QUANTITATIVE STUDIES ON THE TERRESTRIAL ALGAE OF SIGNY ISLAND, SOUTH ORKNEY ISLANDS

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ABSTRACT. Counts of algal cells and filaments in 50 sites representing six terrestrial habitats are given. The Euchlorophyceae, Ulothricophyceae and Xanthophyceae were enumerated using a culture method but this was not so successful for the Cyanophyceae and Diatomophyceae which often required a direct microscopic count. Mean total culture counts of algal propagules in each habitat ranged from 219×10^3 cm.$^{-2}$ in a fellfield moss to $7,641 \times 10^3$ cm.$^{-2}$ in soil below herbaceous vegetation. The depth distribution of algae in two sites and the vertical micro-distribution in the upper stratum of three bryophyte stands was also investigated. Reasons for the differences in the counts of algae in the various habitats are discussed, and numbers found on Signy Island are compared with those found in similar studies elsewhere.

QUANTITATIVE assessments, in terms of biomass, cell numbers, chlorophyll content, etc., of terrestrial algae are few and techniques for their accurate estimation have not yet been fully developed (Lund, 1967). Counts of algae in Antarctic soils are especially limited and only soils devoid of bryophyte, lichen or herbaceous vegetation had been examined prior to the present study (Cameron and Benoit, 1970; Cameron and Devaney, 1970; Cameron and others, 1970). Quantitative accounts of the ecology of the terrestrial algae in two contrasting bryophyte stands on Signy Island, South Orkney Islands (Signy Island terrestrial reference sites 1 and 2), have been given by Broady (1977, 1979). These included data on the seasonal changes in populations and the horizontal and vertical distribution of the algae. A systematic account of the terrestrial algae of Signy Island and their qualitative distribution throughout 123 sites is to be given by Broady (in press). The present paper provides quantitative data for the numbers of algae, especially the Euchlorophyceae, Ulothricophyceae and Xanthophyceae, present in various terrestrial habitats on the island. Information on the vertical distribution of the algae is also given.

MATERIALS AND METHODS

Sites examined

Counts of algae were performed on samples from 50 terrestrial sites, all of which were in the subaerial category as defined by Broady (in press). Short descriptions of the sites are given in that report. Six types of soil or vegetation were examined:

i. Mineral soils devoid of macroscopic vegetation.
ii. Moist moss turf consisting of *Polytrichum alpestre* Hoppe and *Chorisodontium aciphyllum* (Hook f. et Wils.) Broth.
iii. Short cushions of *Andreaea* spp. in dry fellfield habitats.
iv. Wet bryophyte stands dominated by either *Calliergon sarmentosum* (Wahlenb.) Kindb., *Brachythecium austro-salebrosum* (C. Muell.) Par., *Drepanocladus uncinatus* (Hedw.) Warnst. or *Cephaloziella varians* (Gottsche) Steph.
v. Moist loamy soil below herbaceous vegetation consisting of stands of *Deschampsia antarctica* Desv. and, in one instance, the living vegetation and the more mineral soil beneath a stand of *Colobanthus quitensis* (Kunth) Bartl.
vi. A wet relatively organic mud composed of elephant seal excrement, skin and hair partially mixed with mineral soil.

The depth distribution of algae was examined in two sites, one a typical herbfield dominated by *Deschampsia* and the other a typical fellfield dominated by *Andreaea* sp. In addition, the vertical micro-distribution in the upper regions of bryophyte shoots in two stands of *Drepanocladus* and one of dry *Dicranoweisia grimmiacea* (C. Muell.) Broth. was studied. One

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Drepanocladus stand (site 53) was in a boggy area and the other (site 55) was a periodically water-flushed rock face.

The soils of Signy Island have been described by Allen and others (1967) and Holdgate and others (1967), and the macroscopic vegetation by Smith (1972).

Sampling

Aseptic techniques were employed. Sampling took place in either the 1972–73 or the 1973–74 summer when six cores of 1·5 cm.^{2} cross-section were taken in a random manner from each site. Bryophyte samples and the single sample of *Colobanthus quitensis* included the living vegetation. For the vertical distribution study, a single sample was removed from the grass site and two samples from the moss. The samples for the study of the micro-distribution of algae on bryophytes consisted of portions of moss and peat removed without coring.

