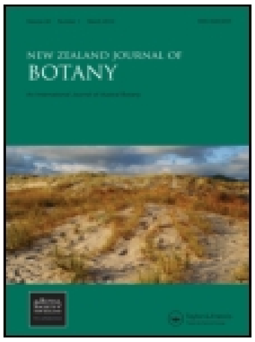

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Vegetation and Flora of the Solander Islands, Southern New Zealand

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ABSTRACT

The Solander Islands, south of South Island, hold 53 vascular plant species, mostly ferns, orchids, and composites with wind-borne propagules. One-third of the species on Big Solander Island are very rare, being either coastal or confined to a sheltered summit plateau. Peat covers the island, supporting *Olearia lyallii* and some *Senecio stewartiae* on the plateau, giving way to *S. reinoldii* at lower altitudes and on rocky sites, then to *Hebe elliptica* near the shore line. Grassland of *Poa astonii* dominates rocky lower slopes, and *P. foliosa* occupies gullies and debris fans.

Wind and salt spray are the main factors affecting plant distribution. Large populations of fur seals modify the shore line vegetation and elsewhere burrowing seabirds and Bullers mollymawk affect the vegetation, both mechanically and by soil disturbance and manuring.

Vegetation most closely resembles that on the Snares and on small islands near Stewart Island, though there are some surprising absences from the flora. All vascular plants and bryophytes are listed.

The islands have received little interference by man and appear to be quite unmodified. No evidence was seen of past fires and the only adventive plants are *Sonchus* cf. *oleraceus* and *S. asper*, both uncommon. The only introduced animal is the weka, which has probably indirectly affected vegetation by depredation of burrowing sea birds, but no introduced mammals are apparent. Thus it is one of the few New Zealand offshore islands lacking rats, so its status as a special area of Fiordland National Park should be rigorously enforced to prevent accidental introductions of vermin.

INTRODUCTION

The Solander Islands, to the west of Foveaux Strait, 40 km south of South Island and 60 km WNW of Stewart Island (Fig. 1) were discovered by Captain James Cook on 11 March 1770 and named by him

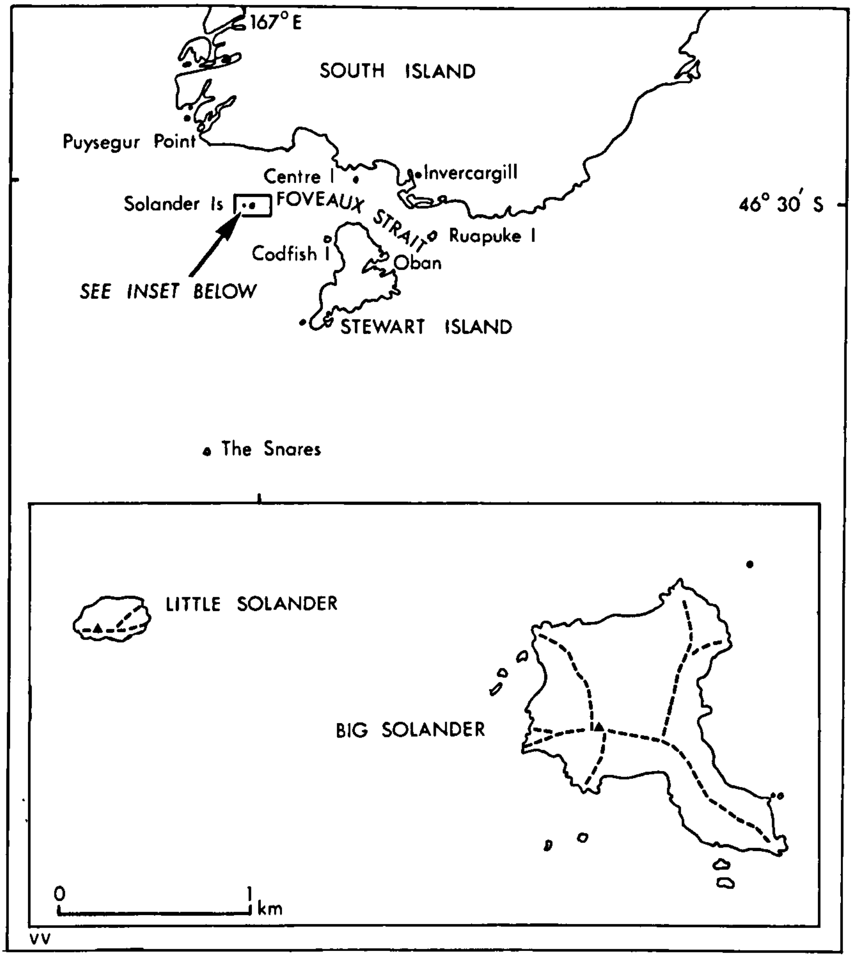

FIG. 1—Location map with inset showing relative position of Big Solander Island and Little Solander Island, and their main ridges.

after Dr Daniel Solander, one of the botanists aboard his vessel–"This Island I have named after Dr Solander (Latde 46°31'S, Longde 192° 49'W) it is nothing but a barren rock of about a mile in circuit remar[k]ably high and lies full 5 legues from the Main" (*in* Beaglehole 1955). Maoris visited the Solanders, which they knew as Hautere (Begg & Begg 1973) and although Big Solander may have made a good defensive position it would have offered little shelter or water and no resources that would not have been more easily reaped elsewhere. During the first few decades of the 19th century, sealers visited the islands, one unfortunate gang being marooned there from 1808 to 1813 (McNab 1907).

Whalers knew the group too, applying their name to the famous "Solander grounds", but giving the islands themselves a wide berth (Bullen 1898).

Scientific visits have been few and brief. In 1908 Captain J. Bollons and Mrs Bollons landed, collecting 19 plant species which were reported by Cockayne (1909), and some rocks which gave the first indication that the island consists of relatively young and isolated hornblende-andesite (Speight 1909).

