral salts medium

Only one type of medium was used for the cultures and the selectivity of this is apparent in the results (Table III). The success in the recovery and identification of the Xanthophyceae, Euchlorophyceae and Ulothricophyceae is attributable to the excellent growth of many species on this medium. The algae could then be isolated into uni-algal cultures which were indispensable for accumulating life-cycle information (Bold, 1970).

Because of the considerable differences in the types of algae recovered by the three techniques, it is clear that the use of only one technique, in a study of this sort, could lead to a false impression of the algal flora and its distribution by habitat. Ideally, to obtain the most complete list of algae, all three methods should be used on all sites, particularly the subaerial sites. However, in the present study, limitations of time and materials did not allow this.

The lists of algae from the aerial sites, although compiled only from direct microscopic examination, are thought to be complete for the taxa which dominate the macroscopic growths seen in this habitat. Algae present in low numbers as relatively insignificant members of the flora would probably have been recovered by culture. Allen (1971) regarded these algae as important and considered that a limited understanding of the whole vegetation is obtained, if the dominant species are allowed to overshadow the lesser species which are at the limits of their environmental tolerance and are therefore good indicators of environmental limiting factors. In any further study of the aerial algae on Signy Island, it is agreed that these should be investigated. Schlichting (1975), in a study of aerial algae in Ireland, used culture techniques and identified 50 algal taxa including several members of the Chlorophyta which can only be identified with confidence from cultures. In the 39 subaerial sites not examined by the moist plate technique, the algae which were recovered only from moist plates could have been overlooked as could other algae present in low numbers. Thus the 33 sites examined by moist plate culture can be regarded as the only fully investigated sites.

In a comparative study of the methods of analysis of the soil algal community, Forest (1962) also found that direct examination of soils failed to detect many species. However, cultures on mineral salts agar medium and moist plate enrichment cultures compared well and both generally gave a similar analysis of the algal community. In the present study the poor growth of many of the Cyanophyceae, Bacillariophyceae and Zygothryx on the BBM mineral salts medium made moist plate enrichment culture the most satisfactory means of analysis.

VII. DISTRIBUTION PATTERNS OF TERRESTRIAL ALGAE ON SIGNY ISLAND

1. Presentation of the data

The distribution of 150 taxa of algae in 72 subaerial sites is presented in Table IV and of 34 taxa in 50 aerial sites in Table V. The total number of taxa of each class are shown in Tables III and VI. Cyanophyceae can be seen to dominate the overall flora (Table III) and both the floras of the subaerial and aerial

TABLE VI
NUMBERS OF TAXA OF EACH ALGAL CLASS RECORDED FROM
SUBAERIAL AND AERIAL HABITATS

Class	Numbers of taxa	
	Subaerial habitat	Aerial habitat
Cyanophyceae	44	16
Dinophyceae	1	0
Chrysophyceae	0	1
Xanthophyceae	17	1
Bacillariophyceae	26	10
Euchlorophyceae	33	2
Ulothricophyceae	19	4
Zygomycetes	10	0
TOTAL	150	34

sites (Table VI) with Euchlorophyceae and Bacillariophyceae abundant in the subaerial habitat and only Bacillariophyceae having numbers of taxa approaching those of the Cyanophyceae in the aerial habitat. The aerial habitat contained a considerably lower number of taxa than the subaerial habitat.

The total numbers of taxa recovered from each subaerial site are given in Table IV. These data are condensed in Fig. 28 in which the mean total numbers of taxa and the mean numbers of taxa of each class are shown in six divisions of the sites from the subaerial habitat. The mean percentage composition of the algal floras of each of these divisions is given in Fig. 29.

The total numbers of taxa in each aerial site are given in Table V. These data are condensed in Fig. 30 in which the mean total numbers of taxa and the mean numbers of taxa of each class are shown in four divisions of the sites from the aerial habitat. The mean percentage composition of the algal flora of each of the four divisions is given in Fig. 31.

An examination of Tables IV and V reveals that each alga can be categorized according to whether:

- i. It was rarely found with only a few occurrences.
- ii. It was recovered from several sites but did not occur in more than 50 per cent of the sites of any of the divisions of the terrestrial habitat made in Figs. 28 and 30.
- iii. It was recovered from more than 50 per cent of the sites in one or more of these divisions of the terrestrial habitat.

The first category is unimportant with regard to the general pattern of algal distribution, although quantitative examination may reveal such algae to be important in the few sites in which they were found. Algae in the second category are more difficult to assess. Although they occur in several sites, sometimes in one of the divisions and sometimes scattered throughout several divisions, they are unimportant within any one. A list of the third category, the most important terrestrial algae, is given in Table VII.

2. Effects of environmental factors on the distribution of algae

a. *General comparison of the subaerial and aerial habitats.* Sites in the aerial habitat were subjected to harsher climatic conditions than sites in the subaerial habitat which limited the number of algae capable of surviving in the former (Table VI). During the 7–8 months winter the algae were exposed to prolonged periods of low air temperatures, which fell as low as -39°C , and high wind speeds. Most of the aerial sites were without an insulating snow cover, which if present would have protected the algae from the coldest conditions. In addition, temperature fluctuations were often rapid and large. The temperature of exposed rock

