A PRELIMINARY ACCOUNT OF THE VEGETATION OF MARION AND PRINCE EDWARD ISLAND

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INTRODUCTION

The vegetation of the sub-antarctic islands has recently been the subject of several papers (Aubert de la Rue 1964,[1] Green 1964,[2] Wace 1965[3]). Only the Crozet and Prince Edward islands have yet to be described in detail, brief accounts having already been given following the short visits by the *Challenger* (Hemsley 1885[4]) and *Bougainville* (Jeannel 1940[5]) expeditions of 1873 and 1939.

Since the establishment of a meteorological station on Marion island in 1948 general botanical collections have been made by Messrs Dike and Rand. The present account is a summary of the botanical results of the Biological-Geological Expedition to the Marion and Prince Edward Islands, 1965-66.

PHYSIOGRAPHY

The geology and topography of the islands have been described by Verwoerd, 1966.[6] Ecologically, the most important features of the group's physiography are the very marked differences in edaphic and microclimatic regimes of the glaciated grey and post glacial black lavas. Due to the very broken nature of the black lavas, innumerable sheltered microhabitats are presented, accounting for their greater floristic and vegetational diversity compared with the bleak glaciated areas.

CLIMATE

In common with other sub-antarctic islands Marion and Prince Edward are cold, wet and windy. Schenck[7] draws attention to the low mean temperature of these islands compared with that of similar latitudes in the northern hemisphere. Fabricius[8] explains the 1.9°C negative temperature anomaly of Marion as due to the influence of the Bouvet current flowing eastwards past Marion from the Weddell Sea. The very strong oceanic influence accounts for the low mean annual temperature range, 4.4°C, and the low warmest month mean of 7.9°C, placing Marion in the isothermal tundra group of Köppen's classification.

Depressions passing eastwards south of the island account for the dominant (71%) westerly winds which bring heavy rain and snow to the island. Winds with an easterly component are very rare. The influence of wind is the major limiting factor to plant growth, mechanical and physiological in effect and resulting in inland transport of saltspray from the littoral.

North westerlies are usually accompanied by enduring rains. Rainfall is high, 255.5 cm (100.5 ins)[9] per annum and well spread, falling on over 300 days. Dry spells seldom exceed three or four days. Humidity is high throughout the year and plants were never seen in a state of wilt.

Snow is usually associated with west and south westerlies. It seldom covers the lowlands for more than a few days but above 500 feet may persist for over a week. Above the vascular vegetation limit of 2,000 feet a snow cover endures the whole winter. Only local sites above 2,500 ft have a permanent snow cover.

Sunshine is strongly attenuated by cloudy conditions and only 28% of the possible total is received.

FLORA

The origin of sub-antarctic island floras has long stimulated discussion. Of the several theories suggested, long distance dispersal by wind or more especially by migrating birds, appears the most tenable. Banding records offer increasing evidence of inter-island movement while some unexpected avian visitors have been seen at Marion in recent years. Successful transport of plant propagules is undoubtedly rare and on arrival immigrants face very harsh environmental conditions. Thus it is not surprising that the vascular flora is very small, 22 species having been recorded to date. With the exception of two endemics all these species occur on at least one of the five other sub-antarctic island groups while sixteen species occur on two.

The non-vascular flora has yet to be identified and will not be discussed here.

VEGETATION SURVEY

Natural selection of immigrants by the rigorous environment would favour species with a wide ecological range, a feature displayed by 75% of the vascular flora. Classification of plant communities on purely floristic composition is thus impossible. An attempt was therefore made to obtain as much quantitative data as possible. The vegetation survey comprised two phases, initially the analysis of over 500 ten by ten metre quadrats spread throughout the island, followed by more intensive syn- and autecological studies near the meteorological station. The methods employed will be briefly discussed.