Mr E. F. Stead spent an hour ashore in 1933 (Falla 1948). Dr R. A. (now Sir Robert) Falla has made four landings on the islands. On the first of these visits (9 December 1947) the party included Dr R. C. Murphy and Mrs Murphy, but only passing reference is made to the islands by Murphy (1948). After a visit on 20 July 1948, Falla (1948) wrote an account of the bird life, and further visits on 21 May 1950 and 20 May 1956 culminated in an ascent to the summit of Big Solander Island. Some plants collected by R. A. Falla, C. J. Lindsay, and R. K. Dell are deposited in the National Museum, and rocks collected by Falla were reported on by Reed (1951). In 1946, seals were taken off the Solanders (Sorensen 1969) and a visit by A. M. Rapson resulted in at least one plant specimen (*Hebe elliptica*) being collected for the Botany Division (DSIR) Herbarium. Harrington & Wood (1958) described the geology of the Solanders after a visit on 16 February 1957. Professor G. T. S. Baylis landed briefly on 27 October 1958 with Fiordland National Park Board members and collected some plants for the Otago University Herbarium. Mr G. J. Wilson camped for several days on Big Solander Island in January–February 1973. He was primarily studying fur seals, but reported on birds (Wilson 1973) and collected a few bryophytes for tardigrade studies by Dr D. S. Horning. These bryophytes are deposited in the Botany Division Herbarium.

The Fiordland National Park Board organised a trip to the Solanders from 10 to 25 November 1973. The party consisted of Mr A. Cragg (Senior Ranger), Dr A. Reay (Otago University Geology Department), Mr R. J. Nilsson (Wildlife Service, Department of Internal Affairs), and the author. Travel was by helicopter from Te Anau. Six days were spent traversing most of Big Solander Island, except the lower north and west faces. A further 8 days of westerly gales confined studies to the vicinity of our campsite in the head of South-west Bay and prevented a planned stay on Little Solander Island.

Physical Features

Solander Island, or Big Solander (Figs 2, 3), is about 1.5 km across, rising to 340 m, with an area of about 100 ha. A gently sloping summit plateau of 10 ha is buttressed by sharp ridges which descend to coastal headlands, and by faces with an average slope of 55°. Peat covers the plateau, ledges, and more gentle faces, and forms debris fans along

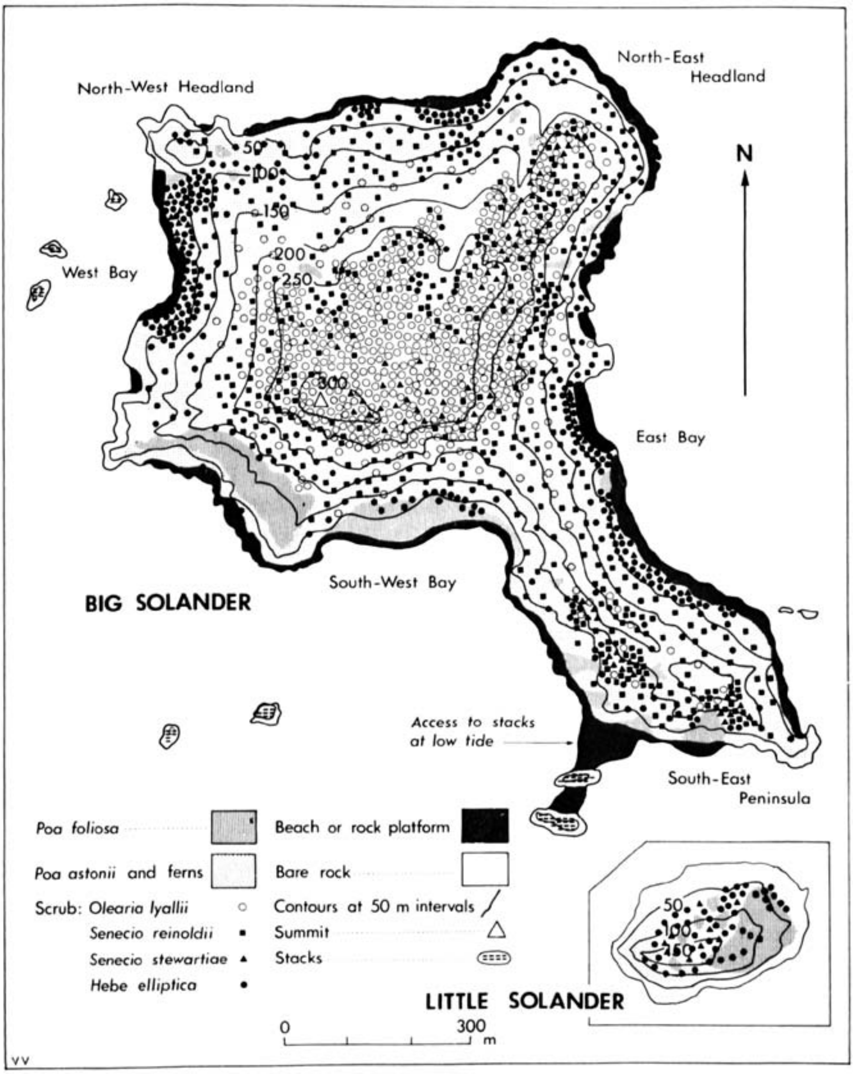

FIG. 2—Solander Islands (drawn from aerial photographs SN 581 P/1–4 with some correction for distortion). Contour lines are approximate. Symbols for scrub do not represent individual plants but their density indicates scrub cover.

the coast, where it has slipped down gullies (Fig. 5). Boulder beaches and rock platforms are contained within steep headlands, and tall stacks stand offshore. Little Solander Island, 2 km to the west, of about 8 ha, has a summit ridge at 180 m, cliffed to the south, but with less steep slopes on the north and east (Figs 4, 8).

FIG. 3—Big Solander Island, seen from Little Solander Island.
Photo: R. A. Falla (1948)

Geologically, the Solanders are erosional remnants of an andesitic volcano, comprising lavas, tuffs, and agglomerates (Harrington & Wood 1958). The nearest similar volcanic area is Mt Egmont.

The general area is characterised by a predominance of westerly winds, at times stormy, and associated with much cloud and frequent rain. These prevent great temperature extremes, either daily or annual, and frosts are not frequent except where there is considerable shelter. Rainfall and temperature observations from the nearest stations (Fig. 1) are as follows:

	Mean annual rainfall (mm)	Raindays (>0.2 mm)	Mean annual temp. (°c)
Puysegur Point	2 355	251	11
Centre Island	1 199	218	11 est.
Oban	1 455	220	9–10 est.
The Snares	1 481	209	12

(Snares records are based on 1972 data only, and the number of raindays refers to days with >0.1 mm rain).