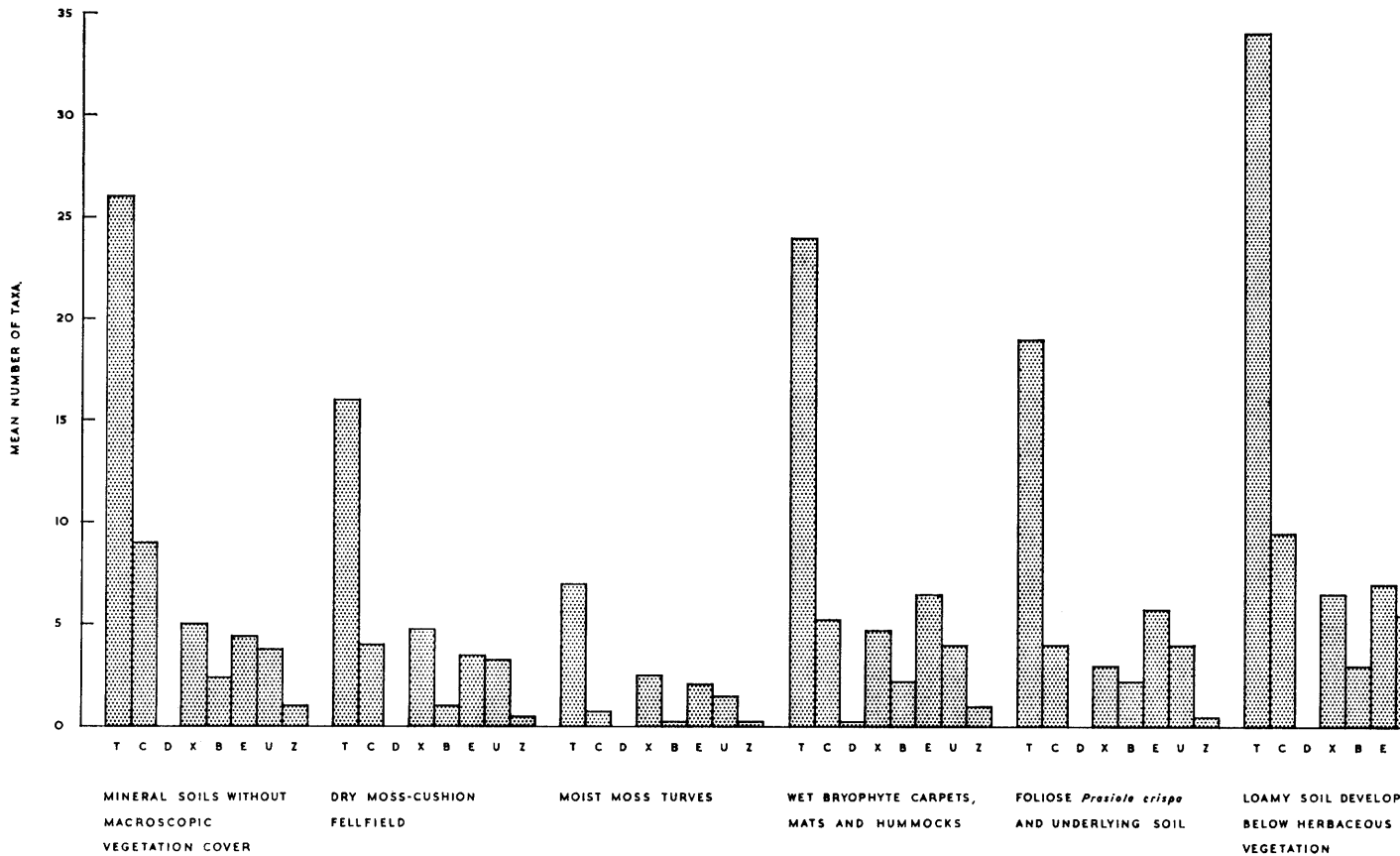


FIGURE 28

Mean numbers of taxa recovered from six sub-divisions of sites from the subaerial habitat. T, total number of taxa; C, Cyanophyceae; D, Dinophyceae; X, Xanthophyceae; B, Bacillariophyceae; E, Euchlorophyceae; U, Ulothricophyceae; Z, Zygothryx.

surfaces rose rapidly to above freezing when exposed to direct sunlight even if air temperatures were well below 0°C . In summer the water supply was irregular and the algal substratum was continually fluctuating between drought and saturation conditions. During early summer, water was abundantly supplied to many of the sites from melting winter snow. Later, only a few sites received water from late-lying snowdrifts and permanent ice and snow, the remainder having to rely on precipitation and atmospheric moisture for their supply.

In contrast, the sites in the subaerial habitat were milder allowing the development of a richer algal flora (Table VI). They were often protected in winter from low temperatures and large temperature fluctuations by the snow cover. Moisture content, although variable between individual sites, was usually adequate throughout summer as the mineral or organic substrata conserved water which was available to the algae when precipitation was low or snow melt had largely ceased.

The algae in Table VII, 46 taxa or 28 per cent of the total flora, can be regarded as the most important and typical terrestrial algae of Signy Island. Seven of these, *Gloeocapsa gelatinosa*, *Merismopedia tenuissima*, *Nostoc punctiforme*, *Plectonema battersii*, *Fragilaria virescens*, *Ulothrix zonata* and *Desmococcus vulgaris*, were only recorded with high frequency from aerial sites and were particularly suited to this habitat. 36 taxa were frequently present only in the subaerial habitat and the remaining three taxa, *Phormidium* cf. *priestleyi*, *Navicula mutica* and *Prasiococcus calcarius*, were intermediate in their habitat requirements, occurring in both the subaerial and aerial habitats. In the subaerial sites, only two species, *Monodus subterraneus* and *Stichococcus bacillaris*, had a wide ecological amplitude, being frequent in all the divisions; *Botrydiopsis constricta* was frequent in all but one division and *Gloeobotrys terrestris* and *Chlamydomonas chlorostellata* in all but two divisions. These five species can be regarded as the ones most suited to the wide range of environmental conditions presented by the subaerial habitat.