(*a*) *Quantitative approach*

The low growing, predominantly densely aggregated growth form of Marion Island plants lends itself to the measurement of cover. Before cover estimates were made, practice was obtained and accuracy assessed in the analysis of eighty quadrats in which exact cover values were read from ten randomly plotted 50 × 50 cm grids. The grid used comprised an aluminium frame with fine wire attached so as to form 100 crosswire points each located at the centre of a 5 × 5 cm square. The grid was placed on the vegetation and hits were recorded for any plant organ falling below the crosswire. The mean of ten grids (1,000 points) was taken as cover value for the quadrat. This procedure was checked by comparison with the known total cover of *Azorella selago* Hook. f. cushions in several quadrats and found to attain a high level of accuracy.

The time required for exact cover value measurement made the use of this technique impractical once sufficient familiarity with cover assessment had been obtained. The bulk of quadrats surveyed comprise cover estimates in 5% classes. The frequency of species in the lowest class made further subdivision necessary, designated by the symbols × for very rare and cover very small, × × for numerous individuals but less than 1%, and 1 for cover between 1 and 5%. In addition to cover values various habitat factors and symbolised species performance data were recorded. Cryptogams were collected wherever field identification was not possible.

(*b*) *Qualitative approach*

Detailed surveys of all major communities included analysis of edaphic and recording of microclimatic elements. Soil analyses comprised the study of profile pits, sampling of A horizons and collection of soil water for pH and specific conductivity measurement. Over two hundred sites were sampled for the latter factors while approximately one hundred soil samples were brought back to South Africa for analysis.

Microclimates were studied with the aid of a five-point temperature recorder, hygrothermographs and whirling hygrometer. The windy clouded isothermal climate of Marion inhibits the development of temperature gradients but on occasion some interesting results were obtained with the former instrument. The hygrothermographs were used in the study of altitudinal zonation of temperature, being run at 500 and 1,000 ft a.s.l. for comparison with the observations made at the meteorological station on the coast.

Several other habitat factors including evaporation rate, light intensity and salt spray deposition were measured in selected sites. It is regretted that two most important factors, wind speed and soil aeration, could not be recorded.

The small vascular flora allows autecological study of nearly all species to be made, a considerable aid in the understanding of vegetation dynamics. Despite wide ecological tolerances, most species have distinct growth forms according to the habitat, in many cases measures of performance were made in conjunction with habitat analysis. Phenological behaviour and altitudinal zonation of many species show a close relation to the annual march of temperature and day length. Germination experiments on the island will be supplemented

Photograph 1 — Macaroni Bay — Marion Island. The steep turffaceous cliffs, dominated by Poa cookii tussocks, are the home of Sooty Albatross and the blue-eyed Cormorant. The base of the cliffs is occupied by thousands of breeding Macaroni and moulting King Penguin. (B.J.H.)

by those to be carried out in South Africa.

MAIN PLANT COMMUNITIES

For descriptive purposes it is best to divide the vegetation into four major units each limited by well defined ecological conditions. Variations in habitat factors within these groups result in the recognition of eleven main plant communities. Further division into sub-associations or groupments, as has been done by Taylor[10] and Cour[11] for Macquarie and Kerguelen islands respectively, is considered inadvisable owing to the tremendous number of minor communities inherent in the vegetation of sub-antarctic islands.