Oban is relatively sheltered, but winds at Centre Island and the Snares are predominantly westerly, often strong, though the influence of Foveaux Strait accounts for 8–10% of easterlies at Centre Island. Winds at Puysegur Point are predominantly north to north-west because of mountains to the north. Rainfall and wind at the Solanders are most likely to resemble those at Centre Island, but with perhaps lighter winds and fewer easterlies, being further from Foveaux Strait.

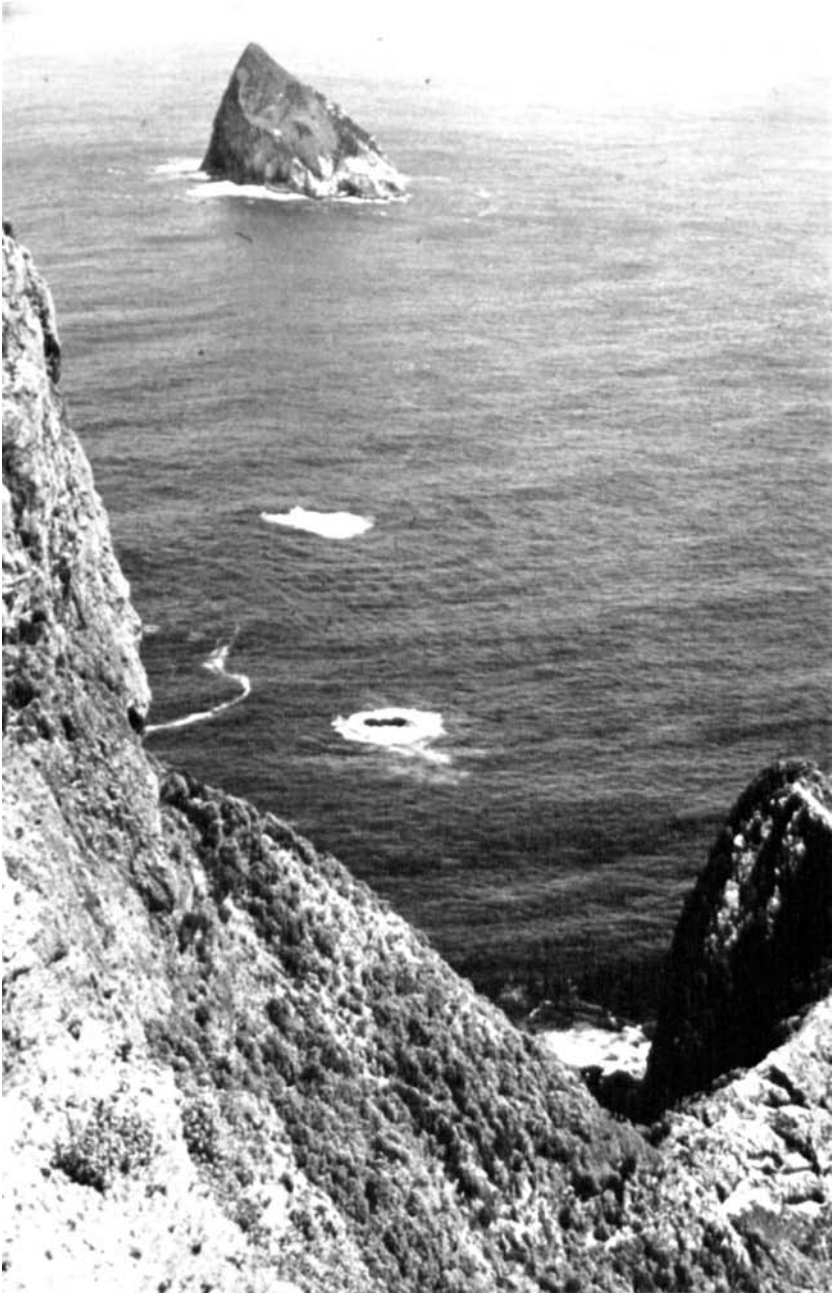

FIG. 4—Little Solander Island from the north face of Big Solander Island. Faces in the foreground hold *Senecio reinoldii*, *Hebe elliptica*, and *Poa astonii*.

FLORA

Vascular plants and bryophytes are listed in an appendix with an indication of their distribution and abundance. Vascular plants total 53, a number probably commensurate with the size of the islands, variety of habitats, and isolation, when these are compared with published lists from other small southern islands. But by the same comparison, the flora of the Solanders contains a high proportion of ferns, orchids, and composites: plants suited to wind dispersal. Most of the other plants are coastal species, seeds of which can probably survive a journey in sea water and become established on the immediate shore on which they are cast. Driftwood in the bay heads gives some clue to this process; a large amount is sawn timber, but attached bark identifies the majority as *Nothofagus*. In South-west Bay some massive logs lie among *Poa foliosa* on the lower part of debris fans, about 8 m above the sea, and show how storms might deposit seeds on well-developed soil, far above normal disturbance by waves.

For grasses and sedges, seed may be carried on the plumage of sea birds, and there are only three plants, *Nertera*, *Gunnera*, and *Stilbocarpa* whose fleshy fruits would seem to require a fruit-eating bird for long-distance dispersal. In this regard it is worth noting that a pair of wood pigeons (*Hemiphaga novaeseelandiae*) was seen during our visit. That such a conspicuous bird has not been previously recorded from Solander Island, and that this pair was seen only on one day, a fine one, suggests that these fruit-eating birds were briefly visiting the islands, probably from the mainland.

The rarity of many species on Big Solander Island is noticeable. For 19 species, over a third of the total, fewer than five plants or clumps were seen, most of them on the plateau. The bryophytes show a similar pattern, 11 of the 33 hepatics and 15 of the 30 mosses being rare. A similar proportion of rare plants can be seen in the lists for several North Island offshore islands (Atkinson 1962, 1964, 1972). On the Auckland Islands too, many species are to be found in only a fraction of the size of the habitat apparently available to them (Johnson & Campbell, in preparation). Although this may not be entirely an island phenomenon, its significance in an island situation is that these species hold a precarious position in the island flora.