TABLE VII
ALGAE WHICH OCCUR IN MORE THAN 50 PER CENT OF THE SITES OF AT LEAST
ONE DIVISION OF THE TERRESTRIAL HABITAT

Taxa	Divisions of sites in the terrestrial habitat									
	Mineral soils without macroscopic vegetation cover (sites 1-13)	Dry moss-cushion fellfield (sites 14-29)	Moist moss turves (sites 30-40)	Wet bryophyte carpets, mats and hummocks (sites 41-60)	Foliose <i>Prasiola crista</i> and underlying soil (sites 61-63)	Soils below herbaceous vegetation (sites 64-72)	Dry exposed rock surfaces (sites 73-93)	Rock surfaces irrigated with melt water; in sea-spray zone but not in immediate vicinity of nesting birds (sites 94-101)	Rock surfaces irrigated with melt water in immediate vicinity of nesting birds (sites 102-111)	Moist cracks and crevices in marble rocks (sites 112-122)
Cyanophyceae										
<i>Aphanocapsa muscicola</i>				+	+	+				
<i>Gloeocapsa gelatinosa</i>										+
<i>Merismopedia tenuissima</i>										+
<i>Nostoc muscorum</i>				+		+				
<i>Nostoc punctiforme</i>										+
<i>Oscillatoria amoena</i>	+									
<i>Oscillatoria subtilissima</i>	+									
<i>Phormidium autumnale</i>	+				+	+				
<i>Phormidium foveolarum</i>	+					+				
<i>Phormidium priestleyi</i>	+				+	+			+	
<i>Phormidium</i> cf. <i>rubroterricola</i>						+				
<i>Plectonema battersii</i>										+
<i>Pseudanabaena catenata</i>				+		+				
Xanthophyceae										
<i>Botrydiopsis constricta</i>	+	+		+	+	+				
<i>Gloeobotrys terrestris</i>	+	+		+	+	+				
<i>Monodus subterraneus</i>	+	+	+	+	+	+				
Unidentified genus of Pleurochloridaceae		+	+							
<i>Heterococcus chodati</i>							+			
<i>Heterothrix debilis</i>							+			
<i>Heterothrix exilis</i>	+						+			
<i>Tribonema vulgare</i>							+			
Bacillariophyceae										
<i>Fragilaria virescens</i>								+		
<i>Navicula mutica</i>							+		+	
<i>Navicula permitis</i>	+									
<i>Pinnularia borealis</i>					+	+				
<i>Pinnularia mesolepta</i> var. <i>angusta</i>						+				
Euchlorophyceae										
<i>Chlamydomonas chlorostellata</i>	+			+	+	+				
<i>Chloromonas rosae</i>						+				
<i>Chloromonas palmelloides</i>			+			+				
<i>Chlamydocapsa lobata</i>				+	+	+				
<i>Chlorella vulgaris</i> var. <i>autotrophica</i>	+				+	+				
<i>Chlorococcum ellipsoideum</i>						+				
<i>Chlorococcum humicolum</i>						+				
<i>Rhopalocystis oleifera</i>				+						
<i>Sphaerocystis oleifera</i>			+							
<i>Sphaerocystis signiensis</i>		+								
<i>Trochiscia</i> sp. A							+			
Ulothricophyceae										
<i>Chlorhormidium flaccidum</i>		+		+		+				
<i>Stichococcus bacillaris</i>	+	+	+	+	+	+				
<i>Ulothrix zonata</i>								+		
<i>Prasiococcus calcarius</i>					+		+			
<i>Prasiola crista</i>					+	+				
<i>Desmococcus vulgaris</i>							+			
<i>Planophila</i> sp. A	+						+			
Zygophyceae										
<i>Cylindrocystis brebissonii</i> var. <i>minor</i>							+			
<i>Cylindrocystis crassa</i>							+			
TOTAL NUMBER OF TAXA	14	7	5	11	14	30	2	2	2	4

+ Indicates the divisions of the terrestrial habitat in which each alga occurs in more than 50 per cent of the sites.

