BOTANICAL STUDIES IN THE ANTARCTIC DURING THE 1963–64 AND 1964–65 SEASONS

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ABSTRACT. In a preliminary account of two seasons' botanical field work in the Scotia Ridge sector of the Antarctic the main objectives of the programme are outlined, and details are given of the itinerary followed. A reduction in the fertility of mosses in the Antarctic Peninsula area compared with South Georgia is reported, in terms both of the flora as a whole and of individual taxa, e.g. species of *Polytrichum*. The maturation cycle of *P. alpinum* capsules on South Georgia is outlined, the young sporophytes being first observed in December, and developing to shed their spores approximately 15 months later. A programme of micro-climatic recording, designed to allow the growth and reproductive cycles in *P. alpestre* to be related to the annual temperature regime within the tufts, is briefly described. The bryophyte genera *Conostomum*, *Lepidozia*, *Metzgeria* and *Riccardia* are reported for the first time in the Antarctic botanical zone.

STUDIES on the reproductive behaviour of bryophytes in southern polar regions were initiated by Greene (1964*a*) working on the sub-Antarctic island of South Georgia on the widely distributed moss *Polytrichum alpestre* Hoppe (= *P. strictum* Banks). Fruiting collections were made on many parts of the island, and regular samples were obtained from one colony over a 14-month period, to determine the maturation cycle of gametangia and sporophytes. The collections were supported by temperature measurements, taken at 3 hr. intervals during the same period, at gametangial and sporophyte level in the colony. From a study of the literature and existing collections, however, Greene concluded that the fruiting of bryophytes in the Antarctic botanical zone may be a rare occurrence.

These studies were extended by the author during the 1963–64 and 1964–65 seasons to a survey of bryophyte growth and reproduction in localities on the Falkland Islands, on islands of the Scotia Ridge, and at various sites on and near the west coast of the Antarctic Peninsula. As well as setting out to review the general level of bryophyte fertility in these areas, the present studies were designed to investigate in detail the biology of selected species in a range of localities with different degrees of climatic severity within the Southern Cool Temperate, sub-Antarctic and Antarctic botanical zones (Fig. 1). Holdgate (1964) and Matsuda (1964) have shown that temperatures within tufts of bryophytes in the Antarctic may at times differ markedly from the prevailing air temperature, and therefore a programme of micro-climatic recording formed an integral part of the present survey. *Polytrichum alpestre*, and other species of the Polytrichaceae, were chosen for detailed study to continue the investigation already begun on South Georgia. Moreover, as several species of *Polytrichum* have a bipolar distribution pattern in temperate and polar regions, there is clearly scope for an experimental comparison of the relationship between climatic factors and growth and reproduction, in individuals of the same species from different parts of this wide range.

Although the survey of bryophyte growth and reproduction was the primary object of the investigations, the two field seasons provided an opportunity for other observations in areas where little serious botanical field work had been undertaken for many years. When fully identified, a general plant collection of over 1,300 specimens should extend our knowledge of plant distribution, particularly of bryophytes, in the Antarctic Peninsula area. For example, species of *Conostomum*, *Lepidozia* and *Metzgeria* collected on Signy Island, and of *Riccardia* from Candlemas Island, represent genera new to the Antarctic zone, while *Psilopilum antarcticum*, collected on Deception and Signy Islands, is a species previously unknown south of the South Sandwich Islands. The collection has been deposited in the British Antarctic Survey herbarium in the Department of Botany, University of Birmingham. Studies on the vegetation of South Georgia begun by Greene (1964*b*) were continued, the vegetation of Candlemas Island was investigated in detail during a comprehensive survey of the South Sandwich Islands (Baker and others, 1964), and the results of less intensive observations elsewhere have contributed towards an over-all view of the vegetation in several parts of the

