STUDIES IN *Colobanthus quitensis* (Kunth) Bartl. AND *Deschampsia antarctica* Desv.:

I. INTRODUCTION

By S. W. GREENE

ABSTRACT. A brief review is presented of literature referring to *Colobanthus quitensis* and *Deschampsia antarctica* in Antarctic regions. The earliest records for both species south of lat. 60°S. are given and a summary is provided of knowledge of their distribution and performance in the field. A few erroneous records are considered. Reference is also made to experiments on the growth and reproduction of both species in controlled environments.

THE field success of *Colobanthus quitensis* and *Deschampsia antarctica*, the only two native phanerogams known from within the Antarctic botanical zone, as defined by Greene (1964*b*), is of considerable interest in any study of the adaptation of terrestrial plants to the Antarctic environment. Some years ago a long-term investigation into aspects of the life history, growth and reproductive performance of the two species, both in the field and under controlled environmental conditions, was begun from Birmingham. A number of people have been involved in this work, including many British Antarctic Survey field personnel who generously collected specimens and made such observations as time and opportunity allowed. A substantial body of information is now beginning to accumulate and two papers already published (Greene, 1967; Holtom and Greene, 1967) have provided some results of this work. It is the intention to publish further results in the present series.

EARLIEST RECORDS FOR ANTARCTICA

When Weddell (1825) reported seeing "a short grass" on Laurie Island, South Orkney Islands, and at an unspecified locality on the South Shetland Islands in 1823, he was the first person to indicate the presence of phanerogams south of lat. 60°S. Unfortunately, his account was not supported by specimens and, as his observation for Cape Dundas, Laurie Island, has never been confirmed, doubts have been cast on its validity. However, a few years later Eights (1833) collected a grass from an unspecified locality in the South Shetland Islands during the 1829–30 season, and specimens were sent to Hooker who described them as *Aira antarctica* Hook. (Hooker, 1837). This species (Fig. 1) is now known as *Deschampsia antarctica* Desv. rather than *Deschampsia elegantula* (Steud.) Parodi, the name proposed by Parodi (1949). A discussion of the nomenclatural problem has been given by Skottsberg (1954). It may be noted in passing that Parodi (1949) reported *Deschampsia parvula* (Hook. f.) Desv. from the Antarctic, but Skottsberg (1954) and Greene (1967) have shown that this record was based on a misidentification of material from Biscoe Bay, Anvers Island.

Turquet, the biologist on Charcot's Expédition Antarctique Française (1903–05), was the first to report a second species of native flowering plant from south of lat. 60°S. This species (Figs. 2 and 3), now known as *Colobanthus quitensis* (Kunth) Bartl., was found in 1905, growing with *Deschampsia antarctica* at Biscoe Bay, Anvers Island, and was reported as *Colobanthus crassifolius* (D'Urv.) Hook. f. (Turquet, 1906), a name which has since become familiar in Antarctic botanical literature. Moore (1968) has indicated the necessity for a change in nomenclature and he will go into the matter in detail in the next paper in the present series (Moore, 1970).

DISTRIBUTION IN ANTARCTIC REGIONS

Skottsberg (1954) was the first to list and map all the known localities for the two species on the islands of the Scotia Ridge and along the west coast of the Antarctic Peninsula. Since then additional localities for both species have been supplied by Greene (1967), while Holdgate (1964) has published a detailed map showing the principal sites for *Deschampsia antarctica* on Signy Island. An account of the distribution of the two species throughout the islands of the sub-Antarctic zone was provided by Greene and Greene (1963), while Greene (1964*a*) gave

Fig. 1. *Deschampsia antarctica* Desv. with contracted panicles; north-facing slope on Observation Bluff, Signy Island, South Orkney Islands; February 1965. The lens cover is 5·5 cm. in diameter. (Photograph by R. I. L. Smith.)