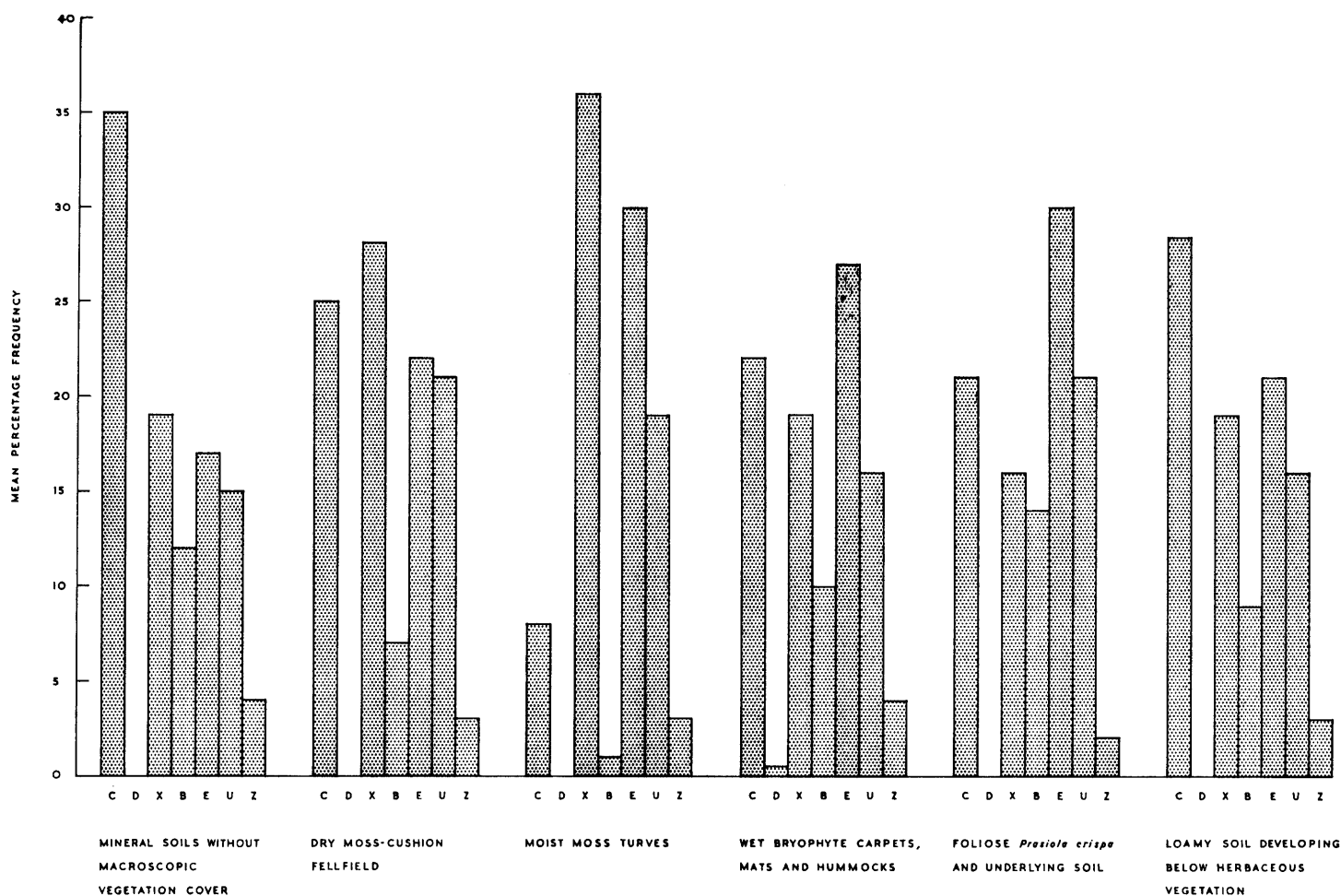


FIGURE 29

Mean percentage composition of algal floras of six sub-divisions of sites from the subaerial habitat. C, Cyanophyceae; D, Dinophyceae; X, Xanthophyceae; B, Bacillariophyceae; E, Euchlorophyceae; U, Ulothricophyceae; Z, Zygophyceae.

b. *Algae of the subaerial habitat.* The mineral soils without macroscopic vegetation cover were of diverse types (Tables I and II) and this was reflected in the wide range of richness and composition of the algal floras of the individual sites (Table IV). However, the sites on the whole were dominated by Cyanophyceae (Fig. 29) and had the second highest mean total number of taxa per site (Fig. 28). The only site which lacked Cyanophyceae was site 5, a soil derived from acid quartz-mica-schist in an exposed situation where leaching must have been considerable. The nutrient and base status of this site were probably lower than the remainder which were either derived wholly from basic rocks, containing fragments of base-rich marble and amphibolite, or were in the vicinity of nesting birds or seal-wallow areas. Soils at sites 8 and 9, also derived from the acid rock but near to birds' nesting areas where nutrient input would be raised, especially that of nitrogen and phosphorus, contained Cyanophyceae in their flora. The soil at site 12, although of base-rich material, was on an exposed rock ledge and had been formed comparatively recently by *in situ* decay of the rock. The immaturity and degree of exposure of the site were reflected in the sparse algal flora. A similar relationship was seen on the moraine soils of Orwell Glacier (sites 1 and 2), where soil from the inner, more recently exposed ramp, had a less diverse flora than that of the outer older ramp. Bacillariophyceae also constituted a larger proportion of the flora in this division of the subaerial habitat than in any of the others (Fig. 29) and *Navicula permitis* was especially suited to the mineral soils (Table VII). All the remaining frequently occurring algae of the mineral soils were also shared by the soils below herbaceous vegetation (Table VII), indicating a close relationship between the algal floras of these two divisions.

The dry moss-cushion fellfield sites had a relatively poor algal flora (Fig. 28), although again there was