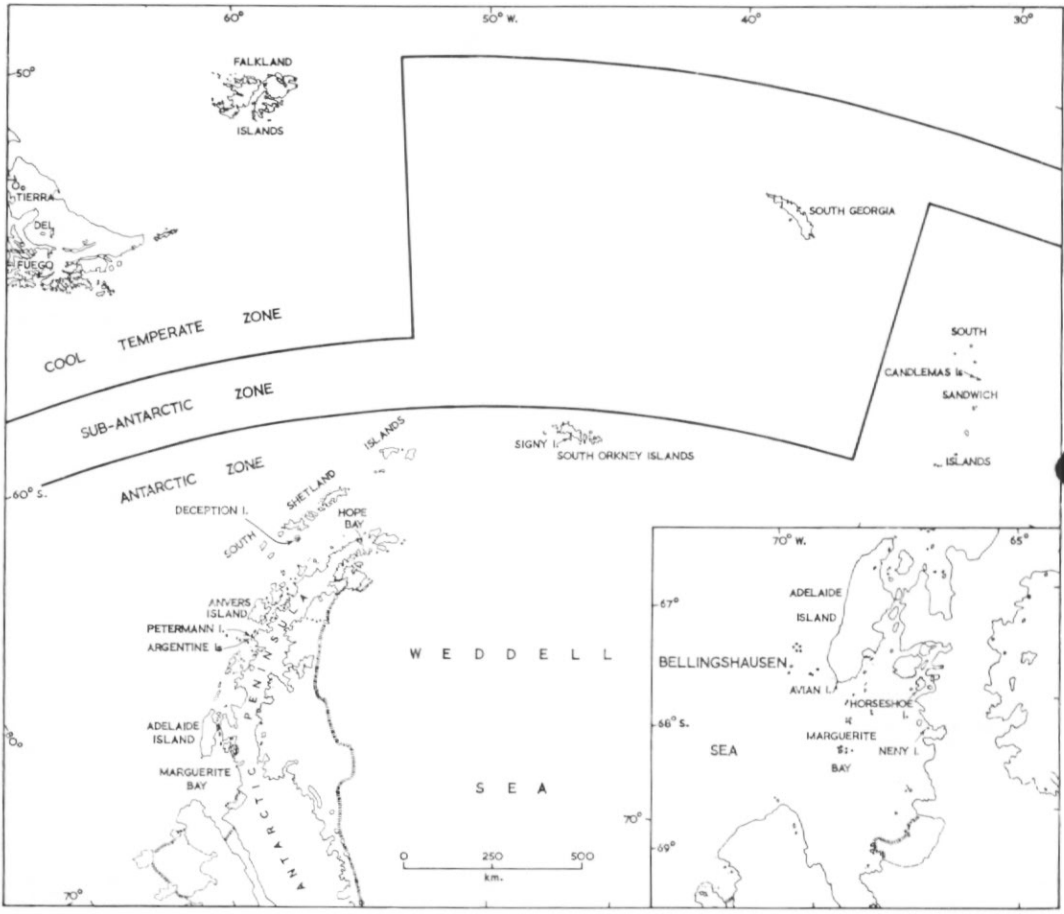

Fig. 1. The Scotia Ridge and Antarctic Peninsula, showing botanical zones and the principal localities visited.

Antarctic Peninsula area. Additional studies included observations on the alien floras of South Georgia and Deception Island (Longton, 1965, 1966), and an investigation of the rings of brown moribund material, associated with fungal infection, which were found to be a characteristic feature of many Antarctic mosses.

Detailed accounts of these studies will be published in due course, as the collections are worked up. The purpose of the present paper is to indicate the areas covered in the field, and the scope of the survey of bryophyte reproductive behaviour, including some preliminary results indicated by the field data.

Itinerary and Organization

The itinerary during the two seasons was designed to allow several months intensive study on South Georgia, and the collection of less detailed comparative data through shorter visits to a range of other localities, principally near past and present British Antarctic Survey stations, from the Falkland Islands southwards to Marguerite Bay. The Survey's supply ships R.R.S. *John Biscoe* and R.R.S. *Shackleton* provided transport between the stations, and the survey of the South Sandwich Islands in March 1964 was undertaken from H.M.S. *Protector*. Local excursions from the Survey's stations were made in launches, dinghies and other small craft, while helicopters from H.M.S. *Protector* were indispensable in the South Sandwich Islands. The itinerary was arranged to fit in with the ships' other commitments.

TABLE I. ITINERARY FOR THE 1963–64 SEASON

Date	*Locality*	*Time spent in the field*
19–25 November 1963	Port Stanley, Falkland Islands	2½ days
1–6 December	Deception Island, South Shetland Islands	3 days
6–8 December	Hope Bay	1 day
10–12 December	Signy Island, South Orkney Islands	1 day
14–16 December	King Edward Point, South Georgia	1 day
16 December 1963–13 January 1964	Husvik, South Georgia	27 days*
13 January–11 February	Barff Peninsula, South Georgia	28 days*
11 February–4 March	King Edward Point, South Georgia	21 days*
5 March	Leskov Island, South Sandwich Islands	3 hr.
6–17 March	Candlemas Island, South Sandwich Islands	10 days
17 March	Vindication Island, South Sandwich Islands	1 day
18 March	Visokoi Island, South Sandwich Islands	3 hr.
21–22 March	Candlemas Island, South Sandwich Islands	1 day
24 March–4 April	King Edward Point, South Georgia	9 days*
7 April	Signy Island, South Orkney Islands	2 hr.
10–15 April	Port Stanley, Falkland Islands	3 days

* Includes time spent sorting and processing collections.