Treatment of samples

Treatment was within 12 hr. of sampling. The top 1·5 cm. of the six cores from each site were bulked and homogenized in 100 ml. of sterile water for 2 min. at maximum revolutions (14,000 r.p.m.) except for the mineral soils which were treated at half maximum speed for 4 min. At faster speeds there was a danger of the rock fragments breaking the flasks. The plant-culture count and the direct microscopic count techniques described by Broady (1977, 1979) were used.

The plate-culture count alone was used to examine the depth distribution of the algae. Numbers were estimated in successive 1·5 cm. long sections of the cores to a maximum depth of 7·5 cm.

The micro-distribution on the mosses was studied using the direct microscopic examination technique described by Broady (1979). Algae were counted along three moss shoots from each site.

Results and Discussion

Vertical distribution in typical herbfield and fellfield soils

The depth distribution of the algae (Table I) is similar to that found in the two Signy Island terrestrial reference sites (SIRS) (Broady, 1977, 1979) with the majority of the algae occurring in the upper 1·5 cm. (Table I). This has been reported in other studies (Petersen, 1935; Flint, 1958; Lund, 1967), although sometimes the largest population is found a few centimetres below the surface due possibly to the action of rain on superficial growths (Lund,

Table I. Vertical distribution of algae in typical herbfield and fellfield sites

Site	*Numbers of algae* ($\times 10^3$ cm.$^{-2}$)				
	0–1·5 cm.	1·5–3·0 cm.	3·0–4·5 cm.	4·5–6·0 cm.	6·0–7·5 cm.
Moist loamy soil below *Deschampsia antarctica* (site 64)*	4,659	312	53	131	211
Andreaea sp., living vegetation and underlying soil (site 14), core 1	83	28	34	0	–
core 2	64	23	0	–	–

* Only one core taken from the grass site.
– Not determined.

1967). The loamy soil below *Deschampsia* is considerably richer in algae than the mineral soil below *Andreaea* for reasons discussed later, but in the latter a larger proportion of the population occurs in the deeper layers (36 per cent of the total compared with 15 per cent below *Deschampsia*). The exposed habitat occupied by the *Andreaea* restricts the population numbers but farther down the profile conditions are probably not so severe, especially the degree of desiccation in periods of drought, so that despite the lowered light levels a greater proportion of the algae survives.

Micro-distribution along moss shoots

In the three sites in which the micro-distribution of the algae on bryophytes was examined the regions of high algal numbers were restricted even within the upper 1·5 cm. (Fig. 1) and