Because of the high proportion of species represented by only a few individuals, Big Solander Island has a depauperate vegetation, in which some species like *Poa foliosa* cover large areas to the exclusion of any other plants, some niches are left unfilled, and a handful of species utilise almost every available habitat. *Anisotome lyallii* illustrates this best, growing at all altitudes, in or out of scrub, on peat or in rock crevices, and in both sheltered and fully exposed stations.

All but three Solander Islands plants occur also on Stewart Island (Allan 1961, Moore & Edgar 1970, Zotov 1965). *Hymenophyllum scabrum* does not, and *Senecio stewartiae* and *Poa antipoda* have odd distributions which do not include Stewart Island proper. All but five occur on South Island, viz., *Poa foliosa, P. antipoda, Olearia lyallii, Senecio stewartiae*, and *Stilbocarpa robusta. Stilbocarpa lyallii* may also fit in this category, South Island records being only those of T. Kirk, seen on Coal Island in Preservation Inlet "from the deck of a passing steamer" (Kirk 1885) and a Kirk specimen (AK 6045) at the Auckland Institute and Museum labelled "Anchor Island, Dusky Sound".

There are some surprising absences from the flora of the Solanders, especially plants which are common on the small islands off Stewart Island (Fineran 1966a, b, 1973). Woody genera which are absent are *Dracophyllum, Coprosma, Myrsine*, and *Leptospermum*, and on the coast one could expect to find *Scirpus cernuus, Gentiana saxosa, Selliera radicans*, and *Samolus repens*.

VEGETATION

The general vegetation pattern on Big Solander consists of dense scrub on the plateau, becoming less dense down the slopes except in sheltered sites. Grassland replaces scrub with decreasing altitude and increasing exposure to wind and salt spray, drier cliffs and headlands being dominated by *Poa astonii*, and moister faces, gullies, and debris fans by *Poa foliosa* and ferns (Fig. 5). A few plant assemblages can be recognised as distinct communities, whose distribution parallels topographic, soil, and exposure factors. But mostly the vegetation can be regarded as a mosaic of overlapping species distributions, with indistinct community boundaries (Fig. 2).

SHORE LINE COMMUNITIES

Where debris fans abut on boulder beaches an eroding peat bank is worn smooth in places by the tracks of fur seals (*Arctocephalus forsteri*). Slippery peat, either bare or with a covering of terrestrial algae, is interspersed with *Tillaea moschata* and *Scirpus praetextatus*, mats of which vary in thickness depending on the severity of flattening by seals (Fig. 6). *Poa foliosa* usually surrounds these seal-worn areas, with *Carex trifida* in wet places and rare clumps of *Lepidium oleraceum, Chenopodium ambiguum*, and *Apium australe*.

Cliffs are dominated by *Poa astonii* and *Anistome lyallii*, but near the sea, *Disphyma australe* hangs from occasional dry ledges, and scattered plants of *Myosotis rakiura* occupy gritty soil near the cliff bases.

GRASSLAND AND FERNLAND

Poa foliosa grows on slopes less than about 45° with deep moist peat. Such sites occur mainly below 200 m, on debris fans, in the broad gullies above them and on some faces, notably above the western

FIG. 5—Southern slopes of South-east Peninsula. *Poa foliosa* covers the debris fan, with ferns showing as darker areas in the gully above, and *Poa astonii* dominates the rocky slopes. White flower heads are those of *Anisotome lyallii*. Scrub clothes the upper slopes.

FIG. 6—Fur seal tracks on a peat bank above the beach, partly covered with *Tillaea moschata. Poa astonii* slope beyond holds fairy prion burrows.

end of South-west Bay. It occupies large areas, virtually on its own, spreading by rhizomes to cover all the available ground space, as it does also on Little Solander Island (Fig. 8). On debris fans the grass is flattened by seals, particularly non-breeding bulls which congregate away from the beaches, but the grassland probably recovers with newly produced tillers when seal numbers are lower outside the breeding season. *Poa foliosa* plants transplanted to Dunedin grew vigorously over most of the year. In broad gullies and the upper part of large debris fans *Poa foliosa* is interspersed with patches of the coastal ferns *Blechnum durum* and *Asplenium obtusatum*, scattered plants of *Anisotome lyallii*, and scrub of *Hebe elliptica* with some *Senecio reinoldii*.

Occasional slips were seen in gullies and the steeper parts of debris fans, leaving behind a bare soil surface on which *Scirpus praetextatus* and *Tillaea moschata* are probably the earliest colonisers. They are quickly joined by *Poa* cf. *antipoda*, *Stellaria parviflora*, *Sonchus asper*, *S.* cf. *oleraceus*, all of which are almost restricted to slips, *Carex trifida* and *Poa astonii* which on these sites will be seral species, plus *P. foliosa* and *Hebe*, which are the likely climax species.

Poa astonii tussocks grow on steep rocky headlands, cliffs, and ridges, especially below 150 m. Its main associates are *Anisotome lyallii* and ferns (Fig. 5). These plants establish in crevices and on ledges, *P. astonii* in particular building up a mound of peat covered in dead leaf bases. The ferns *Blechnum durum* and *Asplenium obtusatum*, where growing in the open, are sheared by wind and salt spray, the upper half of old fronds being dead. *Poa astonii* covers the tops of stacks offshore. Where there is a little shelter *Senecio reinoldii* and *Hebe elliptica* grow among *P. astonii*.

OPEN ROCKY SITES

Many of the steepest cliffs and headlands near the coast are bare of plants. A zone of white lichens is prominent just above the shore line, but elsewhere on dry rocky sites lichens are rare and bryophytes virtually absent. The headland rocks are mainly lava, with little water-holding capacity, in contrast to the faces where more porous tuffs and agglomerates support a thin cover of bryophytes, particularly *Jungermannia* spp., *Kurzia compacta*, and *Telaranea gottscheana*.

Ridge crests generally hold stunted *Senecio reinoldii* and *Olearia lyallii* and often have open tracks used by Bullers mollymawks and burrowing birds. Gritty soil here has less organic material than anywhere else on the island, and holds *Poa astonii* and *Anisotome lyallii* plus a few species characteristic of such sites: *Thelymitra longifolia*, *Luzula banksiana* var. *acra*, *Gnaphalium lanatum*, *Colobanthus muelleri*, *Campylopus introflexus*, and *Lophocolea semiteres*.