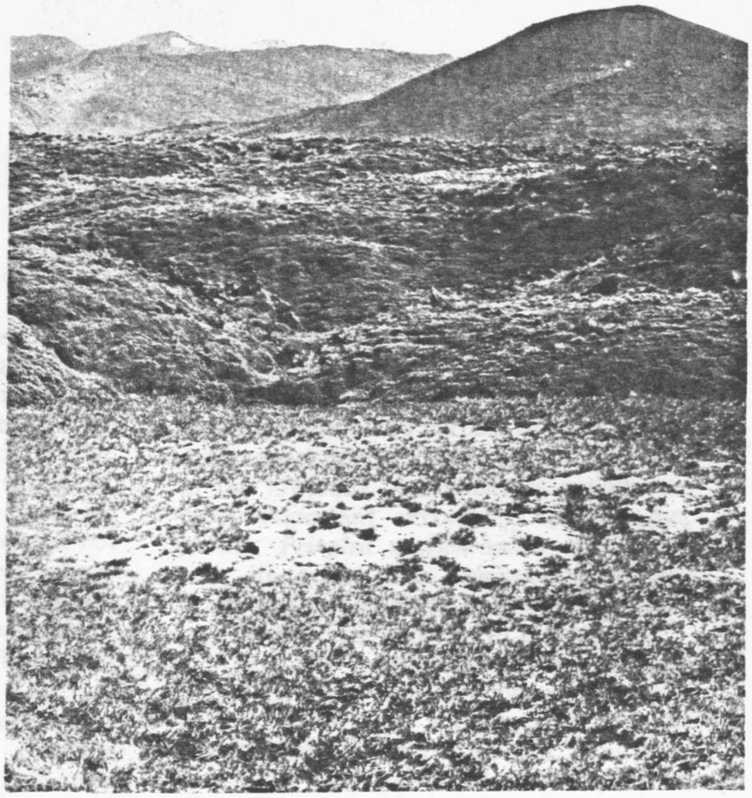
The classification given below must be regarded as tentative. Changes in terminology will undoubtedly be made in the comprehensive account presently in preparation.

(*a*) *Maritime communities*

Strong winds, rough seas and rugged coastline favour the development and inland transport of salt spray from the littoral. The influence of this factor is considerably reduced by the diluting and leaching effect of heavy rains but is sufficient to maintain distinctive communities of *Tillaea moschata* (Forst. f.) DC. and *Cotula plumosa* Hook f. The communities are widest, up to 500 yards, on the windward west coast, elsewhere narrow, usually less than 100 yards, and discontinuous.

The dominant species are exclusively found in areas of heavy salt spray, occurring with such secondary species as *Azorella selago* Hook. f., *Poa cookii* Hook. f., and *Colobanthus kerguelensis* Hook. f.

Tillaea moschata pioneers bare rocks subject to heavy splashing and almost conti-



Photograph 2: Marion Island. Vegetation on black postglacial lava. Mire in foreground, dominated by Agrostis magellanica **and the hepatic** Diplophyllum densifolium. **the moss** Rhacomitrium lanuginosum **forms the whitish patch. On the slopes** Blechnum penna-marina **is dominant. Junior's Kop, 1000 feet, is on the right horizon.** (B.J.H.)

nuous sea spray, forming its own dark and fibrous peat, often containing appreciable amounts of wave deposited gravel and the remains of gull middens. Due to its tolerance of poor drainage it usually dominates *Cotula plumosa* where both occur in water-logged sites.

Cotula plumosa forms a pale highly organic peat on better drained sites within the salt spray zone, often forming a nearly continuous cover for several acres. The burrowing activity of members of the family Procellaridae apparently improves drainage of the peat. Where these birds form intensive colonies a characteristic hummocky relief is developed, emphasized by the influence of penguin or elephant seals. *Cotula plumosa* shows a strong relationship to biotic influence, seldom occurring away from sites subject to animal activity.

(*b*) *Slope communities*

Slopes and well drained flats are typically dominated by *Blechnum penna-marina* (Poir)

Kuhn, *Poa cookii* Hook. f., *Azorella selago* Hook. f. or *Acaena adscendens* Vahl. or by combinations of these species. The peat of these communities is characterised by the absence of a water table in the soil profile, dark colouring and the presence of iron pans.

In the lowlands *Blechnum penna-marina* (Poir) Kuhn dominates nearly all slopes but tends to favour sites with a northern aspect. *Azorella selago* is the most important secondary species with *Acaena adscendens*, *Poa cookii*, *Agrostis magellanica* Lam. and *Uncinia dikei* Nelmes.