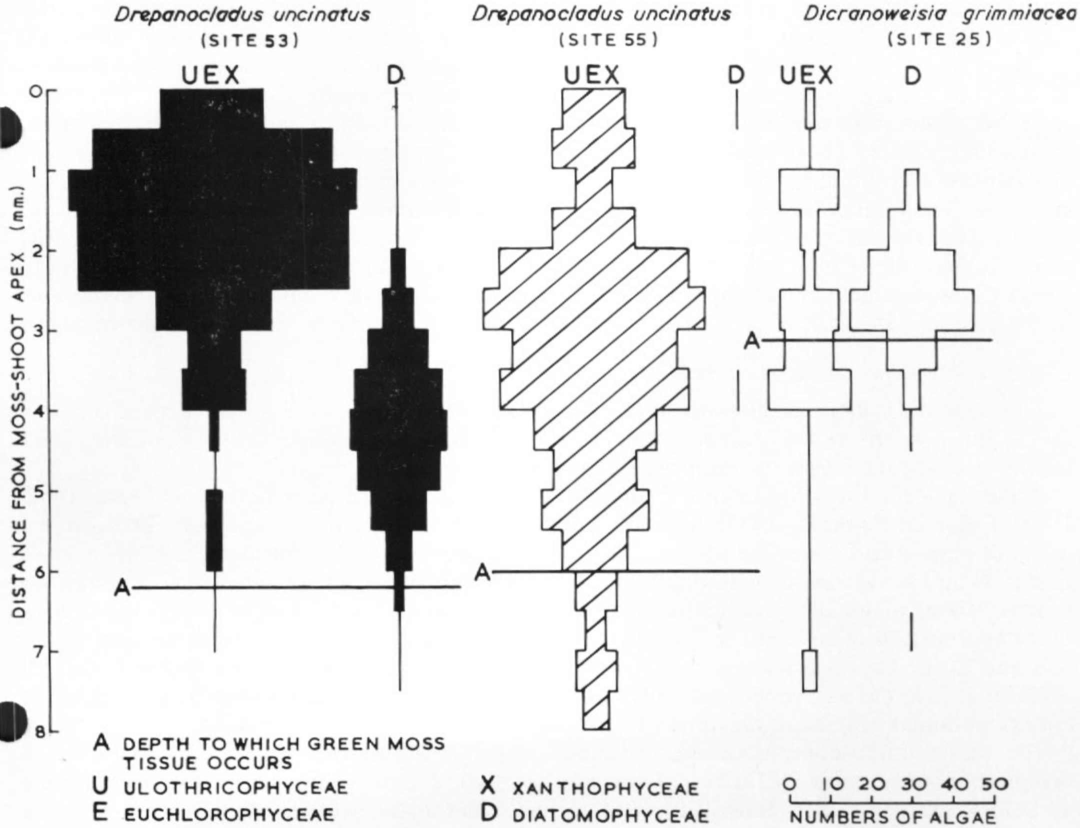

Fig. 1. The micro-distribution of algae along moss shoots from three bryophyte sites. The data are the mean counts of three shoots from each site.

there were few algae below the level to which green moss tissue reached. The same distribution pattern was found at the two reference sites (Broady, 1977, 1979). In relatively dry *Drepanocladus* (site 55), where the majority of algae were members of the Euchlorophyceae, Ulothricophyceae of Xanthophyceae, the algal distribution was similar to that found at SIRS 1 (a *Polytrichum alpestre–Chorisodontium aciphyllum* bank). Low numbers at the moss apices increased to a maximum a few millimetres below the apices and then rapidly decreased lower down the shoot. It is suggested that the highest population develops where light and moisture levels are optimal (Broady, 1977). Above this region the frequent effects of desiccation at the moss apices prevent the establishment of high numbers, while below this level there is insufficient light for optimal photosynthesis. In wet *Drepanocladus* (site 53), in which green and yellow-green algae and diatoms occurred, both had similar regular distribution patterns but occupied different regions of the shoots (Fig. 1). The majority of the green and yellow-green algae occurred between 0·5 and 2·5 mm. with most of the diatoms between 3·0 and 5·5 mm. Similar differences in the regions of the shoots occupied by different groups of algae were found at SIRS 2 (a wet moss carpet dominated by *Calliergon sarmentosum*, *Drepanocladus uncinatus* and *Calliergidium austro-stramineum*) (Broady, 1979). The light and moisture requirements of the green and yellow-green algae may differ from those of the diatoms with the latter possibly being adapted to the lower light level and higher moisture content found lower down the shoots. Amongst the *Dicranoweisia* (site 25) there was no such regular pattern in the distribution of the green and yellow-green algae. However, the diatoms, which in this habitat occupied the same region of the shoots, showed a regular pattern of distribution.

There is little information in the literature on differences in the vertical micro-distribution of different groups of terrestrial algae. Flint (1958) found evidence that the Xanthophyceae were more abundant relative to other groups of algae in sub-surface cultures of certain grassland soils, possibly because of their intolerance of strong light. More detailed investigations are required, combining field studies on a larger range of bryophytes with experimental studies of the light, moisture and possibly nutrient requirements of the algae found on the shoots. The moisture regime of the habitat is thought to be particularly important, probably more so than the type of bryophyte vegetation. Further studies on *Drepanocladus uncinatus*, which has a wide ecological amplitude both edaphically and hydrologically, could be valuable in determining the effects of moisture on the micro-distribution of different types of algae.