The itinerary followed during the two seasons is outlined in Tables I and II, and the principal localities visited are indicated in Fig. 1. During both seasons the bryophytes in the vicinity of Port Stanley, in the Falkland Islands, were briefly examined. The summer of 1963–64, however, was spent largely on South Georgia, where the author was resident for a total of approximately 4 weeks at the British station on King Edward Point. Similar periods were spent camping, first near a disused whaling station at Husvik, and later at a point on the west coast of Barff Peninsula (South Georgia grid reference 143117*). A hut at Hut Point, Jason Harbour, and a building at a disused whaling station at Ocean Harbour, were sound enough to provide a night's shelter, and a derelict hut at the camp site on Barff Peninsula was renovated sufficiently to give dry storage space when partially covered by a tarpaulin. The camping party at Husvik included J. Dye, who was engaged in a survey of the introduced reindeer population, and H. B. Clagg, an entomologist attached to the United States Antarctic Research Program. On Barff Peninsula the party was joined by A. Smith and R. W. Vaughan, who also took part in the reindeer survey.

During the 1963–64 season low-lying ground on South Georgia was examined at a number of localities throughout much of Barff Peninsula as far south as Lönnberg Valley, on the peninsula bounded by Cumberland East and Cumberland West Bays, and in the area between Jason Harbour and the west shore of Fortuna Bay. Higher ground, up to altitudes of approximately 740 m., was examined in several areas, and included the hill on the south side of Sörling Valley (grid reference 144113). Additional brief visits to South Georgia were made in

* A 5 km. grid is overprinted on the 1 : 200,000 map of South Georgia, D.O.S. (Misc.) 372A, which accompanies *British Antarctic Survey Scientific Reports* No. 45.

TABLE II. ITINERARY FOR THE 1964–65 SEASON

Date	*Locality*	*Time spent in the field*
11–15 November 1964	Port Stanley, Falkland Islands	3 days
18–21 November	King Edward Point, South Georgia (with brief visits to Leith Harbour and Dartmouth Point)	2 days
30 November–6 December	Signy Island, South Orkney Islands	6 days*
8–10 December	Deception Island, South Shetland Islands	2 days
19–31 December	Adelaide Island (visiting Avian Island)	3 days
2–4 January 1965	Deception Island, South Shetland Islands	½ day
7–12 January	Port Stanley, Falkland Islands	4 days
15 January–10 February	Signy Island, South Orkney Islands	26 days*
13–15 February	Deception Island, South Shetland Islands	1½ days
16 February	Norsel Point, Arthur Harbour, Anvers Island	2 hr.
16–18 February	Galindez Island, Argentine Islands	1 day
19–22 February	Adelaide Island (visiting Avian Island)	2 days
23 February	Horseshoe Island, Marguerite Bay	2 hr.
23 February–1 March	Stonington Island, Marguerite Bay (visiting Neny and Trepassey Islands)	2 days
3 March	Laggard Island, Arthur Harbour, Anvers Island	½ day
4–17 March	Galindez Island, Argentine Islands (visiting Skua, Uruguay, the more easterly of the Corner Islands and Petermann Island)	13 days*
18–20 March	Deception Island, South Shetland Islands	1½ days
23–28 March	Galindez Island, Argentine Islands	4 days
30–31 March	Adelaide Island	1 day
31 March–2 April	Stonington Island, Marguerite Bay	1 day
4–5 April	Deception Island, South Shetland Islands	1 day
7–14 April	Signy Island, South Orkney Islands	7 days*
16–23 April	Port Stanley, Falkland Islands	4 days
26 April	King Edward Point, South Georgia	3 hr.

* Includes time spent sorting and processing collections.

November 1964 and April 1965. A list of squares of the South Georgia grid in which observations on the flora and vegetation were made is given in Table III.

In March 1964, 10 days were spent camping on Candlemas Island, in the course of the South Sandwich Islands survey (Baker and others, 1964), and most of the northern part of the island, together with the western coast of the southern ice-capped section, was investigated. Brief observations were also made on Leskov, Vindication and Visokoi Islands.

