SHORT NOTE

BOTANICAL SURVEY OF DECEPTION ISLAND

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Introduction

Deception Island, South Shetland Islands, in the maritime Antarctic (Fig. 1) is of particular biological interest because of the volcanic nature of its terrain. The island's situation only 950 km south of Tierra del Fuego and its relatively mild and humid climate make it potentially one of the most favourable localities in Antarctica for the immigration of plant propagules and the establishment of vegetation. However, the aridity and instability of the substrata, particularly of the fine ash soils, render them unsuitable for extensive plant colonization and community development. Vegetation is therefore very sparse and closed stands are restricted to occasional small areas receiving a permanent supply of moisture and afforded some degree of stability. Two major factors affecting the survival of vegetation on the island are soil erosion by water and wind, and burial by wind-blown ash and volcanic eruptions (notably those between 1967 and 1970).

The most detailed account of the island's vegetation and, in particular, of the colonization of new surfaces and the recovery of vegetation following burial by volcanic activity has been given by Smith (1984*a*). However, the few studies on which that account was based were limited to comparatively few areas, mainly around the inner slopes of the caldera. Between 26 February and 22 March 1987 a botanical survey was carried out over a much greater part of the island by A. Morton during the course of a geological investigation lead by Dr J. L. Smellie. A large collection of bryophytes and lichens was made from 51 sites on the island, several of which were on the summit ridges and outer slopes of the caldera. The main emphasis of the study was an investigation of the vegetation of geothermal areas. As has been shown by Collins (1969), Young and Kläy (1971) and Smith (1984*a*, *b*) these areas of warm ground with constantly high humidity offer ideal conditions for bryophyte colonization and the establishment of unusual associations of taxa and occasional unique communities. During 1987/88 the thermal regime of some of these communities was studied. At present, for a number of the bryophytes and many of the lichens, only provisional identifications are available. When final determinations have been made and the environmental data analysed, an ecological account of these unique habitats will be prepared.

Some Noteworthy Plant Records

The vegetation of several areas of geothermal activity, including fumarole vents, was examined and brief ecological accounts prepared of each. The pre- and post-eruption flora of Deception Island has been reported by Smith (1984*a*) and most of the taxa recorded after 1970 were seen again in 1987. However, several species new to the island or to the Antarctic were also discovered. Although as yet only provisionally identified the more important taxa, either ecologically or biogeographically, are reported here. An extensively vegetated heated slope emitting steam north-east of Ronald Hill, noted in 1984, could not be reached because of bad weather.