Counts in the upper layer of six habitat types

The counts of algae in 50 sites representing six habitat types were all performed on only the upper 1·5 cm. of the sample cores. From the above results and those from the SIRS studies it is apparent that the majority of the algae occur in this region.

Accurate techniques for counting algae in soil have not yet been devised (Forest, 1962, 1965; Fogg and others, 1973). Culture counts often underestimate numbers because the medium employed is selective for certain types of algae. Algae present in the soil as inactive spores would be included in the counts if they developed in culture. The algal colonies on agar or the growths in liquid media may be the result of the development of a single cell or of an aggregation of cells in the form of adhering unicells or filaments. The dispersion of the soil and algae during preparation of the sample suspensions and dilutions will not split all unicellular aggregates, gelatinous colonies and filaments into their component cells. The counts obtained in culture are thus of "propagules" and not individual cells.

The direct microscopic counting technique also has limitations. In the method used in the present study, large quantities of soil and vegetation were suspended in the homogenate and algal cells were often difficult to discern. The mineral soils were found to form too dense a suspension for the technique to be worthwhile. The use of fluorescence microscopy in which the pigments of the algal cells glow red (Tchan, 1952) might have made counts in these soils possible, although the method would not have been any use for counts of algae amongst bryophytes, since there would be interference from the chlorophylls of the bryophyte tissues. The separation of the algae from the soil by centrifugation (Shtina, 1960) might also have made counts of the algae in the mineral soils possible. However, the bryophytes and the algae were of similar density and this method was found unsuitable for counting the algae in such samples. The direct microscopic technique allows the growth form of the algae in the soil to be determined and also permits counts of algae which may be selectively inhibited in culture.

In the present study the culture-count method was used more extensively than the direct microscopic count. The growth medium, Bold's modified Bristol's medium (Chantanachat and Bold, 1962), supported the growth of many species of Euchlorophyceae, Ulothricophyceae and Xanthophyceae but proved to be a poor medium for most of the Cyanophyceae and Diatomophyceae (Broady, in press). Table II gives counts of Cyanophyceae and Diatomophyceae at seven sites where both counting techniques were used. *Nostoc* spp. were recovered with approximately equal efficiency by both methods and the culture counts given in Table III are considered to be a reasonable estimate of the numbers of propagules of these algae in each habitat. The other filamentous Cyanophyceae were most efficiently recovered by the direct microscopic count, the discrepancies between the two techniques being generally large. Even these counts may be underestimates of the numbers of filaments as some species were narrow, pale and inconspicuous, and could have been overlooked amongst the large quantities of soil detritus. In the habitats in which filamentous Cyanophyceae were represented by a large number of species, namely, the mineral soils, wet bryophytes, soils below herbaceous vegetation and the seal-wallow mud (Broady, in press), the culture count is likely to have largely underestimated the numbers. The coccoid Cyanophyceae and the Diatomophyceae were also best counted using the direct microscopic method (Table II). However, the former were not common and direct observation of sample material revealed significant numbers only in sites 42 (*Calliergon sarmentosum*) and 59 (*Cephaloziella varians*). Diatoms were more common, especially in the mineral soils, wet bryophytes and soils below herbaceous vegetation, and the culture counts for these sites are underestimates. For an accurate assessment of total algal numbers in a site, a combination of direct microscopic and culture techniques is required. The technique producing the highest count for each alga should then be chosen for estimating the contribution of each to the total count.

The culture counts are given in Table III. The total counts are mostly composed of Euchlorophyceae, Ulothricophyceae and Xanthophyceae for the reasons described above. The soil below the herbaceous vegetation had a considerably higher population than any of the other habitats. The relatively fertile, moist loamy soil, resembling a brown earth typical of more temperate regions, is the most mature soil on Signy Island (Holdgate and others, 1967). All the principal sites of herbaceous vegetation on the island occur on sheltered north-facing slopes receiving maximum insolation (Smith, 1972) and therefore providing a highly favourable substratum and micro-climate for algal development. Site 65 contained the highest numbers of algae found in this study with a count of $13{,}867 \times 10^3$ algae cm.$^{-2}$. The lowest number found in this habitat was in site 72 where the count was still as high as $2{,}471 \times 10^3$ cm.$^{-2}$. This habitat also contained the most diverse algal flora (Broady, in press). Petersen (1935), using culture counts for algae in cultivated and garden soils in Denmark, counted a maximum of $3{,}000 \times 10^3$ algae cm.$^{-3}$ of soil but most of his counts were between 10 and 400×10^3 algae cm.$^{-3}$ of soil. Lund (1967) listed counts of algae g.$^{-1}$ of soil in diverse soil types from several parts of the world, most of which were below $1{,}000 \times 10^3$ algae g.$^{-1}$ soil.