SCRUB

The main scrub communities from sea level upwards are:

(a) *Hebe elliptica* alone in small pockets near the coast, or with *Senecio reinoldii* and *S. stewartiae* on debris fans. Clumps of *Asplenium obtusatum* and *Blechnum durum* occur underneath, with scattered small plants of *Stilbocarpa lyallii*, but otherwise the ground is bare, especially where used by seals. Scattered low mats of *Chiloscyphus chlorophyllus* grow on the ground but bryophytes are generally sparse except in very moist places, usually at cliff bases. *Pterygophyllum dentatum* and *Eriopus apiculatus* are then prominent, not only on the ground, but extending up the stipes of *Blechnum durum*, a station used also by fern gametophytes. *Megaceros* sp. covers wet fallen branches and *Frullania patula* and *Metzgeria decipiens* are common as low epiphytes. A few species descend from higher altitudes to these moist sheltered sites, for example, *Nertera depressa*, the hepatic *Trichocolea mollissima*, and the fern *Histiopteris incisa* which occupies clearings in the scrub.

(b) *Senecio reinoldii* and *H. elliptica* grow also on the lower faces. The scrub is taller and more dense on shady faces, especially those of Southwest and East Bays, than it is on exposed sites where plants are scattered with lax and partly dead canopies. *Blechnum* and *Asplenium* constantly accompany the scrub, with *Poa astonii* on more open sites. Rocky faces between the scrub are clothed in bryophyte mats, mostly *Chiloscyphus chlorophyllus*, *Kurzia compacta*, and *Telaranea gottscheana*, plus the small fern *Hymenophyllum minimum*.

(c) *Senecio reinoldii* is joined by *Olearia lyallii* on the upper slopes where the influence of wind and salt spray is reduced. *Hebe* is much less common and the scrub covers more ground than it does on lower slopes, extending onto the ridges and into gullies and leaving less room for grassland. *Asplenium* and *Blechnum* are dominant beneath the scrub, along with a little *Polystichum vestitum*, and some *Stilbocarpa* in gullies. *Nertera depressa* and *Hymenophyllum minimum* are common, ground cover increasing with altitude. Appressed mats of hepatics are joined by more robust cushion-formers, particularly *Ptychomnion aciculare*, *Bazzania adnexa*, and *Trichocolea mollissima*.

(d) *Olearia lyallii* dominates the plateau, with *Senecio stewartiae* around the periphery. Winds deflected upslope by the island mass seem to bypass the plateau, and its gentle slope has allowed the accumulation of deep stable peat. A pit dug on the plateau showed peat down to at least 155 cm, dark brown and fibrous on the surface, becoming slimy red-brown below 30 cm, then black and gritty below 100 cm. No water table was evident. Sturdy trees form a tight canopy 6 m high, offering protection to tall ferns of *Blechnum durum*, *Asplenium obtusatum*, and *Polystichum vestitum* and to extensive clumps of waist-high *Stilbocarpa* (Fig. 7). A number of plants restricted to the top part of the island are common: *Grammitis billardieri*, *Lycopodium varium*, and

FIG. 7—Dense thicket of *Stilbocarpa lyallii* beneath *Olearia lyallii* and *Senecio stewartiae* scrub on the plateau.

Uncinia aucklandica. Many others are represented only by a few clumps, for example, *Earina autumnalis, Phymatodes diversifolium*, and *Hymenophyllum scabrum*. Under *Stilbocarpa*, the ground is bare, friable peat, kept loose by the trampling of burrowing birds, as described by Fineran (1964) for the Snares, and assisted perhaps by the pecking of wekas. Elsewhere, litter covers the ground, except on logs and at tree bases which are clothed with bryophyte cushions, in variety not seen on lower slopes. Thus one finds genera typical of Fiordland forests–*Plagiochila, Tylimanthus, Trichocolea, Hypopterygium, Hymenophyton, Trachyloma, Mniodendron*, and *Schistochila*. On the trees too can be found *Macromitrium longipes, Porella elegantula, Dicranoloma menziesii*, and corky tufts of *Leptostomum inclinans*.

The density of the shrubs was measured in two 10 $\times$ 10 m quadrats, one on a 5° slope on the plateau at 290 m and the other on a 45° slope on the south face at 60 m. The three categories recorded were R = rooted in plot, L = live stems at breast height, D = dead stems >2 cm diameter at breast height:

	PLATEAU			SOUTH FACE		
	R	L	D	R	L	D
Senecio reinoldii	—	—	—	37	87	45
Olearia lyallii	15	45	60	16	26	28
Senecio stewartiae	4	6	0	—	—	—
TOTAL	19	51	60	53	113	73

The taller scrub of the plateau (to 6 m high) is less dense than that on the face (3–4 m high). The branching pattern of *O. lyallii* and *S. reinoldii* shows in the figures, there being about three stems at breast height to every one at ground level, with a large number of dead lower branches still attached. *S. stewartiae* does not branch freely near its base and lacks the many dead stems.

AUTECOLOGY OF WOODY SPECIES

The distribution of woody species can be explained in terms of their habit, vigour, tolerance of salt spray, wind, and downslope soil movement. *Olearia angustifolia* was not seen on this visit and must be one of the many rare species, though it might be expected to extend to sites equal to or exceeding the exposure tolerated by the other four woody species. Such is the case on islands near Stewart Island (Cockayne 1928, Fineran 1973).

Hebe elliptica tolerates high soil salinity and seems little damaged by salt spray (Gillham 1960), its thick glossy leaves, and compact leaf bud probably giving it the necessary protection. On Big Solander Island it is most common in the lower half of the island, seeming to prefer fans, ledges, and gullies where the soil is reasonably deep. Seedlings are numerous. Stems branch frequently right from ground level and are generally contorted, bending outwards then upwards. Large specimens collapse either by downslope soil movement or by their own weight, but when the trunk rests on the ground its curvature ensures that the foliage is still held aloft. Adventitious roots may be produced where the trunk rests, but they are not a constant feature. Dead twigs and branch systems are common, but *Hebe* produces new foliage low on the main stem, to replace these. The contorted stems may resist wind breakage by being able to absorb both lateral and twisting forces.