Acaena adscendens requires some protection from wind in order to compete successfully with *Blechnum penna-marina* and is especially common on slopes subject to peat slipping. Where *Acaena adscendens* dominates, a closed canopy of summer leaves covers a dense carpet of mosses, mainly *Drepanocladus uncinatus* (Hedw.) Warnst. and *Rhynchostegium brachypterygium* (Hornsch.) Jaeg., exposed by the dying back of old *Acaena adscendens* leaves in winter.

Corresponding to the altitudinal limits of *Blechnum penna-marina*, *Azorella selago* starts to dominate slope communities, often forming continuous carpets of several hundred square yards, a sight seldom met with in the lowlands. *Poa cookii* is usually the most important secondary species, but, locally, *Pringlea antiscorbutica* R.Br. may take its place. This community is best developed on the north and west highlands, rare in the south and east of the island.

Where the burrowing of Procellaridae opens the cover of slope communities, *Poa cookii* enters and with increased biotic activity may become dominant, ultimately forming a characteristic community extending from the sea cliffs to highlands. Trampling and burrowing tends to isolate individual tussocks and a relief similar to that of the *Cotula plumosa* community is developed. On steep sea facing slopes burrowing may result in considerable erosion and peat slipping, bare peat being pioneered by mosses and liverworts, and such vascular plants as *Callitriche antarctica* Engelm. ex

Photograph 3: Marion Island. Feldmark vegetation of glaciated grey lava. Note large cushions of Azorella selago **with epiphytic** Agrostis magellanicum. (B.J.H.)

Hegelmeyer, *Montia fontana* L., *Ranunculus biternatus* Sm. and the alien grasses *Poa annua* L., and *Agropyron repens* (L.) P. Beauv.

(*c*) *Swamp communities*

The term swamp is used in a broad sense, to include all those plant communities occurring in sites having a water table above, at or just below the soil surface.

Over 90% of this division comprises poorly drained mire dominated by *Agrostis magellanica* Lam. Phanerogams of secondary importance include *Uncinia dikei* Nelmes., *Juncus sp.* and *Ranunculus biternatus* Sm. A continuous ground cover of bryophytes, composed mainly of the hepatic *Diplophyllum densifolium* (Hook.) Steph. is typically present. Soil water from mire is usually acid, pH 4.5-5.5, on black lavas, to slightly acid, pH 5.5-6.5, on grey lavas.

Bog communities dominated by bryophytes with very few vascular plants occur in many lowland sites, most frequently in the younger black lavas. The peat is generally more acid than that of mire, ranging from pH 4.0 to pH 5.5.

Around the eyes of perennial springs and extending for a short distance below them, a distinctive plant community is found. The floristic composition is very similar to that of the *Acaena adscendens* slope community, this species usually dominant with *Poa cookii*, *Pringlea antiscorbutica*, *Ranunculus biternatus* and *Montia fontana* the most prevalent secondary species. The community is best developed on well drained peats fed by rapidly flowing springs arising from grey lava, the pH of the water high, pH 7.0 to 8.4, and richer in dissolved salts than that of mire or bog.

Flushes are most frequent in upland sites, especially on grey lava flows where local sites are too exposed for the development of mire but too moist for feldmark.