The second highest populations occurred amongst the moss turves. In the top 2 cm. of moss turves the moisture content is low and most is held in the moss tissues. This, combined with the acid, base-poor nutrient status and the large diurnal temperature fluctuations in the summer, which are probably greater than in other bryophytes with day-time temperatures frequently reaching 25°C and falling to −5°C at night, restricts the type of algae which develop, and it has the least diverse flora of the subaerial habitats (Broady, in press). However, the algae which are present produce a high standing crop. *Monodus subterraneus* Boye Pet. was the dominant species recovered in culture (Table IV) but gelatinous green algae may have a higher biomass (Broady, 1977). The latter are probably able to survive desiccation because of the protective, water-retaining gelatinous sheaths but the reasons why the former are able to survive in high numbers in this harsh habitat require further investigation.

The wet bryophytes showed a wide range in size of the algal populations. One of the

TABLE II. COMPARISON OF NUMBERS OF CYANOPHYCEAE AND DIATOMOPHYCEAE RECOVERED BY CULTURE AND DIRECT MICROSCOPIC COUNTS FROM THE TOP 1·5 cm. IN SEVEN SITES

Algal habitat†	*Site number*	*Numbers of algae** (× 10^3 cm.$^{-2}$)							
		Nostoc spp.		Other filamentous Cyanophyceae		Coccoid Cyanophyceae		Diatomophyceae	
		Culture count	Direct count	Culture count	Direct count	Culture count	Direct count	Culture count	Direct count
Drepanocladus uncinatus	53	1·5	0	15	500	0	0	0	4,845
Brachythecium austro-salebrosum	57	0	0	12	168	0	0	+	14
B. austro-salebrosum	58	11	12	0	28	0	0	0	103
Cephaloziella varians	59	167	347	24	–	0	378	0	13
Soil below *Deschampsia antarctica*	70	+	0	48	1,662	0	0	0	+
Soil below *D. antarctica*	71	0	0	22	727	0	0	0	+
Seal-wallow mud	61	0	0	690	4,415	0	0	0	+

* Data are the counts of six bulked cores from each site.
† Bryophyte samples included the living vegetation.
+ Count of less than 1 × 10^3 cm.$^{-2}$.
– Not determined.

TABLE III. MEAN CULTURE COUNTS OF ALGAE* IN THE TOP 1·5 cm. OF BRYOPHYTE STANDS AND SOILS

Algal habitat	*Site numbers*‡	*Number of sites examined*	*[illegible]n count with standard error* ($\times 10^3$ cm.$^{-2}$) Euchlorophyceae Ulothricophyceae Xanthophyceae	Diatomophyceae	Coccoid Cyanophyceae	*Nostoc* spp.	Other filamentous Cyanophyceae	Total
BRYOPHYTES								
Wet *Drepanocladus uncinatus* carpet	47, 51, 52, 53, 56	5	411 ± 79	0	4·6 ± 4·6†	+	15 ± 7	431 ± 77
Drier *D. uncinatus* carpet	49, 50	2	483 ± 379	0	0	+	6 ± 2	489 ± 380
Wet *Calliergon sarmentosum* carpet	42, 43, 44, 45	4	333 ± 183	+	0	50 ± 33	48 ± 25	431 ± 154
Wet *Brachythecium austro-salebrosum* hummocks	57, 58	2	1,003 ± 560	+	0	5 ± 5	6 ± 6	1,014 ± 560
Wet *Cephaloziella varians* mat	59	1	508	0	0	167	24	699
Moist *Polytrichum alpestre–Chorisodontium aciphyllum* turf	30, 31, 32, 33, 34, 35, 36, 37, 38, 41	10	1,998 ± 389	0	0	+	0	1,998 ± 389
Dry wind-swept *Andreaea* spp. cushions	14, 15, 17, 18, 19, 20, 21, 22, 23	9	219 ± 120	0	0	0	0	219 ± 120
SOILS								
Mineral soils devoid of macroscopic vegetation	1, 2, 3, 4, 5, 6, 7, 8, 10	9	631 ± 168	19 ± 6	0	14 ± 12	132 ± 120	796 ± 258
Wet seal-wallow mud	61	1	2,556	+	0	0	690	3,246
Loam beneath *Deschampsia antarctica*	64, 65, 66, 69, 70, 71	6	8,475 ± 1,796	+	0	21 ± 21	16 ± 7	8,512 ± 1,806
Colobanthus quitensis and underlying soil	72	1	2,229	0	0	58	134	2,471