TABLE III. 5 km. SQUARES OF THE SOUTH GEORGIA GRID EXAMINED DURING THE INVESTIGATION

Squares examined in detail	*Squares examined briefly*
115130	110135
115135	115140
120125	120135
120130	120140
125130	125120
130120	125125
130125	125135
140110	135120
140115	140125
140120	145120
145110	160095
145115	

Work in the Antarctic Peninsula area was mainly carried out directly from the ships during relatively short visits to the stations, though the author was resident for periods of several weeks at the stations on Signy Island and the Argentine Islands and, more briefly, on Deception Island. Preliminary visits to Deception and Signy Islands were made in the 1963–64 season, and the ground between the Survey's station and the lower slopes of Mount Flora was examined during a brief call at Hope Bay in December 1963. Most work in the Antarctic Peninsula area was carried out in the 1964–65 season when the author was accompanied by another plant ecologist, R. I. L. Smith, until 12 January 1965.

Over 5 weeks were spent on Signy Island during three visits at different periods in the 1964–65 summer, and most of the snow-free low-lying ground on the island, except the south-east coast south of Jebsen Point was covered. Several brief visits to Deception Island enabled the area around Whalers Bay, extending from Cathedral Crags to the inlet north of Kroner Lake, to be studied in some detail. Observations were also made on the coast north of South East Point, in the area around Collins Point, and on the eastern shore of Port Foster from Penfold Point to midway between Pendulum Cove and Telefon Bay. At the southern end of Anvers Island, the ground immediately north of the American Palmer Station near Norsel Point was briefly investigated, together with the north coast, central plateau and part of the south coast of Laggard Island. At the Argentine Islands strong winds and inshore pack ice restricted boat work among the islands, but observations were made on Galindez, Skua and Uruguay Islands, on the more easterly of the Corner Islands and on the more distant Petermann Island. In most cases the relatively rich north and north-west coasts of the islands received most detailed attention. Observations on Adelaide Island were restricted to the small rock outcrop near the British Antarctic Survey station at the southern end, but the nearby Avian Island was fully investigated. Also in Marguerite Bay, Stonington and Trepassey Islands were examined, as were parts of the north-west side of Horseshoe Island, and the north and north-east coasts of Neny Island, from Norseman Point to approximately 400 m. west of Store Point.

BRYOPHYTE FERTILITY

Collections and notes were made in most localities visited to show the frequency of the principal constituents of the bryophyte flora, and the species normally producing sporophytes.

The distribution of the prominent male inflorescences in species of *Polytrichum* was also recorded in the field, but that of the less conspicuous perichaetia will not become apparent until after a detailed examination of the specimens collected.

Sporophytes of many mosses and liverworts were recorded on South Georgia, including species of *Polytrichum*, *Tortula* and other prominent genera. In contrast, relatively few bryophytes were seen in fruit in most localities in the Antarctic zone. Species of *Brachythecium*, *Dicranum*, *Drepanocladus* and *Polytrichum* predominated in much of the bryophyte vegetation south of South Georgia, but they were without sporophytes, except very locally in *Drepanocladus uncinatus*, *Polytrichum alpestre* and *P. alpinum*. On Signy Island, for example, where there are approximately 50 species of mosses, sporophytes have so far been recorded in only 10; and none are known in the hepatics. Moreover, several of the fruiting mosses (e.g. species of *Encalypta*) were among the islands' rarer plants. In contrast, however, a few taxa, including species of *Bartramia* and *Grimmia* were both widespread and common in fruit on Signy Island and elsewhere. Indeed, sporophytes of *Pohlia nutans* and a species of *Bartramia* were recorded in a range of localities as far south as Horseshoe Island, and several species, including *Pohlia cruda*, were seen in fruit on the Argentine Islands, though they were widespread but barren on the more northerly Signy Island.