(*d*) *Feldmark communities*

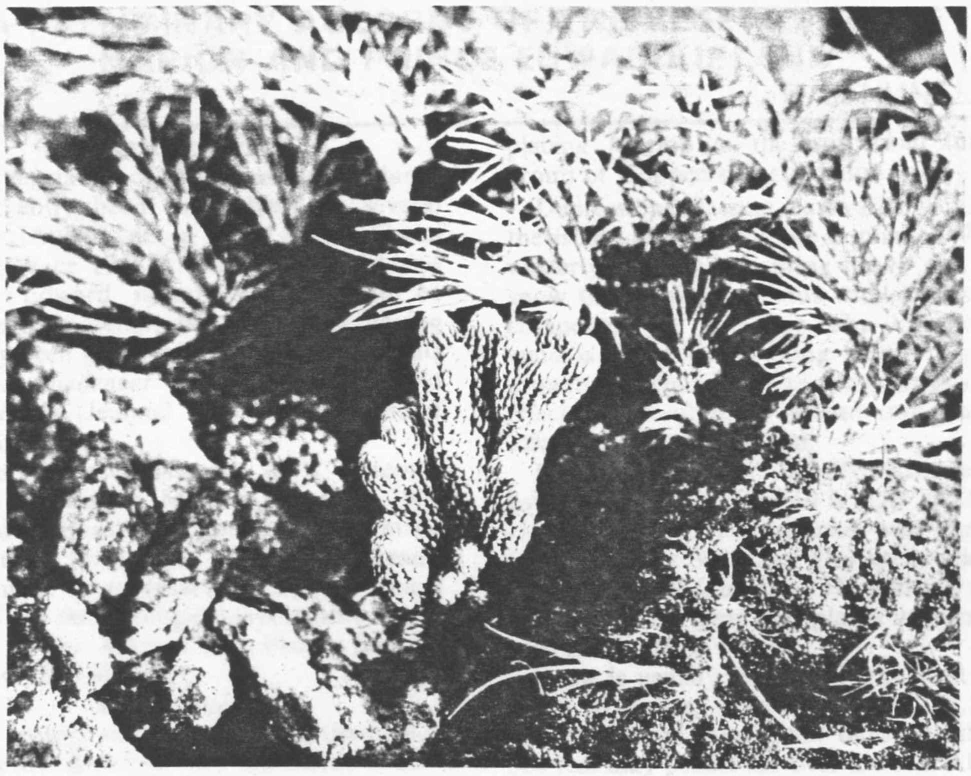
Where exposure to strong winds inhibits the development of closed vegetation communities, feldmark occurs. Extending from the coast to the upper altitudinal limit of vegetation, the community is best developed above 300 feet a.s.l., where longer-lying snow and kryoturbation increase the rigour of plant life. Shallow mineral soils overlie the parent lava, the surface cover of loose pebbles and flagstones often displaying the stonelines and polygons typical of tundra soils.

Azorella selago is the dominant species with *Agrostis magellanica* typically epiphytic on cushions of the former. Several other phanerogams are occasionally found epiphytic on or growing in the lee of *Azorella* cushions. The importance of wind as a limiting factor in this community is illustrated by the diverse flora of a sheltered microhabitat such as this.

Phanerogam cover seldom exceeds 50% and is usually below 20%. Lithophytic cryptogams often exceed vascular plant cover.

A striking feature of the feldmark vegetation is the orientation towards the sun of cryptogams compared to wind orientated *Azorella* cushions. Where *Azorella*, *Campylopus* spp. and *Rhacomitrium lanuginosum* Brid. together form large arcuate cushions the latter species very frequently lie to the east of the former.

The above summary of the main communities is necessarily brief, several important topics such as the role of competition, the climax concept, alien species, fauna and man having been omitted. The short descriptions may give the erroneous impression of clear-cut differences between the main communities. In actual fact the distinctions are not so sharp, ecotones often being well developed. Individual communities, with the exception of feldmark and mire, seldom cover areas greater than an acre. A mosaic of communities is thus produced, the heterogeniety of vegetation corresponding to that of the lava subtrate, reaching its greatest diversity on black lavas, considerably variable in age, area and microrelief.



Photograph 4: Marion Island. Lycopodium saururus **growing from the side of an** Azorella selago **cushion on which epiphytic** Agrostis magellanicum **occurs.** (v.Z.B.Jr.)

The author wishes to express his gratitude to Prof. E. M. van Zinderen Bakker and other members of the Prince Edward Islands Expedition for assistance and encouragement throughout the expedition, and to the Secretary of Transport for permission to publish this preliminary paper.

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c/o BOTANY DEPARTMENT,
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