Br. Antarct. Surv. Bull. No. 80, 1988, pp. 129–136

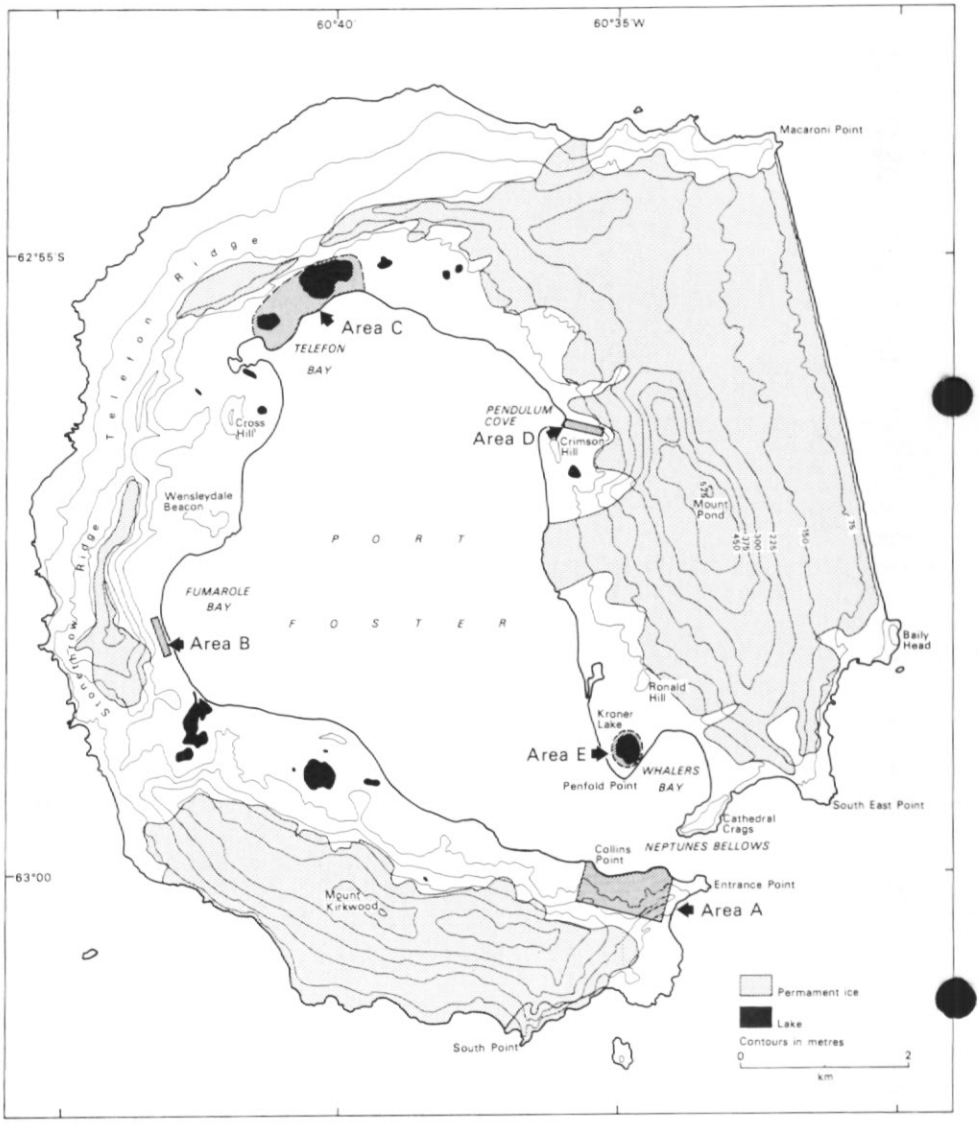

Fig. 1. Deception Island, showing Areas A–E which comprise Site of Special Scientific Interest No. 21. Two areas in Port Foster are designated a marine SSSI.

A major aim of the survey was to try to locate the site of *Philonotis gourdonii*. This endemic moss is known from a single collection made by E. Gourdon during the visit of the second French Antarctic Expedition. On 28 December 1909, according to the collection details, it was found growing in small mats on calcareous and sulphurous deposits of warm springs at 450 m on the summit of Mount Pond (Cardot, 1911, 1913; Matteri, 1968). [Robinson (1972) reported the collection by G. E. Watson on 18 February 1964 of this species from inside a covered 'whale boat' embedded in the heated beach near the former whaling station on the island, but the identity of this