A detailed study of bryophyte fertility was concentrated in 64 scattered sites on South Georgia and 18 sites on Signy Island. For each one, altitude and date of observation were recorded, and notes were made on the habitat, abundance and fertility of each of the species listed in Table IV. A fertility index was assigned to each species (Table V) and specimens were

TABLE IV. SPECIES STUDIED IN DETAIL ON SOUTH GEORGIA AND SIGNY ISLAND

South Georgia	*Signy Island*
Conostomum australe	*Bartramia* sp.
Dicranum aciphyllum	*Dicranoweissia* sp.
Drepanocladus uncinatus	*Dicranum aciphyllum*
Polytrichum alpestre	*Drepanocladus uncinatus*
P. alpinum	*Grimmia* sp.
P. juniperinum	*Polytrichum alpestre*
P. piliferum	*P. alpinum*
Psilopilum antarcticum	
P. tapes	
Tortula robusta	

TABLE V. DEFINITION OF FERTILITY INDICES

Fertility index	*Definition*
4	Fruiting freely in most tufts
3	Fruiting freely in some tufts
2	Fruiting sparingly in most tufts
1	Fruiting sparingly in some tufts
0	No sporophytes present

collected. This system of routine observations was designed to provide objective, quantitative data on the reproduction of mosses. Analysis of the data for *Polytrichum alpinum* on South Georgia, for example, shows that it was recorded in 48 of the 57 sites below 330 m. altitude, and was fruiting in each one, normally with fertility indices of 3 or 4. *P. alpinum* was also recorded in six of the seven sites above 330 m. altitude, but it was fruiting in only three, with fertility indices of 2, 1 and 1, respectively. It is therefore clear that *P. alpinum* fruits freely on low ground in South Georgia, but its fertility appears to be reduced at high altitudes. It is noteworthy that the sporophytes in the three upland colonies were smaller than those collected nearer sea-level, and the gametophytes were stunted in two cases.

Fruiting colonies of *Polytrichum alpestre*, *P. juniperinum*, *P. piliferum* and *Psilopilum antarcticum*, as well as *Polytrichum alpinum*, were widespread on South Georgia, but the fertility of these species was found to be considerably reduced under the more severe climatic conditions prevailing farther south. *P. alpinum* was abundant in most localites southwards to the Argentine Islands, but only three fruiting colonies were seen south of South Georgia, one on Candlemas Island and two on Deception Island. The capsules in these colonies were small, resembling those developed at high altitudes on South Georgia, and, although observations on Deception Island covered a 16-month period, there was no evidence that sporophytes developed during more than one season. Male plants of *P. alpinum* were generally widespread in the Antarctic Peninsula area, though in several localities they were largely confined to sunny north-facing banks and other relatively favourable habitats. The results of a preliminary microscopic examination of specimens from Signy Island suggest that perichaetia of *P. alpinum* may also be widespread on the island, and the presence of at least four bisexual colonies has been confirmed. Many gametangia appeared to have dehisced normally, and motile antherozoids were observed in fresh material from both Signy and Galindez Islands.

Polytrichum alpestre was also abundant in many localities near the Antarctic Peninsula, occurring on Signy, Laggard and Petermann Islands, at several localities in the Argentine Islands and on Norsel Point. Most colonies comprised only female or sterile plants, but male inflorescences and a single fruiting colony were recorded on Norsel Point. Of the other species of the Polytrichaceae recorded in the Antarctic zone, *Polytrichum juniperinum* was collected on Candlemas, Deception, Signy and Uruguay Islands, and male inflorescences were present in all except the latter locality. *P. piliferum* was also collected on Candlemas Island, while male inflorescences of this species were recorded on Deception Island. *Psilopilum antarcticum*, however, is now known from Deception and Signy Islands, and from the South Sandwich Islands, but no perigonia has yet been recorded south of South Georgia. *Polytrichum alpestre* and *P. piliferum* were both collected in the Falkland Islands, where they were fruiting in several localities.

To determine more precisely the stage at which failure in the reproductive cycle occurs in *Polytrichum alpestre* and *P. alpinum*, material of both species with young sporophytes and male inflorescences was transplanted in April 1964 from South Georgia to non-fruiting colonies on Signy Island. The performance of these plants was followed over a 12-month period, but the full results of the experiment will not be available until the transplants are collected at the end of the 1965–66 season.

Bryophyte Maturation Cycles

Several authors have shown that bryophyte maturation cycles can be determined by comparing the state of development of gametangia and sporophytes in dried specimens collected at intervals during the growing season. A series of developmental stages has been recognized (Green, 1960), and a quantitative method of recording the data has been described (Longton, 1963). To investigate the development of gametangia and sporophytes in South Georgian mosses, over 450 specimens of the ten species studied in detail on the island (Table IV) were collected between mid-December 1963 and early April 1964. This material was supplemented by other collections made in mid-November 1964 and late April 1965. On Signy Island the seven species studied in detail (Table IV) were sampled at intervals throughout each visit, and collections of these species were made whenever possible farther south. Several previous collections made by other workers are also available, and they may provide additional data.