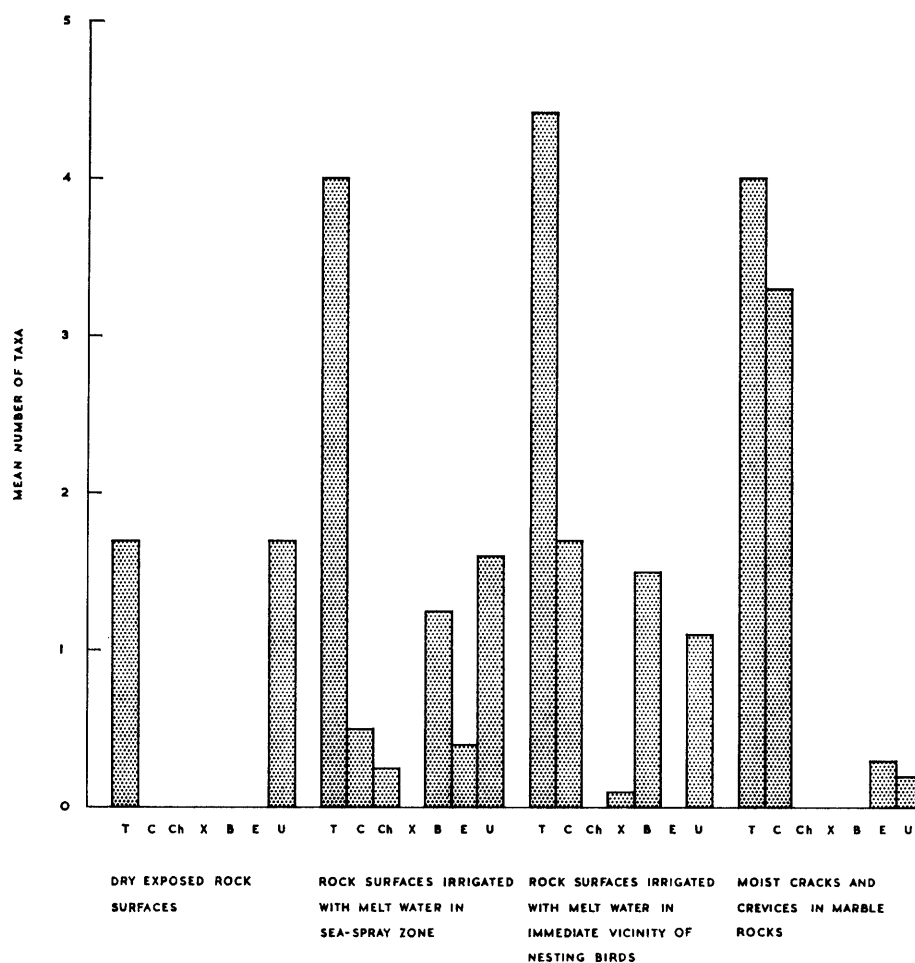


FIGURE 30

Mean numbers of taxa recovered from four sub-divisions of sites from the aerial habitat. T, total number of taxa; C, Cyanophyceae; Ch, Chrysophyceae; X, Xanthophyceae; B, Bacillariophyceae; E, Euchlorophyceae; U, Ulothricophyceae.

some diversity within this division as a whole (Table IV). Sites 16–24, which consisted of cushions of *Andreaea* spp., occupied the most exposed snow-free areas on Signy Island and were the most prone to desiccation on days of high insolation, especially when combined with high winds. In addition, many of the sites did not receive melt water. This was probably a major factor in limiting the diversity of the algal flora amongst these mosses (Table IV). Because of the only slight accumulation of peat under the living moss, nutrients in the underlying mineral soil were probably utilized unlike under the thick peat deposits of the moss turves. As in the mineral soils without macroscopic vegetation cover, the occurrence of Cyanophyceae amongst *Andreaea* spp. was probably a result of an increased availability of basic cations. This effect was more apparent in sites 25–29 where *Dicranoweisia grimmiaea*, *Tortula* spp. and *Pottia austrogeorgica* all received nutrients from nesting birds or were on base-rich marble soils. In consequence, they contained a generally more diverse flora with a greater representation of Cyanophyceae and Bacillariophyceae than amongst the *Andreaea* spp. cushions (Table IV). Only one alga, *Sphaerocystis signiensis*, was particularly frequent in this division of sites alone and the remaining six frequent algae (Table VII) were also shared by other site divisions.

The moss turves formed a quite homogeneous division. All consisted of quite acid (pH 4.0–4.8), deep peat banks which, although not containing as high a water content as in the bryophyte carpets, mats and hummocks (sites 41–60), remained moist throughout summer. The algal flora of these sites contained markedly few Cyanophyceae and Bacillariophyceae, and the mean total number of taxa per site was low (Figs. 28 and 29). The acid base-poor conditions were detrimental to the establishment of a diverse algal flora. Even at site 39, where wallowing seals had killed the moss cover, the flora showed little difference