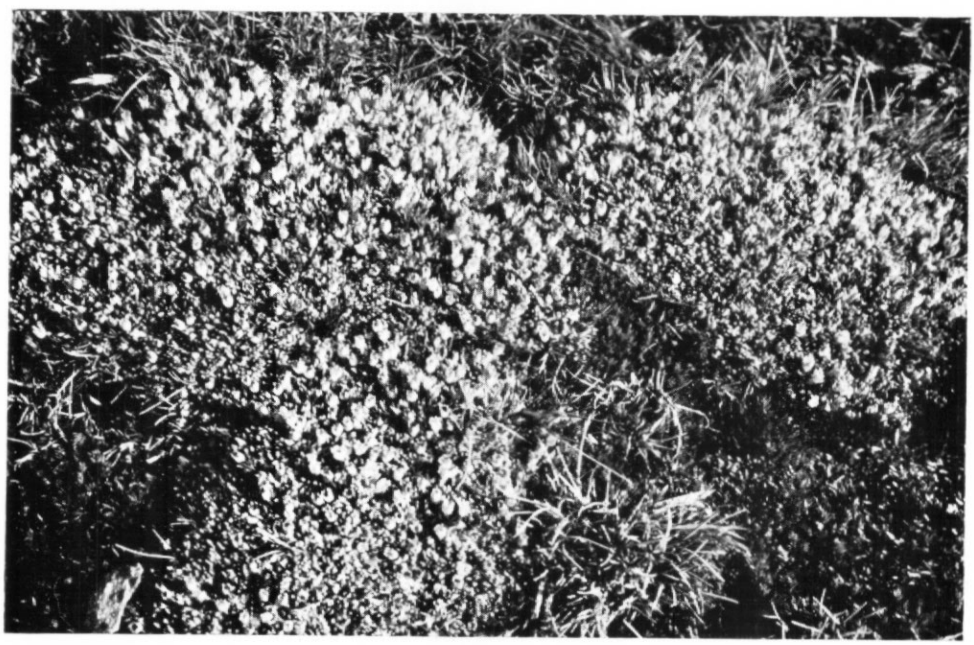

Fig. 2. *Colobanthus quitensis* (Kunth) Bartl. with open capsules; north-facing slope on Observation Bluff, Signy Island, South Orkney Islands; February 1965. The small stone in the bottom left of the photograph is 1·7 cm. long. (Photograph by R. I. L. Smith.)

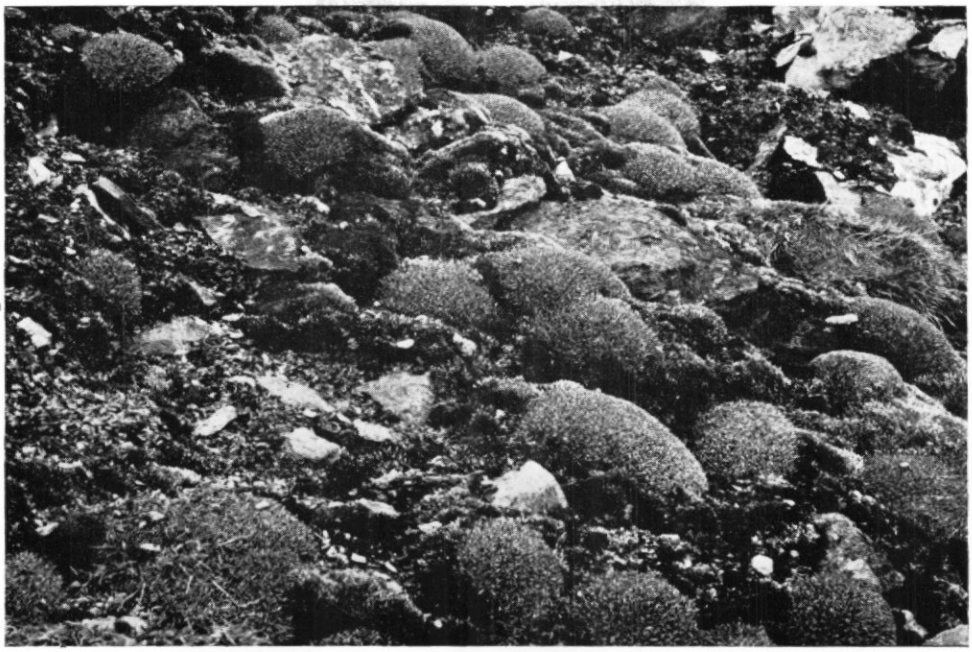

Fig. 3. *Colobanthus quitensis* (Kunth) Bartl. showing cushion growth form; near Spindrift Rocks, west coast of Signy Island, South Orkney Islands; January 1967. (Photograph by R. I. L. Smith.)

detailed maps of their known distribution on South Georgia. More recent data on their South Georgian distribution has been published by Greene (1969).

A comparison of the distribution data given in the foregoing papers with information given by Lourteig and Cour (1963) shows various discrepancies. These authors, in their paper on the distribution of the vascular flora of Archipel de Kerguelen, included the east coast of the Antarctic Peninsula and Bouvetøya in their "aire de distribution probable" for *Deschampsia antarctica*. During the present investigations no specimens or records for this species on the east coast of the Antarctic Peninsula have been found. Cour (personal communication) has stated that the Bouvetøya record was based on a comment by Skottsberg which indicated that a specimen of *D. antarctica* from this island was present in a Scandinavian herbarium, but enquiries in numerous herbaria have failed to trace any material. P. Størmer of Oslo has said (personal communication) that he knew of no specimens of vascular plants from or any reference to their occurrence on Bouvetøya, while O. Holtedahl, the leader of the Norwegian Antarctic Expeditions, 1927–28 and 1928–29, has confirmed (personal communication) that no plants were seen on the island during the landings made by his expeditions. C. Skottsberg (personal communication) was also unable to confirm any such record.