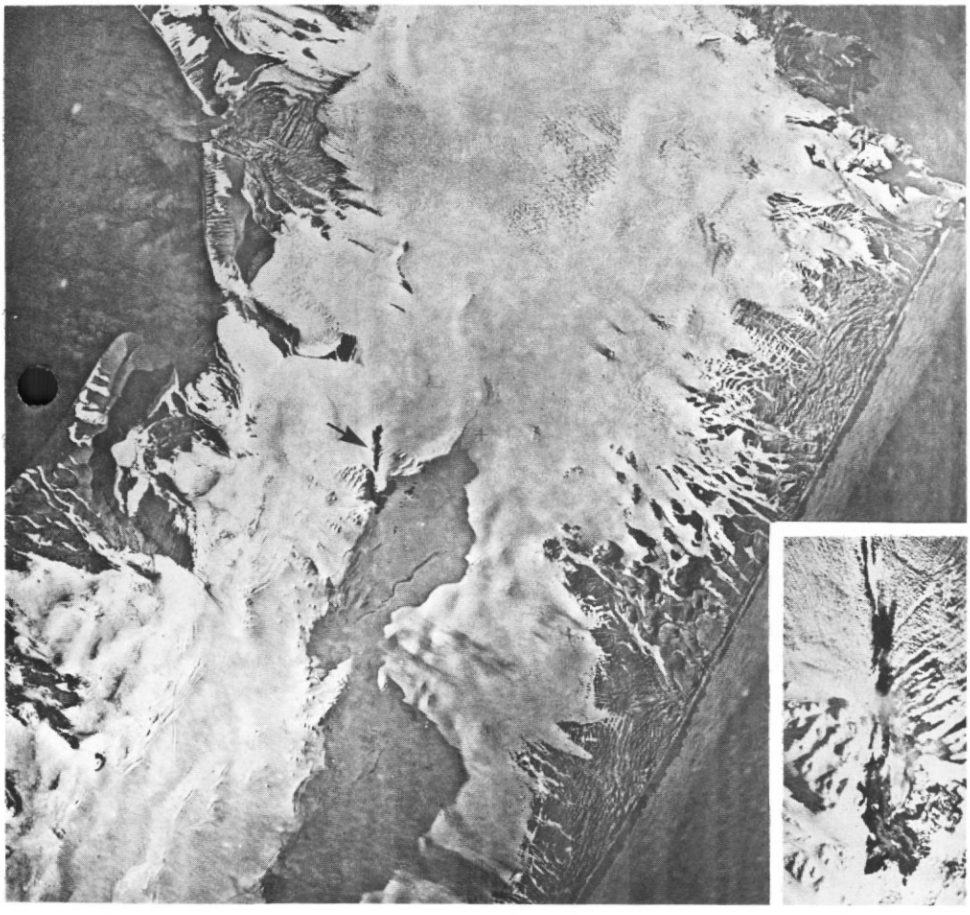

Fig. 2. Aerial photograph of north-east Deception Island from 4500 m (31 December 1956). Macaroni Point lies at the top right and Pendulum Cove at mid-left; Mt Pond (550 m altitude) is at the lower centre. Arrow indicates the subsidiary summit which is geothermally active where *Philonotis acicularis* and *Dicranella hookeri* form extensive stands. A series of rime domes created by steam emissions are visible along the ice ridge running towards Mt Pond. Inset. The geothermally active area from 1850 m (7 March 1979). Note cloud of steam over centre of the ridge. (Photographs by FIDASE and Hydrographic Department.)

material must remain suspect.] However, there has never been a record of ice-free ground near the summit of Mount Pond which, in fact, rises to almost 550 m altitude. An examination of aerial photographs of the island revealed a narrow strip of ice-free ground about 750 m long from *c.* 480 to *c.* 380 m altitude running along a ridge on a subsidiary peak 1 km north–north-west of the summit of Mount Pond (Fig. 2). Because of its lack of ice cover it seemed possible that the ground was heated. The area was therefore visited on 22 March 1987 and a unique community of mosses was discovered associated with active fumarolic fissures emitting steam, and neighbouring moist ashy soil which was diffusely heated (Fig. 3). This was dominated by two mosses, one a species of *Philonotis* and the other a species of *Dicranella*. The *Philonotis* is clearly the moss found by Gourdon; it dominates three stands each of

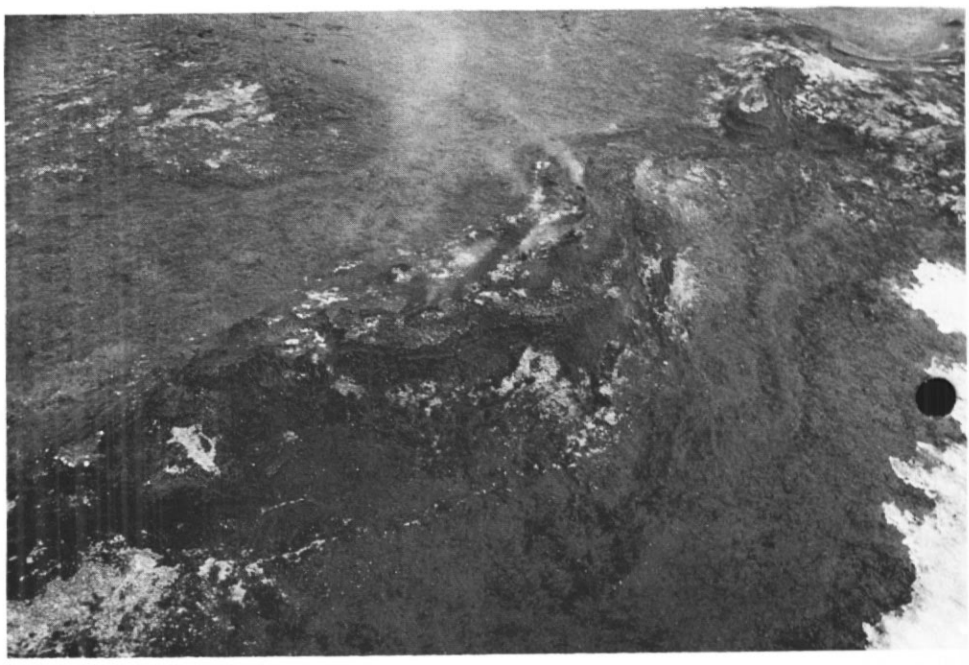

Fig. 3. Fissure with fumarole vents emitting steam at *c.* 450 m altitude on subsidiary summit north of Mt Pond. Light grey patches are sulphurous deposits. Several species of moss grow within 30 cm of the vents. (Photograph by A. Morton, 22 March 1987.)