* The classification of Bourrelly (1966, 1968, 1970) is followed.
† One site produced a count of 23×10^3 cm.$^{-2}$ of *Merismopedia tenuissima* Lemm.
‡ Broady (in press) has provided site descriptions and locations.
\+ Count of less than 1×10^3 cm.$^{-2}$.

TABLE IV. FREQUENCY OF OCCURRENCE OF THE DOMINANT TAXA OF EUCHLOROPHYCEAE, ULOTHRICOPHYCEAE AND XANTHOPHYCEAE AS DETECTED BY CULTURE COUNTS

Algal habitat	*Number of sites examined*	*Number of sites in which alga is dominant*										
		Monodus subterraneus Boye Pet.	*Gloeobotrys terrestris* Reisigl	*Chloridella* sp. A	*Pleurochloridaceae* sp. A	*Heterothrix exilis* Pascher	*Heterothrix debilis* Vischer	*Chlorella vulgaris* Beij. var. A	*Chlorococcum* cf. *ellipsoideum* Deason and Bold	*Myrmecia bisecta* Reisigl	*Rhopalocystis oleifera* Schusswig	*Stichococcus bacillaris* Naeg.
BRYOPHYTES												
Wet *Drepanocladus uncinatus* carpet	5	3	0	0	1	0	0	0	0	0	0	1
Drier *D. uncinatus* carpet	2	0	0	1	0	0	0	0	0	0	0	1
Wet *Calliergon sarmentosum* carpet	4	2	0	0	1	0	0	0	0	0	1	0
Wet *Brachythecium austro-salebrosum* hummocks	2	0	0	0	0	0	0	1	0	0	0	1
Wet *Cephaloziella varians* mat	1	1	0	0	0	0	0	0	0	0	0	0
Moist *Polytrichum alpestre–Chorisodontium aciphyllum* turf	10	10	0	0	0	0	0	0	0	0	0	0
Dry wind-swept *Andreaea* spp. cushions	9	6	1	0	0	0	0	0	0	1	0	1
SOILS												
Mineral soils devoid of macroscopic vegetation	9	1	0	1	0	1	1	3	1	0	0	1
Wet seal-wallow mud	1	0	0	0	0	0	0	1	0	0	0	0
Loam beneath *Deschampsia antarctica*	6	2	0	0	0	0	0	0	0	0	0	4
Colobanthus quitensis and underlying soil	1	0	0	1	0	0	0	0	0	0	0	0
TOTAL SITES	50	25	1	3	2	1	1	5	1	1	1	9