To gain information on the maturation cycles in specific colonies, it was arranged for the resident personnel in several areas to collect samples at fortnightly intervals over periods of 12 months or more from nine specified colonies. These include stands of *Polytrichum alpestre* on Galindez and Signy Islands, and on King Edward Point, South Georgia, as well as colonies of *P. alpinum* on South Georgia, Signy and Deception Islands. In each stand of *P. alpestre* 50 stems were marked with a cotton tied 5 mm. below the apex, to allow direct measurement of annual growth increment after collection one year later.

In colonies of *P. alpestre* and *P. alpinum* on Signy Island, and of *P. alpestre* on Galindez Island, the regular collections were complemented by measurements of the temperature within the moss turfs. Ten thermistor probes were arranged in these colonies, to be read at 3 hr. intervals during the period of regular collecting. Most probes were located at a depth of 2–3 mm. in the moss turf, but measurements were also made 2·5 cm. deep in a *P. alpestre* turf on Signy Island, as well as in the air 2·5 cm. above the surface. Comparable data are already available for a colony of *P. alpestre* on South Georgia (Greene, 1964*a*), and thus it is hoped to relate growth and reproductive development to the annual temperature regime within colonies in different localities.

Little of the collections and data has yet been analysed, but a preliminary examination of material of *Polytrichum alpinum* from South Georgia has confirmed that a clearly defined seasonal cycle of sporophyte development is followed (Figs. 2 and 3). The material was scored in the usual way except that distinct EOI and LOI stages were not recognized, as the capsules

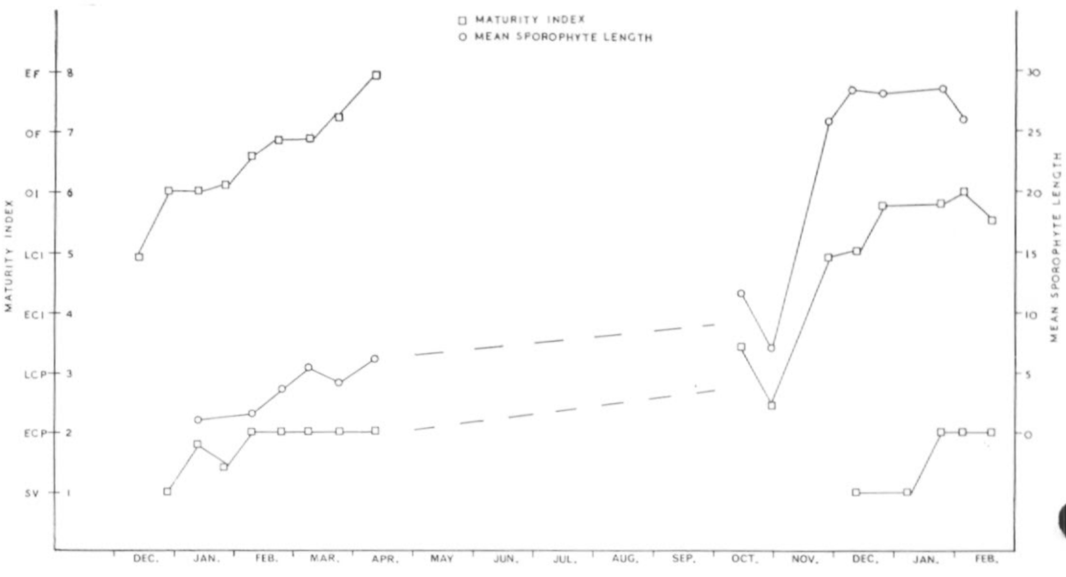

Fig. 2. The maturation cycle of *Polytrichum alpinum* sporophytes on King Edward Point, South Georgia.

of *P. alpinum* frequently dehisce while still green. Sporophytes in the SV and ECP stages cannot be detected without dissection of the inflorescence, and thus the maturity indices for these stages are normally based on samples of five sporophytes per collection, and have not yet been scored in every case. As in other mosses, it was seldom that more than three stages of development were recorded among the sporophytes of a given cycle in any individual specimen. Between December and April, sporophytes representing two annual cycles were frequently recorded in *P. alpinum* and two maturity indices were assigned to such collections. In addition, dehisced, empty capsules persisting from previous cycles were present in much of the material. In many of the specimens from the King Edward Point series, the lengths of five sporophytes were measured from the base of the vaginula to the apex of the calyptra or operculum.