Ecology and Reproductive Performance

In the field

Rudmose Brown (1912), discussing the factors affecting the growth of plants in Antarctic regions, remarked "it is doubtful if a flowering plant could obtain the requisite amount of heat needed for its various life functions even to reach the flowering stage while the maturation of its fruit would be next to impossible". Skottsberg (1954) disagreed with Rudmose Brown, asserting that flowers, at least, were produced by *Deschampsia antarctica* at sites along the Antarctic Peninsula. But it was not until some years later that Corte (1961) produced the first confirmation of successful reproduction under field conditions, when he noted seeds of *Colobanthus quitensis* germinating *in situ* at Spring Point, Danco Coast. He also reported successful experimental germination of seeds of both species out of doors, thus proving that

viable seed, capable of germinating under the prevailing conditions, can be produced in the field. However, Holdgate (1964) observed that, on Signy Island, although vegetative growth was vigorous and inflorescences developed in both species, it was unlikely that seed was often set. From the results presented by Holtom and Greene (1967), it appears that the observations of the foregoing authors are not as contradictory as might be supposed, and in fact present a reasonable picture of the reproductive performance of the two species as understood by them from their field observations. The explanation is simply that Rudmose Brown and Holdgate worked in the South Orkney Islands, where both species fail to produce mature seed except in specially favourable seasons, while Skottsberg and Corte knew the plants from sites along the Antarctic Peninsula where viable seed is often set.

The earliest attempt at correlating the presence of the two species with habitat and edaphic factors was made by Holdgate (1964). He investigated the occurrence of both species on Signy Island with respect to altitude, aspect, angle of slope and soil enrichment, and he concluded that preference was shown for north-facing sites, where some degree of flushing takes place. Both species, but particularly *D. antarctica*, are quite abundant at certain sites (Fig. 4), and

Fig. 4. Community of *Deschampsia antarctica* and *Colobanthus quitensis*; Lynch Island, South Orkney Islands, 7 February 1966. The lens cover is 5 cm. in diameter. (Photograph by R. I. L. Smith.)

Longton (1967) recognized these more extensive communities as distinct types in his classification of Antarctic vegetation. Longton's primary division was into two formations, the Antarctic cryptogam formation (with six sub-formations) and the Antarctic phanerogam formation, with a single sub-formation, the "grass and cushion plant" sub-formation. In his description of this sub-formation, Longton included remarks on the percentage cover achieved in places by the two species, and commented on their relationship to bryophyte species and to environmental factors such as water availability and aspect.

In a paper on the temperature relationships of Antarctic vegetation, Longton and Holdgate (1967) gave some temperature readings taken within a population of *D. antarctica* on Candlemas Island, South Sandwich Islands, which showed that the mean temperature recorded within the colony was $+6^{\circ}$ C when the ambient temperature was $+2^{\circ}$ C. In this case it appeared that the heating may have resulted from conduction through the soil from a nearby

fumarole, but Holtom and Greene (1967) quoted some figures which show that the growth forms of both species are well suited to absorb radiant energy, since colonies of both can rapidly become warmed above ambient.

Little information is available on the relationship of the two species to the soils on which they occur. Holdgate and others (1967) provided some chemical analyses for sites bearing one or both species on Signy Island and they commented on the dark loamy nature of soils which varied in depth from 5 to 15 cm. These soils, which are well penetrated by roots, contrast strongly with the highly organic rootless soils developed under stands of wholly cryptogamic vegetation. These authors, as well as Allen and Northover (1967), pointed out that the integration of so much litter suggests an active microbial population and that, both in structure and composition, the soils developed under stands of *Colobanthus* and *Deschampsia* can be compared with the brown earth soils of temperate regions. Northover and Allen (1967) made some reference to the seasonal availability of nutrients in these soils.

Under controlled conditions

Using South Georgian populations of *D. antarctica* and *C. quitensis*, Holtom and Greene (1967) tested the effects of cold pre-treatment, a range of temperatures and various day lengths on vegetative growth, reproductive performance and seed germination under controlled environmental conditions in a phytotron. Their results suggested that, while each species has varying and, at times contrasting, requirements for the separate stages of their growth and reproductive cycle, they are both well adapted to grow and reproduce successfully under the climatic conditions prevailing on South Georgia. They pointed out, however, that the results of these experiments must be used with care when interpreting the performance of plants in the field, particularly those from other parts of their range.

The present series of papers is concerned with the results of field and laboratory investigations into the problems raised in the foregoing papers, as well as with related topics.

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