eutrophic *Brachythecium austro-salebrosum* sites (site 58), which received nutrients particularly nitrogen and phosphorus from nesting cape pigeons (*Daption capensis*) and snow petrels (*Pagodroma nivea*), had the highest numbers with 1,575 $\times 10^3$ algae cm.$^{-2}$. However, the total culture counts are again underestimates in sites where diatoms and Cyanophyceae were present (Table II). In particular, the algal population of *Drepanocladus uncinatus* at site 53 was dominated by diatoms, although they did not appear in culture. The combined culture and direct microscopic counts gave a total of 5,587 $\times 10^3$ algae cm.$^{-2}$, considerably higher than the 258 $\times 10^3$ algae cm.$^{-2}$ detected in the culture count alone. The percolation of water containing nutrients from nearby nesting birds as in site 55 may have been responsible for the high algal numbers in this site. Lowest algal numbers were detected in the drier *Drepanocladus uncinatus* at site 50 with a culture count of only 109 $\times 10^3$ cm.$^{-2}$. However, dryness of the habitat alone is not responsible for low algal numbers since *D. uncinatus* at site 49, also from a drier well-drained area had high numbers, 870 $\times 10^3$ cm.$^{-2}$, higher than some of the wet *D. uncinatus* sites; this suggests that nutrient status of the substratum is probably of importance. Direct microscopic counts of algae in Russian bog peats produced counts of 5–988 $\times 10^3$ algal cells g.$^{-1}$ (Lund, 1967; Shtina and Nekrasova, 1971). Although the results in Table III are expressed in different terms, the fresh weight of bryophytes and peat in the upper 1·5 cm. was generally between 1·4 and 1·8 g.; the Russian counts are thus of the same order as those from Signy Island.

The lowest algal populations were in the exposed mosses of the fellfield habitat. Except when adjacent to melting snow banks and during precipitation, these mosses are prone to desiccation and often become quite dry for long periods. This is thought to be the major factor limiting algal numbers. The lowest count, of 3 $\times 10^3$ algae cm.$^{-2}$, was in *Andreaea* sp. (site 18), a sample from very dry small moss cushions; the highest of 965 $\times 10^3$ algae cm.$^{-2}$ was from the same genus flushed with water during periods of snow melt and heavy precipitation. Direct microscopic examination of samples showed diatoms and Cyanophyceae to be absent or insignificant members of the algal flora and the culture counts are probably reasonable assessments of the total numbers of algae.

The mineral soils produced a wide range of counts because of their varied origin, stage of maturity, water and nutrient status, texture and content of organic matter at the sites examined. At the sites where Cyanophyceae and Diatomophyceae were present, the counts are probably underestimates. Only from this habitat did diatoms produce a significant growth in culture. There were three species which are apparently suited to this habitat, namely *Hantzschia amphioxys* (Ehr.) Grun., *Navicula mutica* Kuetz. and *Navicula permitis* Hust. with the latter being dominant. Highest total counts were in sites where the soils received nutrient enrichment from bird excrement. A soil derived from acid quartz-mica-schist directly below the nest of a cape pigeon (site 8) contained 1,303 $\times 10^3$ algae cm.$^{-2}$. A similar soil not influenced by birds (site 5) contained only 278 $\times 10^3$ algae cm.$^{-2}$. A soil from the older outer ramp of the lateral moraine of Orwell Glacier, on which Dominican gulls (*Larus dominicanus*) deposited limpet (*Patinigera polaris*) shells, contained 2,399 $\times 10^3$ algae cm.$^{-2}$. On the same ramp, where there was no apparent bird influence, the count was lower, 1,074 $\times 10^3$ algae cm.$^{-2}$. At the former site, bird excreta probably provided a plentiful supply of nitrogen and phosphorus, and the decaying limpet shells increased the calcium content of the soil. On the inner ramp of the moraine, where the soil had only recently been exposed by ice retreat and was devoid of macroscopic vegetation, only 57 $\times 10^3$ algae cm.$^{-2}$ were recovered with diatoms dominant. In a similar immature moraine soil from the ice edge below Garnet Hill (site 4), there were also low numbers, 208 $\times 10^3$ algae cm.$^{-2}$. In these soils, colonization by microorganisms was at an early stage. In a previous investigation the young Orwell Glacier moraine soil was found to contain low numbers of fungi and bacteria compared with the more mature soil of the outer ramp (unpublished data of A. D. Bailey). The initial colonizers may be important in preparing the soil for the growth of bryophytes and lichens which were present on the older more mature soil. Young soils from cinder cones on Deception Island (South Shetland Islands), which were also at an early stage of colonization, also yielded low numbers of algae, 0–10 $\times$ 10^3 g.$^{-1}$ of soil in culture counts (Cameron and Benoit, 1970). Mineral soils in South Victoria Land (continental Antarctica) contained from 0 to 6,400 $\times$ 10^3 algae g.$^{-1}$ soil in culture counts, the highest counts occurring where the algae formed a visible surface crust (Cameron and Devaney, 1970; Cameron and others, 1970; Cameron, 1972). It was concluded that the duration of available water was a primary factor in determining the abundance of algae. Lowest numbers were found in the driest sites. On Signy Island, water availability in the mineral soils does not appear to be so critical. The frequent precipitation and high humidity maintain moist conditions in these sites at most times (Allen and Northover, 1967). The concentration and quality of nutrients are probably more important.