The regular series of collections from King Edward Point was made in an area of relatively dry *Rostkovia* bog situated behind Shackleton House at an altitude of approximately 10 m. In this material (Fig. 2), young sporophytes in the SV stage were recorded in December, both in 1963 and 1964, and they had reached the ECP stage by the end of February. In 1964 the sporophytes remained in the ECP stage until April but an increase in length was recorded during February. The break in collections from April to October represents the period of winter snow cover. In the first spring collection, of mid-October 1964, most sporophytes had reached the LCP stage and a few ECI sporophytes were recorded. Even in the latter, setal elongation was far from complete and in the second spring collection, made later in October, the majority of sporophytes were still in the ECP stage. There is evidence of rapid development in November, since by the end of the month setal elongation was almost complete and most capsules were in the LCI stage, having begun to swell. Development continued to give predominantly OI capsules from late December 1964 to early February 1965. The low maturity index of the mid-February collection may not be significant because it is based on only four capsules. The completion of this developmental cycle during March and April may be predicted from the performance of the older sporophytes present in the samples collected between December 1963 and April 1964. In December 1963, development from the LCI to OI stage was noted and it can be seen from Fig. 2 that capsule dehiscence occurred during February 1964, while in the April collection most of the spores had been shed. The present data therefore suggest that on King Edward Point the sporophytes of *P. alpinum* appear in the SV stage in December and develop to shed their spores approximately 15 months later.

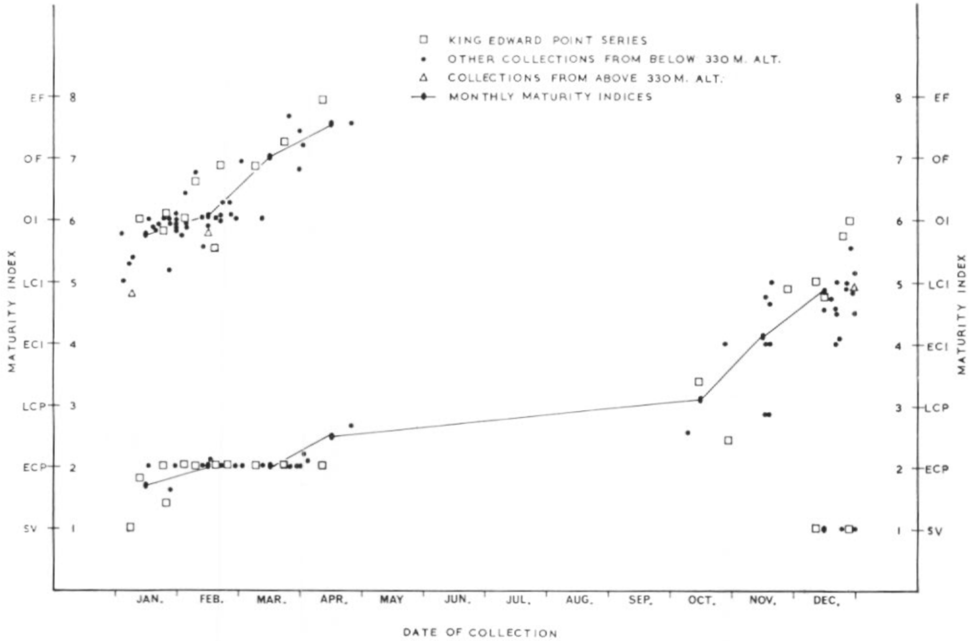

Fig. 3. The maturation cycle of *Polytrichum alpinum* sporophytes on the north-east coast of South Georgia Monthly maturity indices are the means of the maturity indices of all specimens scored for each month.

A comparison of the maturity indices of the King Edward Point series with those of other collections from the north-east coast of South Georgia (Fig. 3) suggests that a basically similar cycle of sporophyte development takes place throughout the area investigated. During much of the cycle, however, the maturity indices recorded in the King Edward Point material were slightly higher than those of specimens collected at comparable times from most other colonies; of the three collections from upland sites the results in two cases suggested very slight delay in sporophyte development compared with plants growing near sea-level.

Owing to the break in collections during the winter months, the question arises whether slow sporophyte development continues under winter snow cover, and four points may be made concerning this possibility. First, a collection made near the end of April 1965 contained three young sporophytes, of which two were ECI and one LCP, indicating that development past the ECP stage occurs in at least some colonies prior to winter. Secondly, a specimen collected in early October 1964 contained approximately equal numbers of ECP and LCP sporophytes, and any development in the colony during the winter had thus been very slow. The third point concerns the King Edward Point series; although the specimen collected in mid-October 1964 contained LCP and ECI sporophytes, the mean increase in sporophyte length compared with the April collection was only 5 mm. At the rate of elongation recorded during November such an increase would have taken only a few days and, moreover, an increase in mean sporophyte length of less than 1 mm. compared with the April figure was recorded in the late October collection. It is possible that the difference between the two October collections was related to local variation in snow cover over different parts of the colony.