Senecio reinoldii grows over most of the island, though competition with the taller *Olearia* probably excludes it from the plateau. Its greatest selective advantage seems to be an ability to grow on thin soils over rock. Seedlings are numerous and prefer completely open stations, developing in rock crevices or even on smooth faces with a thin covering of bryophytes, then sending roots out in all directions over the face. Plants grow near the coast so they must tolerate high soil salinity, though the abundance of dead branches may indicate susceptibility to salt spray (Fig. 10). The leaves are concentrated at branch tips so if these are killed, a dead branch system results and new shoots do not arise from lower parts of the stem. Tomentum covers the leaf undersides, a feature considered by Gillham (1960) to be an effective means of minimising wind abrasion and salt entry. This would be particularly so in young leaves, which present only their underside when in bud. The leaf is quite small when it emerges from the bud stage and then has some tomentum also on the upper surface.

The open nature of the shrubs probably allows wind to pass through the plant rather than buffeting it as a whole. The branches are extremely stiff and difficult to break laterally, though they will snap easily and cleanly at a point of branching if twisted. This feature is true also of *Olearia* and enables a track to be broken through the scrub, but at the same time it offers some limitation on their suitability as handholds on steep country.

Olearia lyallii dominates the plateau and on the slopes is most common in the upper half of the island, suggesting less tolerance of salty soils. Seedlings are rare under the canopy of plants on the plateau, but are common at its margin and in clearings. Trees are multileadered, allowing more flexing of stems in windy conditions, and should a windbreak occur it need not involve the whole tree, although some trees on the plateau have in fact been completely toppled. The foliage is all borne at the extreme stem apices, and, combined with a regular branching system, this produces a completely closed canopy which must deflect wind. As in *S. reinoldii*, young leaves are tomentose on both surfaces, later becoming glossy above with a thick cuticle and very thick-walled upper epidermis (Herriott 1906).

There is considerable variation between *O. lyallii* plants in the time of bud break and flowering. In November some species were still dormant while others had fully expanded their leaves and undergone much stem elongation. The selective advantage of such variation could be to prevent a single untimely storm from killing a large part of the population at a time when the foliage is at its most sensitive to salt damage.

Senecio stewartiae is only locally common, appearing to have some very specific site requirements. It grows mainly on gentle slopes or, when on steeper slopes, on stable terraces where there is little downslope movement. Nevertheless, it seems common on the north slopes of Little Solander, growing with *Hebe*, and where, in the apparent absence of competition from *Olearia* and *S. reinoldii*, it may be able to utilise sites which on Big Solander are unavailable to it. The trunk tends to be erect and unbranched and the foliage mainly at the extreme branch tips so it would not seem well equipped to regenerate after wind damage. Hence it tends to be in more sheltered sites, though some of its shore line stations must be subject to much salt spray. Drury (1973) illustrates the superbly protected inrolled leaves of *S. stewartiae*, and his measurements indicate that thickness of upper epidermis and of hypodermis is greater in *S. stewartiae* and also in *S. reinoldii* than in most other New Zealand Senecioniae. Unlike *S. reinoldii*, the upper surfaces of young leaves of *S. stewartiae* are more glossy at the time of unfolding, but are much closer to their final size. *S. stewartiae* seedlings occur only under mature trees and then they are rare. They have smaller leaves than adults, are slightly toothed and quite fleshy, with an overall appearance very like a herbaceous, erechtitoid *Senecio*. Low seed viability or poor seedling establishment may partly explain the restricted range of the species, it being known otherwise only from Bench and Herekopare Islands near Oban, and from the Snares.

Little Solander Island

Among Dr W. R. B. Oliver's papers in the Botany Division library is a note on Little Solander Island: "Dr Falla landed on the island July 1948 and climbed to the top. He reports only 6 species of plants: *Hebe elliptica, Poa* probably *astonii, Stilbocarpa robusta, Senecio stewartiae, Poa foliosa, Carex trifida*. Specimens of the last 4 species were collected".

My observations and photographs, from the air, confirm all but the *S. robusta* and the *Carex*, and add nothing extra.

The eastern side of Little Solander, the least steep face, is clothed in *Poa foliosa*, with *Hebe elliptica* in slight gullies (Fig. 8). *Hebe* and *S. stewartiae* cover the steeper north slopes, in a mosaic with grassland which extends over the summit (Fig. 9). The south face and lower slopes are all cliffed.

Effects of Birds

Burrowing sea birds can have a considerable influence on coastal island vegetation, by trampling the soil surface, aerating the soil and undermining trees, and generally manuring the soil (e.g., Fineran 1964, 1973). Burrow density does not seem high on Big Solander Island. Falla (1948) considers that depredation by wekas (*Gallirallus australis scotti*), placed on the island by Maori sealers as a food standby, is reponsible for the high proportion of disused burrows. The burrows of sooty shear-water (*Puffinus griseus*) are scattered throughout but principally under scrub. In *Poa astonii* grassland (Fig. 6) smaller burrows can be found, belonging to fairy prion (*Pachyptila turtur*) and southern diving petrel (*Pelecanoides urinatrix chathamensis*). Mottled petrel (*Pterodroma inexpectata*) and broad-billed prion (*Pachyptila v. vittata*) also breed on Solander but little is known of the relationship of bird species to vegetation. It is noticeable, however, that *Poa foliosa* grassland is almost

FIG. 8—Little Solander Island, eastern slopes with dense *Poa foliosa* and patches of *Hebe elliptica.* Nesting platforms of Bullers mollymawk are visible along the clifftop.

devoid of burrows, possibly because it occupies slopes too moist or with downslope soil movement too great to attract burrowing birds.

Fiordland crested penguins (*Euaypies p. pachyrhynchus*) breed among caves and rock crevices on the coast, but unlike *E. robustus* on the Snares (Fineran 1964, Warham 1974) they do not ravage large areas of vegetated ground.

Bullers mollymawk (*Diomedea bulleri*) has the greatest mechanical effect on the vegetation, building nests over most of the slopes, both within scrub and in the open. It digs out a platform about one metre across, prunes the ferns or grasses beyond that, then erects a pedestal-shaped nest (Fig. 10). Progressively older nest sites are colonised by *Campylopus introflexus* and *Lophocolea semiteres,* then *Scirpus praetextatus, Tillaea, Stellaria,* and *Colobanthus,* then *Sonchus* spp., *Carex trifida, Poa foliosa,* and fern sporelings. Scrub roots enter the nest itself from below, and in the manner of roots in a pot plant must help to stabilise it. But as the nest disintegrates and is abandoned, scrub seedlings appear and it seems to be a fortuitous race wherein scrub, fern, or grass becomes the sole occupier of the site. This may explain the patchwork distribution of these plants on the hillsides. Were it not for such disturbance of the slopes, the establishment of scrub in dense *Poa foliosa* or grasses among dense fern would seem difficult.