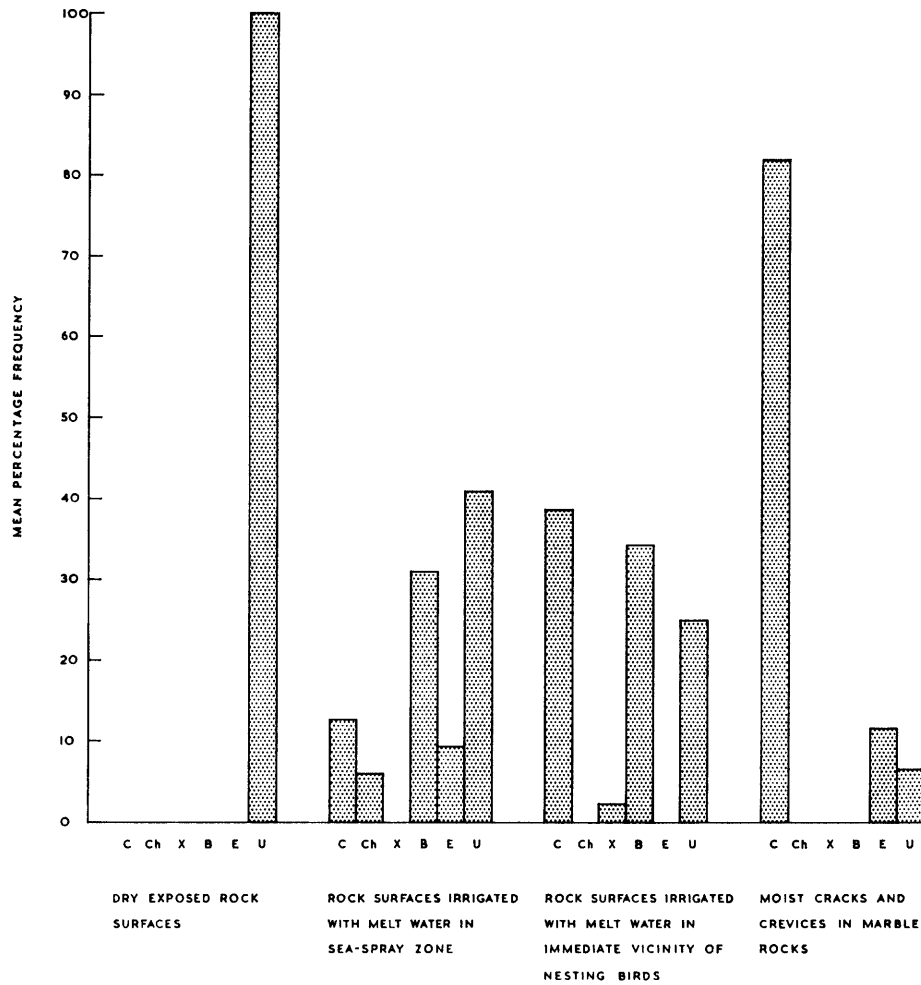


FIGURE 31

Mean percentage composition of algal floras of four sub-divisions of sites from the aerial habitat. C, Cyanophyceae; Ch, Chrysophyceae; X, Xanthophyceae; B, Bacillariophyceae; E, Euchlorophyceae; U, Ulothricophyceae.

from the sites with a living moss cover. Leaching of nutrients from the upper layers of the contaminated peat may have prevented the establishment of a flora more typical of other bird- or seal-affected sites, e.g. the presence of *Phormidium autumnale*, *Navicula mutica*, *Chlorella vulgaris* var. *autotrophica* and *Prasiola crispa* at sites 13, 29, 61 and 62. *Sphaerocystis oleifera* appeared to be particularly suited to growth amongst moss turves (Table VII) but two of the remaining five frequent species, *Monodus subterraneus* and *Stichococcus bacillaris*, were widely distributed and tolerant of a wide range of conditions.

The wet bryophyte carpets, mats and hummocks were a diverse group of sites, both in the constituents of the bryophyte vegetation, the nutrient relations and the water content (Table II), although the latter was generally higher than in any of the other divisions. The algal flora was generally richer than in other sites with cryptogamic vegetation (Fig. 28) but poorer than in the mineral soils without macroscopic vegetation cover and the soils below herbaceous vegetation. All the major classes of algae were well represented, with Euchlorophyceae dominant, as was the case in the *Prasiola crispa* and underlying soils division. The individual sites did, however, show variations in the richness and diversity of their algal floras. The large number of species at site 47 (Table IV) was probably a consequence of the favourable nutrient concentrations in this base-rich site and the slight flushing of the slope with water flowing down the gentle gradient. Site 41, the most acid site in this division in a flat boggy area, had a less diverse flora in which Cyanophyceae and Bacillariophyceae were far less frequent. *Rhopalocystis oleifera* was the only alga particularly characteristic of this division (Table VII). The remaining frequent algae were also recovered from other divisions.

Only three sites dominated by *Prasiola crispa* were sampled but, from the limited data, it appeared that

in general richness and composition of the algal flora (Figs. 28 and 29) this division was most similar to the wet bryophytes.

The soils from below herbaceous vegetation contained by far the richest algal flora (Fig. 28) and individual sites consistently contained a high number of taxa (Table IV). The vascular plants grew on moist sheltered slopes which received maximum insolation. The warm micro-climate, with temperatures up to 30° C on days of high insolation (Edwards, 1972), would have been favourable for algal growth. Water was usually supplied from melting snow and ice higher up the slopes and good drainage prevented the soils from becoming waterlogged. Nutrients from birds' nesting areas, which were often present in the vicinity of the herbaceous vegetation stands were carried down-hill in solution. The loamy soils were the most mature on the island and had a rich heterotrophic micro-flora (Heal and others, 1967), which would have aided in the mineralization of organic matter. This combination of moist nutrient-rich soil and a favourable micro-climate was responsible for the rich algal flora. A large number of algae was particularly frequent in these soils and eight of these were frequent in this division alone (Table VII). According to Edwards (1972), the present-day patterns of distribution and abundance of *Deschampsia antarctica* agree well with the sequence of glacial retreat postulated by Matthews and Maling (1967). Individual and small groups of plants of the grass are commonest in those areas which have been deglaciated most recently, while large and small swards have developed only in areas which have been snow- or ice-free for longer periods. The eight taxa of algae which were largely restricted to the grass sites may represent forms which have been able to colonize Signy Island only since the amelioration of the climate following the last major glacial retreat. Their scattered occurrences in other sites may be evidence of their slow colonization of other suitable situations where conditions are not so favourable.

c. *Algae of the aerial habitat.* The dry, exposed rock surfaces supported a total of only three species of algae, *Prasiococcus calcarius*, *Prasiola crispa* "Hormidium" stage and *Desmococcus vulgaris*, with a mean of less than two species per site (Fig. 30). The latter species was particularly characteristic of these sites as indicated by its inclusion in Table VII. Despite only being represented by few taxa, the algae were in high numbers as indicated by the bright green macroscopic rock-encrusting growths, although these may have accumulated over a long period. These sites were subjected to the harshest conditions of all those in which free-living algae were found. Unlike the other three divisions of the aerial habitat where moisture was more readily available, supplied by melting snow or conserved in cracks and crevices in the rock, water in summer was only supplied by precipitation and atmospheric moisture after melting of the winter snow accumulations. Algae inhabiting these sites had to be resistant to long periods of drought. There was no large difference between acidic and basic rock substrata (Table V) and it appeared that moisture was the major limiting factor.