about 200 m^2 and smaller isolated patches (often with *Dicranella* and species of *Bryum*, *Pohlia* and *Tortula*, and *Didymodon gelidus* and *Schistidium antarcticum*). It has developed a turf up to 4 cm tall. However, the rather variable specimens from different microsites are ecological variants (slender, small-leaved forms) of *P. acicularis*, a species common in mires and flushes in Tierra del Fuego and also on South Georgia (Matteri, 1968; Clarke, 1973). In fact, Cardot (1911) commented that *P. gourdonii* is close to *P. varians* (a synonym of *P. acicularis*). The *Dicranella* is *D. hookeri*, as yet unknown from the Antarctic. However, Bell and Blom (1[redacted]) described a single specimen of *D.* cf. *hookeri* from a steam vent on Bouvetøya. At the Mt Pond site, some colonies of this moss, or another dicranaceous taxon, were fruiting profusely. Occasional crusts of lichens occurred beyond the influence of the fumaroles. Around many of the *c.* 3 dozen steam vents the vegetation has developed distinct zones.

Another geothermal area of particular interest is situated east–south-east of Pendulum Cove close to the heated gully described by Smith (1984*a*, p. 43–4) which supported a distinctive and unique community (*Campylopus introflexus* was reported as new to the island – its only other known Antarctic locality being in the South Sandwich Islands – and *Leptobryum* cf. *pyriforme* was new to the Antarctic biome). The new site was on a flat area of scoria and lava close to the edge of the ice cap at an altitude of about 100 m. As with the sparse vegetation on the Pendulum Cove beach, the plants here were mainly sublithic. The surface of the scoria was dry but beneath the ash was quite moist. On the underside of many of these were very small, short-branched plants of *Racomitrium lanuginosum* and *R. heterostichum*. Both are new to the Antarctic but occur widely on Tierra del Fuego and South Georgia

Fig. 4. Moss stand comprising a thick turf of *Philonotis acicularis* (top left to lower right) and short turves of *Dicranella hookeri* (lower left) associated with heated ground on the steep east slope of the subsidiary summit north of Mt Pond. Note ice dome formed by freezing of condensing steam from a fumarole vent in background. Knife is 16 cm long. (Photograph by A. Morton, 22 March 1987.)

(Roivainen, 1955; Bell, 1973). An early record of *R. lanuginosum* collected by the *Discovery* II Expedition, allegedly from the South Orkney Islands (Dixon, 1935), is incorrect since the specimen is mixed with *Tortula* cf. *robusta* and *Acaena magellanica*, neither of which is known in the Antarctic; no collecting details accompany the specimen. Other species growing here include *Bryum algens*, *Ceratodon* sp., *Polytrichum alpinum*, *P. juniperinum*, and dicranaceous species (possibly *Distichium capillaceum*, *Leptobryum pyriforme* or *Campylopus* sp.).

In 1981, no macroscopic vegetation was detected on a strip of low-lying land which, following the 1970 eruption, linked the new island created in 1967 to the 'mainland' (Smith, 1984*a*). However, in 1987 moist ground is now very sparsely colonized by several species of moss (*Bartramia patens*, *Bryum algens*, *Ceratodon* sp., ?*Funaria* sp., *Pottia austro-georgica*, *Schistidium antarcticum*, *Tortula* sp.). Farther to the east in the vicinity of the 1967 land centre a large lava boulder about 200 m inland is now colonized by small thalli of a species of *Caloplaca*. In 1981 a thorough search of this area revealed no visible vegetation.

On much of the lower western slope of Mount Pond 0.5–1.0 m or more of ash and scoria was deposited on the surface of the glacier during the 1969 eruption. At an altitude of 50–60 m a heterogeneous community of at least nine mosses and four lichens has become established. Colonization has probably been enhanced by the presence of a small colony of 20–30 gulls (*Larus dominicanus*) nesting on the debris. *Phormidium* sp. and filamentous green algae were also frequent and the latter also grew in a $2 \times 5 \times 1$ m deep pool. Several similar pools occurred in the ash deposits on the glacier.

Elsewhere on the higher parts of the island, notably on Mount Kirkwood, Stonethrow Ridge, Telephon Ridge and Cross Hill several other species are new records for the island, although they are not uncommon on other islands in the South Shetland Islands. These include the lichens *Dermatocarpon lachneum*, *Massalongia carnosa*, *Pannaria hookeri*, *Placopsis contortuplicata*, *Usnea aurantiaco-atra* (= *U. fasciata*) and several unidentified species of *Buellia*, *Lecanora*, *Lecidea* and other crustose taxa, a species of *Cladonia*, and the mosses *Distichium capillaceum*, *Pottia austro-georgica* (both fertile) and one or more dicranaceous taxa. A few other species, previously known from only one or two sites on the island were relatively widespread in this area, e.g. *Dicranoweisia grimmiacea*, ?*Funaria* sp., *Ochrolechia parella*, *Peltigera didactyla* and *Stereocaulon* cf. *glabrum*; a new site for *Marchantia berteroana* near Entrance Point was also located.