FIG. 9—Little Solander Island summit with a mosaic of *Poa astonii* tussocks, *P. foliosa* on the flat ridge crest, *Hebe elliptica* (the dark shrub), and *Senecio stewartiae*.

CONSERVATION STATUS

The Solander Islands lie within Fiordland National Park and in September 1973 were gazetted as a special area, entry being allowed by written permit only.

FIG. 10—Nest of Bullers mollymawk on a terrace excavated among *Asplenium obtusatum* and *Blechnum durum*. *Scirpus praetextatus* and *Poa foliosa* are colonising the terrace. Many of the *Senecio reinoldii* shrubs beyond are dead.

Human influence upon the islands seems to have been slight. Sealers introduced the weka, which by reducing numbers of burrowing sea-birds may have indirectly affected the vegetation. Falla (1948) makes no mention of wekas on Little Solander, and there is less chance of wekas being there as sealers would have had less reason to visit it. Sealing gangs such as the one marooned on Big Solander from 1808 to 1813 (McNab 1907) may have burned the island, particularly if attempting to attract passing ships. However, no signs of past fires were seen, although charcoal was not specifically searched for. The scrub and *Poa astonii* would be moderately vulnerable to fire, which could also become established in drier areas of peat.

In 1946, an open season for sealing was declared, mainly as a result of pressure from fishermen, and fur seals were taken from the Solanders at that time (Sorensen 1969). Fishermen take rock lobsters off the coast and have a mooring offshore in East Bay. Their activities are manifested by such items as bollards and beer crates washed ashore, and fishing floats and plastic bottles with Japanese writing attest the international attitude that the oceans are a rubbish depository. Pauas are plentiful along the coast and may have missed the exploitation these shellfish have had on adjacent coasts.

Introduced mammals appear to be absent from Big Solander Island. Eight break-back rat traps set by R. J. Nilsson for a total of 42 trap-nights at South-west Bay indicated that no rats were present, nor was any sign seen elsewhere on the island. This makes the Solanders one of the few remaining parts of New Zealand lacking introduced mammals (Atkinson & Bell 1973, Atkinson 1973b).

Island ecosystems, because of their relative simplicity, are generally vulnerable to induced changes (Holdgate & Wace 1960). Big Solander Island vegetation is modified only to the extent of containing two adventive species, *Sonchus asper* and *S.* cf. *oleruceus*. Browsing mammals would greatly alter the vegetation, though their introduction is unlikely. Accidental introductions of rats could occur through shipwrecks or through careless landings from smaller boats, and the introduction of mice in the food or gear of parties planning to camp on the islands is a very real threat. Adventive plants could easily be dispersed by the same means, and also in soil attached to footwear or helicopter skids. Finally, the possibility of offshore oil drilling in Foveaux Strait could put human pressures on the islands.

The value of unmodified islands such as the Solanders, especially as scientific baselines, cannot be overstressed (Atkinson 1973a). This value can be preserved only with stringent enforcement of landing regulations to prevent introducion of vermin and weeds.

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Appendix

Plant Species Recorded from Big Solander Island

Specimens are lodged in the Botany Division (DSIR) Herbarium. Authorities for names are based on Allan (1961), Moore & Edgar (1970), Zotov (1965), Sainsbury (1955), and Hamlin (1972), except where noted otherwise. An asterisk indicates species listed by Cockayne (1909). Superscript numerals refer to notes on particular species (p. 210). For each species a code of two letters indicates distribution then abundance. Distribution symbols are : P=mainly on plateau, C=mainly near coast, W=widespread throughout, S=scattered throughout. Abundance symbols are M=many, F=few (5–10 plants seen), R=rare (<5 plants seen).

MOSSES

Acanthocladium extenuatum	PR	*Leptostomum inclinans*	PF
Bryum appressifolium	CR	*Macromitrium ligulare*	CF
B. truncorum	SM	*M. longipes*	SM
Camptochaete arbuscula	PR	*M. longirostre*	SR
Campylopus introflexus	WM	*Mniodendron comosum*	PR
Ceratodon purpureus	CR	*Pterygophyllum dentatum*	WM
Cladomnion ericoides	PF	*Ptychomnion aciculare*	PM
Cyathophorum bulbosum	SF	*Racopilum strumiferum*	PR
Dicranoloma menziesii	WM	*Rhynchostegium laxatum*	SM
D. robustum	PF	*Rhizogonium bifarium*	PR
Distichophyllum rotundifolium	CR	*R. distichum*	PR
Eriopus apiculatus	WM	*R. pennatum*	PR
Hypnum cupressiforme	SM	*Trachyloma planifolium*	PR
Hypopterygium novae-seelandiae	PF	*Weissia controversa*	CR
Lembophyllum divulsum	PR	*Weymouthia cochlearifolia*	PR

HEPATICS

Aneura sp.	PF	*Megaceros* sp.	SM
Bazzania adnexa	SM	*Metzgeria colensoi*	PR
Chiloscyphus allodontus	PF	*M. decipiens*	WM
C. coalitus	PR	*Plagiochila gregaria*	PR
C. chlorophyllus	WM	*P. strombifolia*	PR
Frullania patula	WM	*Porella elegantula*	PM
Hymenophyton flabellatum	PR	*Riccardia* sp.	PF
Jungermannia inundata	CM	*Schistochila ciliata*	PF
J. sp.	CM	*S. nobilis*	PF
Kurzia compacta	WM	*Siphonolejeunea nudipes*	CF
Lepidozia concinna	PR	*Telaranea gottscheana*	WM
Lophocolea biciliata	PR	*Trichocolea lanata*	PF
L. lenta	CF	*T. mollissima*	SM
L. novae-zeelandiae	PR	*Tylimanthus saccatus*	PR
L. semiteres	SM	*T. tenellus*	PR
L. subporosa	SM	*Zoopsis argentea*	PR
Marchantia berteroana	SM		