The fourth point provides more direct evidence of a relationship between snow cover and sporophyte development. In mid-November 1964 snow cover had largely cleared from low-lying ground but numerous large snow banks persisted. It was noted both near Grytviken and around Leith Harbour that sporophytes of *P. alpinum* remained largely in the CP stage near the snow banks, though in more exposed sites setal elongation and frequently swelling of the capsules had taken place. For example, the two specimens with maturity indices of 2·9 indicated in Fig. 3 for mid-November were both collected about 25 cm. from the edge of snow banks, while the collections with maturity indices of 4·0 to 5·0 were made some distance from the nearest snow. Taken as a whole, therefore, the present evidence suggests that, if sporophyte development takes place at all under winter snow cover, it is very slow.

Discussion

The survey of bryophyte reproduction has covered a range of localities from the Falkland Islands southwards to Marguerite Bay, to allow the fertility of the bryophyte floras in areas with differing climatic severity to be compared in terms both of the proportion of species producing sporophytes, and of the fertility of individual species in different localities. The field observations suggest that, whereas sporophytes develop in a high proportion of the mosses on South Georgia, relatively few species fruit freely in the Antarctic Peninsula area. Moreover, a decrease in the fertility of several individual taxa (e.g. species of *Polytrichum*) was demonstrated in the Antarctic Peninsula area compared with South Georgia. Sporophytes of a few species occur as far south as Horseshoe Island (lat. 67°51′S.) and several species appear to fruit on the Argentine Islands but not farther north on Signy Island, suggesting that local climatic variation may over-ride the effect of increasing latitude.

The field results for the distribution of sporophytes in *Polytrichum alpinum* emphasize the reduction in fertility of this species with increasing altitude and latitude. Capsules were abundant on low ground in South Georgia, but they became less frequent at higher altitudes on the island and were seen in only a few widely scattered colonies farther south. In several dioecious British mosses a rarity of sporophytes has been attributed to spatial separation of male and female gametangia, often combined with a rarity of plants bearing male inflorescences, and it has been found that sporophytes develop regularly year after year in occasional bisexual colonies of such species (Longton, 1963). It already seems unlikely that these factors wholly explain the rarity of *Polytrichum alpinum* capsules in the Antarctic. Perigonia appear to be widespread in favourable habitats and, although the distribution of perichaetia will not become clear until a critical examination of the collections is complete, preliminary observations suggest that they are also relatively widespread, at least on Signy Island, where the presence of non-fruiting bisexual colonies has been confirmed. Moreover, sporophytes of only one cycle were recorded in the fruiting colonies on Candlemas and Deception Islands, and this, together with the small size of the capsules found at high altitudes on South Georgia and in the fruiting colonies in the Antarctic zone, suggests that the process of sporophyte development itself may be limited by the prevailing climatic conditions. It is not yet clear, however, whether fertilization fails completely in the bisexual colonies of *P. alpinum* on Signy Island, or whether young sporophytes are formed and abort at an early stage of development.

The development of perigonia in Antarctic colonies of *Polytrichum alpestre* appears to be more restricted than in *P. alpinum*. Their rarity could in itself account for the rarity of sporophytes, though the position should become clearer when the distribution of perichaetia in Antarctic colonies of *P. alpestre* has been determined from the collections.

In order to determine the outlines of gametangial and sporophyte maturation cycles, samples of ten South Georgian mosses were collected over the period mid-November to late April, thus covering much of the summer growing season. It will be of interest to determine whether the sporophyte cycles of these plants show the variation from one species to another demonstrated in British mosses (Greene, 1960), or whether the shorter growing season in South Georgia imposes a greater degree of uniformity. In this connection it may be noted that the sporophyte cycle for *Polytrichum alpinum* on South Georgia, reported in the present paper, resembles the cycle for *P. alpestre* outlined by Greene (1964*a*). In addition to the South Georgian material, the specimens collected in other localities will allow the cycles for several species to be compared in areas with different climatic severity. From the results given by the thermistors set up in several sites, it is hoped to relate annual growth and reproductive cycles to the temperature regime within the colonies.

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