A culture count of 3,246 $\times$ 10^3 algae cm.$^{-2}$ was obtained in seal-wallow mud (site 61), where there was a visible surface felt of Cyanophyceae. When the direct microscopic count for the latter (Table II) is added to the culture count for the green and yellow-green algae (Table III), the total is even higher, being 6,971 $\times$ 10^3 algae cm.$^{-2}$. This soil is similar in algal abundance to the soil under herbaceous vegetation, although culture counts of filamentous Cyanophyceae in the latter may also be too low, making even the high total culture counts conservative estimates. Nitrogen and phosphorus concentrations are high in seal-contaminated areas (Holdgate and others, 1967) and this, combined with the moist conditions in the sampling area throughout summer, provides a favourable environment for rich algal growth. Other adjacent similarly contaminated areas were covered by abundant growths of the nitrophilous macro-alga *Prasiola crispa* (Lightf.) Menegh. and here algal biomass was undoubtedly greater than over the area sampled. The numbers of micro-algae in such areas remain to be determined.

Only three species of Euchlorophyceae, Ulothricophyceae and Xanthophyceae were frequently dominant in the culture counts (Table IV). *Monodus subterraneus* was the most frequent, especially in the moss turves, fellfield mosses and wet bryophytes. *Stichococcus bacillaris* Naeg. tended to be dominant in those sites which had high counts. The four *Deschampsia* sites, the two wet bryophyte sites and the mineral soil, which had the highest culture counts in their respective habitats, were all dominated by *S. bacillaris*. This alga may be well suited to utilizing the high nutrient concentrations in these sites. *Chlorella vulgaris* Beij. var. A dominated three moraine soils (sites 1, 2 and 3) and two wet biotically influenced sites, namely sites 57 (*Brachythecium austro-salebrosum*) and 61 (seal-wallow mud). The remaining eight algae in Table IV were dominant in no more than three sites each. It is apparent that only a small number of the total of 73 taxa of these classes of algae recorded in terrestrial habitats on Signy Island (Broady, in press) is able to dominate the algal flora of a particular site. It is possible that other species become dominant at other times of the year. Successions were not detected because each site was sampled on only one occasion.

Concluding remarks

The quantitative data presented in this paper are of a preliminary nature. The counts demonstrate that considerable differences in abundance of algae exist between habitats on Signy Island. Many sites contain populations larger than those found in similar habitats in more temperate regions but because of the use of different techniques for sampling and counting and different ways of expressing the data, the results are not entirely comparable. Forest (1965) reported that Soviet investigators are conscious that accurate calculation of algal quantities in absolute terms is not yet possible, although Soviet studies have perhaps progressed the furthest in estimating the biomass of algae in soils and, as no new techniques have been developed, this is still the situation. On Signy Island, a combination of techniques best suited to the type of site under investigation and the types of algae present would produce more accurate total counts. Direct microscopic measurements of algal propagule sizes after preparation of the sample homogenates would allow estimates of biomass to be made.

Quantities of algae in different sites would then be directly comparable. Regular sampling at several sites over a number of seasons, as for the SIRS (Broady, 1977, 1979), could yield assessments of the annual production of algal material which could be related to measured environmental factors such as temperature, water and nutrient status. The importance of the algal contribution to soil processes may then be realized (Shtina and Nekrasova, 1971).

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