The survey has greatly increased knowledge of the distribution and composition of the flora and vegetation of Deception Island. Several individual sites appear to h[illegible] unique heterogeneous assemblages of bryophytes and lichens, particularly th[illegible] associated with geothermal areas. During the post-eruption period (i.e. since 1967–70) changes in surface features and occasionally of vegetation cover, caused by substrate erosion, have proceeded rapidly in some areas, for example above Entrance Point where moss stands have been removed by land slips since 1981. Elsewhere plant colonists are prevented from developing uniform communities, remaining as disparate assemblages, by substrate instability and frequent burial by ash. The best developed and most complex communities occur on lava outcrops and coarse scoria fields, often on the crests of exposed ridges and summits. In favourable habitats colonization and growth proceed quickly, although this process is frequently reversed by natural perturbations. Deception Island therefore offers excellent opportunities to undertake studies of ecosystem dynamics with particular regard to colonization and community development and to its resilience to or recovery from perturbation.

Conservation Areas on Deception Island: A Case Study for Improved Management

Because of the instability of the island's terrestrial and freshwater habitats and the fragility of its biota and communities, five small areas around the inner coast of the caldera have been designated parts of Site of Special Scientific Interest (SSSI) No. 21 (Antarctic Treaty, 1987) (see Fig. 1). It is intended to propose to the Scien[illegible] Committee on Antarctic Research (SCAR) that the fumarolic ridge to the north of Mount Pond (Fig. 3) with its unique vegetation should be designated another area within the Deception Island SSSI. For the present survey to be undertaken, a permit to enter these areas had been issued by the Director, British Antarctic Survey. However, despite the modest form of protection afforded to the SSSI, one site (Kroner Lake, which by 1987 had become an inlet of Whalers Bay) had been violated when, in January, a private yacht (*Northanger*) anchored in this unique heated 'lake' with dense growths of macroalgae. Within other sites several sets of recent footprints were observed. The shoreline below Wensleydale Beacon, close to the Fumarole Bay SSSI sub-site was littered with refuse, including large amounts of fresh fruit and vegetables discarded from the ship *Alcazar* over a marine SSSI in Port Foster (Bonner and Smith, 1985). In recent years tourist ships frequently enter the caldera and allow large numbers of visitors, often unaware of the island's fragile ecosystem, to disperse over the inner shoreline and slopes from where they remove biological specimens and historical artefacts as souvenirs. These examples illustrate the problem of managing conservation areas in the Antarctic and of dealing with waste disposal at sea.

Unfortunately, private expeditions are rarely aware of Antarctic Treaty regulations or of the location or boundaries of conservation areas and the code and conduct pertaining to them under the Antarctic Treaty.

It should be the responsibility of the country which proposed a specific site designated as a Specially Protected Area or Site of Special Scientific Interest to have its boundaries clearly demarcated (see, for example, Fleming and Keage, 1987) and suitable signs, erected at obvious access points, which indicate the name, number and purpose of the protected area. At present none of the sites throughout the maritime Antarctic are so marked and this fault must quickly be rectified if they are to serve any meaningful conservation purpose and if their management is to be at all effective. It is also crucial that private expeditions, when they are made known, are aware of these sites and their management 'regulations', and respect their conservation status. It is especially important that ships operated by national Antarctic organizations and tourists ships operating south of 60° S are also aware of these areas, and give special attention to the disposal of waste at sea, particularly close to shore and in embayments with restricted water circulation. It is totally irresponsible of ships' personnel to discard non-biodegradable flotsam in such areas to be washed up on shores, a problem which is becoming increasingly serious in the Antarctic. Fortunately, the issue of waste disposal on land and at sea is being reviewed by a SCAR working group and a Code of Conduct should shortly be approved. However, because of Deception Island's unique shape and physical characteristics, its biota are more vulnerable to perturbation than most other Antarctic localities. Its exceptional flora and vegetation deserve more responsible management than is currently being afforded.

Acknowledgements

I am indebted to A. Morton, Wairarapa, New Zealand, who very kindly offered to undertake this botanical survey and make substantial collections of plants from around Deception Island, during the course of assisting Dr J. L. Smellie in his geological survey of the island. I am also grateful to Dr P. J. Lightowlers, Institute of Terrestrial Ecology, for determining some of the new moss records.

Received and accepted 25 February 1988

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