PTERIDOPHYTES

[1]*Asplenium flaccidum*	PR	*H. minimum*	SM
*[1]*A. lucidum*		*H. multifidum*	PF
*[1]*A. obtusatum*	WM	*H. peltatum*	PR
Blechnum capense	PR	*H. scabrum*	PR
B. durum	WM	*Lycopodium varium*	PF
Grammitis billardieri	PM	*Phymatodes diversifolium*	PR
G. crassa	PR	*Polystichum vestitum*	PM
G. heterophylla	PR	*Tmesipteris tannensis*	PF
* *Histiopteris incisa*	SM	*Trichomanes venosum*	PR
Hymenophyllum flabellatum	PR		

ORCHIDS

Corybas trilobus	PR	*Pterostylis* aff. *australis*	SR
Earina autumnalis	PR	*Thelymitra longifolia*	SM

GRASSES

Poa. cf. *antipoda*	ST	*P. foliosa*	WM
P. astonii	WM		

OTHER MONOCOTYLEDONS

* *Carex trifida*	WM	*S. praetextatus*	CM
* *Luzula banksiana* var. *acra*	SM	*Uncinia aucklandica*	PM
Scirpus aucklandicus	PR		

COMPOSITES

Gnaphalium audax subsp. *ruahinicum* D. G. Drury	PR	*Senecio glomeratus* Desf. ex Poir.	SR
G. lanatum Forst.f.	SM	* *S. reinoldii*	WM
[2]*Olearia angustifolia*		* *S. stewartiae*	SM
*[3]*O. colensoi*		[4]*Sonchus asper*	SM
[3]*O. lyallii*	WM	[4]*S.* cf. *oleraceus*	SM

OTHER DICOTYLEDONS

*[5]*Anisotome lyallii*	WM	*Lepidium oleraceum*	CR
* *Apium australe*	CR	* *Myosotis rakiura*	CM
Chenopodium ambiguum	CR	*Nertera depressa*	PM
Colobanthus muelleri	SM	*Stellaria parviflora*	CM
* *Disphyma australe*	CF	*[6]*Stilbocarpa lyallii*	WM
Gunnera monoica	PR	[6]*S. robustum*	
* *Hebe elliptica*	WM	* *Tillaea moschata*	CM

NOTES ON PARTICULAR SPECIES

1. *Asplenium.* Complex populations of *A. flaccidum*, *A. lucidum*, and *A. obtusatum* are a feature of many southern islands, e.g., Codfish, Bird, and Snares Islands (Fineran 1966a, b, 1969), and Auckland Islands (Johnson & Campbell, in preparation). On Big Solander Island only two plants of *A. flaccidum* were seen, both quite distinct and without intergrades to other species of *Asplenium*. Cockayne (1909) lists both *A. lucidum* and *A. obtusatum* from the Solander Islands but any distinction is difficult to make in the field. The plants are fairly uniform, much more so than those illustrated by Fineran (1969, 1973) and fit best into *A. obtusatum*. Certainly plants growing under scrub have longer fronds and more distant pinnae than those growing in the open. The pinnae are less obtuse on shaded plants but pinnae apices vary on individual plants from obtuse in young fronds to acute in old ones.

2. *Olearia angustifolia.* Collected only by R. A. Falla, Big Solander Island, near summit, 20 May 1956, WELT 4598. I did not observe this species, being unaware of Falla's collection at the time.

3. *Olearia lyallii.* Cockayne (1909) listed *O. colensoi* but within this species, plants from Big Solander Island best fit var. *grandis*, a taxon which several authors have suggested is close to *O. lyallii* of the Snares and Auckland Islands (*see* Wardle *et al.* 1971). Fineran (1973) discusses plants from the south-west Mutton Bird Islands, placing them in *O. lyallii.* Big Solander Island specimens also seem better placed within *O. lyallii* than *O. colensoi.* They show considerable variation in timing of bud break and flowering, in degree of grooving in the bark, and in leaf size. Leaves are biggest on small plants, decreasing gradually in size on taller specimens, but this does not seem related to environment or maturity. Thus some small specimens with leaves equal in size to Auckland Islands *O. lyallii*, were growing in exposed sites and also flowering.

4. *Sonchus.* The sow thistles *S. asper* and *S. oleraceus* seem to be considered as adventives to New Zealand, though Allan (1961) suggests that *S. asper* may have come with the Maori. These would be the only adventive plants on Big Solander Island, though it is possible they came from the mainland without the help of man.

5. *Anisotome.* Allan (1961) considers *A. acutifolia* to occur on the Solanders and mentions a specimen collected by Cockayne [Bollons]. Dawson (1961) cites such a specimen under *A. lyallii* and considers *A. acutifolia* to be endemic to the Snares.

6. *Stilbocarpa.* *S. lyallii* and *S. robusta* were placed in a new genus, *Kirkophytum* by Allan (1961) but Philipson (1965) considers the split to be unwarranted. *S. robusta,* known otherwise only from the Snares, was reported from Little Solander Island by Falla (1960) who notes that Bullers mollymawk is common to the two island groups. Carlquist (1965) repeats this information but Fineran (1969) queries the Little Solander record. Herbarium specimens collected by Falla from Big Solander are *S. lyallii* but those from Little Solander seem to have disappeared from the National Museum. Their identity as *S. robusta* was agreed upon by Dr W. R. B. Oliver (Sir Robert Falla, pers. comm.) and among Oliver's papers in the Botany Division Library is a list of Solander Islands collections which includes *S. robusta.*

   Cockayne (1909) noted that Solander Island *S. lyallii* seems slightly different from that around Stewart Island, being ". . . much more hairy, of a rather dull green, and the small veins on the back of the leaf are much raised, making it almost lacunose. It increases by means of runners, as does the Stewart Island plant, and consequently differs altogether from the Snares plant, with its massive rhizome and no runners". However, the Big Solander *Stilbocarpa* may give some indication of hybridisation with *S. robusta,* in so far as some clones have the reddish-purple flowers given by Allan (1961) as characteristic of *S. lyallii,* whereas a larger proportion of plants have yellowish flowers typical of *S. robusta.* Plants of each flower colour bear the stolons typical of *S. lyallii* and the only other obvious variation between plants, in the size and shape of bracts, bears no relation to flower colour.

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