Irrigated sites in the sea-spray zone, not in the immediate vicinity of nesting birds, were distinctly different in the composition of their algal flora from irrigated sites which were in the immediate vicinity of nesting birds (Tables V and VII; Fig. 31), though both had a similarly higher mean total number of taxa than the previous division due to the increased water availability. Two species, *Ulothrix zonata* and *Fragilaria virescens* were particularly characteristic of the sea-spray zone (Table VII), macroscopic filamentous growths of the former appearing on coastal rocks towards the end of winter when snow melt from cliffs and slopes above flowed down over the sites. These then survived desiccation when the melt flow ceased in early summer and, when the winter sea ice had dispersed from around the coasts, they survived periodic splashing by sea-water. The sites affected by birds lacked these two species but contained two characteristic species of their own, *Navicula mutica* and *Phormidium* cf. *priestleyi*, both of which also occurred in the subaerial habitat. These sites also had a higher proportion of Cyanophyceae (Fig. 31) due to the increased nutrients brought down to the sites dissolved in water which had percolated through birds' nesting areas.

The moist cracks and crevices in the marbles had a distinct flora richer in Cyanophyceae than any of the other three divisions (Fig. 31). This class of algae appeared particularly capable of growth on the calcium-rich marbles and four species, *Gloeocapsa gelatinosa*, *Merismopedia tenuissima*, *Nostoc punctiforme* and *Plectonema battersii*, were characteristic of this division of the aerial habitat alone (Table VII). The mean total number of species equalled those of the irrigated sites (Fig. 30) and it is thought that retention of moisture in the cracks and crevices and in the mucilaginous secretions of many of the Cyanophyceae was responsible for this.

VIII. DISCUSSION OF THE RESULTS IN RELATION TO OTHER INVESTIGATIONS

FEW other studies of all groups of terrestrial algae in an Antarctic region have been conducted and, as stated by Koob (1967), this makes it difficult to form valid conclusions concerning their distribution patterns in the Antarctic. Many of the studies of Antarctic algae have been performed on incomplete preserved collections of algae from a few localities, for instance, the terrestrial algae in the collections studied by Fritsch (1912*a, b*, 1917) and West and West (1911*b*); others have concentrated on one type of algae, for instance, Bunt (1954), who studied the diatoms of Macquarie Island. However, the data so far collected show the Signy Island terrestrial algal flora to be generally similar in its composition to the non-marine flora, including both terrestrial and fresh-water forms, given by Koob (1967), with a preponderance of Cyanophyceae, followed by Chlorophyta and then Bacillariophyceae (Table III). However, the number of Xanthophyceae is higher with 17 species from Signy Island compared with only six in all previous studies. The alpine soil algal flora of Europe similarly contains a high proportion of Xanthophyceae, as shown by the studies of Vischer (1945) and Reisinger (1964). Whether this is due to common features of the environment in these two regions requires further study. The terrestrial algal flora of Signy Island contrasts with that of Arctic regions, where Chlorophyta often predominate (Novichkova-Ivanova, 1972; Bunnell and others, 1975).

A study of the terrestrial algal flora of the Ongul Islands, eastern Antarctica, in which all classes of algae were included (Akiyama, 1968) listed only 32 species belonging to 28 genera. These islands experience a harsh coastal continental climate and it appears that the less extreme maritime Antarctic climate of Signy Island allows the development of a more diverse flora (Table III). On the sub-Antarctic Macquarie Island, Bunt (1954) recorded 44 taxa of diatoms from only ten soils, which is somewhat more than the 30 taxa found in 122 sites on Signy Island. It is probable that the other classes of algae are also represented by a greater number of taxa on Macquarie Island due to its milder climate. The Antarctic Peninsula-Scotia Ridge region would be ideal for the study of the effects of an increase in latitude on the diversity of the terrestrial algal flora, as suggested by Hirano (1965) and Koob (1967).

The general nutrient richness of terrestrial habitats on Signy Island (Holdgate and others, 1967) may be responsible for the high numbers of Cyanophyceae. Nitrates and phosphates, largely derived from the extensive colonies of birds and seals, are distributed throughout the island in wind-blow particles and dissolved in melt water and precipitation (Northover and Allen, 1967). Lund (1947), in the soils of the United Kingdom, also found Cyanophyceae were frequent on nutrient-rich soils. Cyanophyceae and Bacillariophyceae have also been found to be infrequent in acid soils (John, 1942; Lund, 1947; Flint, 1968) and on Signy Island the acid, moist moss turves contained the lowest abundance of both these classes (Fig. 28). Fogg and Stewart (1968) and Horne (1972) both reported *Nostoc* sp. only from neutral or alkaline areas on Signy Island. However, in the present more extensive study *Nostoc muscorum* was recovered from slightly acid sites and was an important member of the algal flora of the carpets of *Calliergon sarmmentosum* at site 42 (pH 4.9), part of the Signy Island terrestrial reference site (SIRS) 2. The ecology of the algae at this site has been discussed by Broady (1979*a*). John (1942) and Lund (1947) found Xanthophyceae were also characteristic of more alkaline sites. On Signy Island, this class was only slightly less abundant in the acid moss turves than in the other divisions of the subaerial habitat (Fig. 28) and, despite the presence of only a few species, it still dominated the flora of the moss turves (Fig. 29). In the similarly acid heathland soils studied by John (1942), Chlorophyta were the most abundant forms present and low numbers of Xanthophyceae were reported.

Calcium-rich sites also contained a majority of Cyanophyceae. In the subaerial sites this is best illustrated by comparing the nodular, mineral marble soil (site 10) with the acid, calcium-poor mineral soil (site 5), and *Tortula fuscoviridis* cushions on marble soil (site 27) with similarly exposed *Andreaea* spp. cushions on soils largely derived from the acid quartz-mica-schists (sites 14-24). In both cases the former had a high proportion of Cyanophyceae and the latter a low proportion. This agrees with the results in the United Kingdom of John (1942) and Lund (1947), who also found that Cyanophyceae were largely calcicolous. Fogg and others (1973) stated that the apparently good growth of Cyanophyceae in calcium-rich soils may be related to the need for the alkaline to neutral conditions often present in such soils. This may be the case on Signy Island. John (1942) and Lund (1947) also found Xanthophyceae were calcicolous but no

such correlation was apparent on Signy Island. In the aerial habitat, Cyanophyceae dominated the marble sites (112–122) (Fig. 31). This was also the case in the studies of Jaag (1945) in Switzerland, Fjerdingstad (1965) in France and Allen (1971) in Wales.

Other studies have commented on the importance of water for the growth of terrestrial algae. Petersen (1928, 1932*a*) recovered most taxa from moist sites in Iceland and Denmark. Cameron (1972*c*), in the Antarctic, and Bunnell and others (1975), in the Arctic, both noted that the longer the period that water was available at a site then, in general, the more abundant and diverse were the algae. Despite the often plentiful supply of water on Signy Island, the moss-cushion fellfield sites were prone to desiccation in summer and had a less diverse flora than the generally wet bryophyte carpets, mats and hummocks (Fig. 28). This was also true of the relatively dry moss turves but here the acidity of the sites was probably an additional limiting factor. Petersen (1928, 1932*a*) found Bacillariophyceae were the class least resistant to drier conditions and Brendemühl (1949) also recovered more from wetter soils. Likewise, in the present study, this class occurred with lowest numbers of taxa in the two driest divisions of the subaerial habitat, amongst the moss-cushion fellfield and the moss turves (Fig. 28). Similarly, in the aerial habitat the dry, exposed rock surfaces had a low diversity of algae, whereas the two water-irrigated divisions of the sites had an increased diversity (Fig. 30) especially with regard to the proportion of diatoms (Fig. 31). Although not irrigated by melt water, the aerial marble sites on Signy Island conserved moisture in the narrow cracks and in this aspect were similar to the chasmolithic habitats described in rocks in the Negev Desert, Israel, by Friedmann and others (1967). These sites also had a higher mean total number of taxa than the dry aerial sites (Fig. 30), although conditions were still apparently not moist enough for the growth of Bacillariophyceae (Fig. 31). They were also similar to the diaphanous substrata reported by Cameron and Blank (1966) in desert soils, where algae grew beneath translucent pebbles. The marbles on Signy Island transmitted sufficient incident light to allow the growth of algae under flakes of marble up to about 1.5 cm. in thickness.

Lund (1967) mentioned that waterlogging is unfavourable to the growth of soil algae, best growth occurring in damp soil. This may contribute to the lower mean total number of taxa in the often waterlogged bryophyte carpets, mats and hummocks than in the moist but well-drained soils developing below herbaceous vegetation (Fig. 28) although the input of dissolved nutrients in water flushing the latter sites is undoubtedly of equal or greater importance.

It is apparent that the algae on Signy Island are able to colonize a wide range of terrestrial habitats from moraines, solifluction stripes and frost-sorted soil polygons and soils grossly contaminated by birds and seals, all of which are either mechanically or chemically unsuited to herb, bryophyte or lichen growth, to the comparatively mature soils below herbaceous vegetation stands. Also, in the aerial habitat free-living algae, though not as widespread as lichens, are able to colonize equally unfavourable sites. The presence of an epiphytic algal flora on the lichens or in dust and soil particles accumulating around lichen thalli has not been investigated but it is likely to be present. The harsh climate, compared with more temperate areas, and the short 3–5 month growing season still permit members of a diverse algal flora to maintain their reproductive capacity. Holdgate (1964) showed that the environment at ground level on Signy Island is considerably more favourable for plant growth than ambient data alone suggest. However, the environmental factors responsible for the patterns of distribution of the terrestrial algae on Signy Island which the present study has outlined require further study. Only careful measurement of factors, such as water content, duration of water availability, nutrient content of soils and water supplies and pH, in a number of sites in which the total algal flora has been identified, combined with cultural studies of growth requirements, will elucidate the reasons for the distribution patterns. Also, before conclusions can be drawn regarding the relationship of the Signy Island terrestrial flora to the terrestrial algae in other Antarctic regions, further analyses of the total algal floras of other areas must be performed.

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APPENDIX

INDEX TO GENERA AND SPECIES

Synonyms are shown in italics

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