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The Flora and Vegetation of Open Bay Islands

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Abstract

THE paper lists the flora of Open Bay Islands, South Westland, New Zealand, and describes the vegetation. Brief ecological notes are given for the terrestrial vegetation. The importance of seals, in particular, in affecting the vegetation is described. Notes about colonisation of the islands by plants are included and there are five appendices. The first describes small plots installed to exclude seals, the second describes the soils, the third describes glacial deposits on the islands, the fourth includes notes about some of the animal life and the fifth, by Dr and Mrs D. S. Horning, lists additional cryptogams collected by them.

INTRODUCTION

THE Open Bay Islands group consists of two small islands with shrubby vegetation and some smaller barren islets and rocks, lying about three miles off the coast of South Westland near Okuru at about 43°50′S latitude and 168°53′E longitude.

The larger, more northerly island, Taumaka, is about 720 yd (658 m) long and 280 yd (256 m) wide. Its highest point lies about 70 ft (21.3 m) above high tide level. The smaller island, Popotai, is about 440 yd (400 m) long and about 65 ft (20 m) high. At the northern end of Taumaka a smaller, barren islet is accessible at low tide, and at the southern end of Taumaka a narrow ravine cuts off a small portion of scrub-covered rock from the main island except at low tide. On the exposed western sides of the islands, broken rocks slope down into the sea, isolated rocks and wave-cut platforms being exposed at low tide. On the eastern side, however, there is an abrupt cliff. The summit of Taumaka is scrub-covered, plateau-like, flat to gently sloping (Fig. 1) and broken only by a few minor gullies and some sink holes. One small, intermittent stream is known. Popotai rises to a peak from a broad base.

Bedrock on the islands consists of indurated, semi-crystalline, contorted, Oligocene limestone with some thin bands of muddy limestone. It is similar to small outcrops of Landon limestone at Jacksons Bay and near Martins Bay (Mutch and McKellar, 1964). The long axes of the two main islands are continuous with lines of wave-swept reefs and submerged rocks extending several miles to north-east and south-west. A series of channels and crevices, oriented west–east, is cut into the rock along Taumaka; these may indicate lines of weakness related to structure, jointing or faulting. The bedrock is capped by a sheet of glacial till, possibly of middle Pleistocene age and varying from about 1.5 m to 12 m in thickness. A few erratic boulders, mostly schistose, lie above this (see Appendix III).

Inhabiting the islands are several thousand southern fur seals (*Arctocephalus forsteri*), numerous little blue and sulphur-crested penguins (*Eudyptula minor* and *Eudyptes pachyrhynchus*), several hundred spotted shags (*Stictocarbo punctatus*), a large population of South Island wekas (*Gallirallus australis*), some sooty shear-waters (*Puffinus griseus*) and prions (*Pachyptila* sp.), as well as several other species of birds (Stirling and Johns, 1969, and Appendix IV).

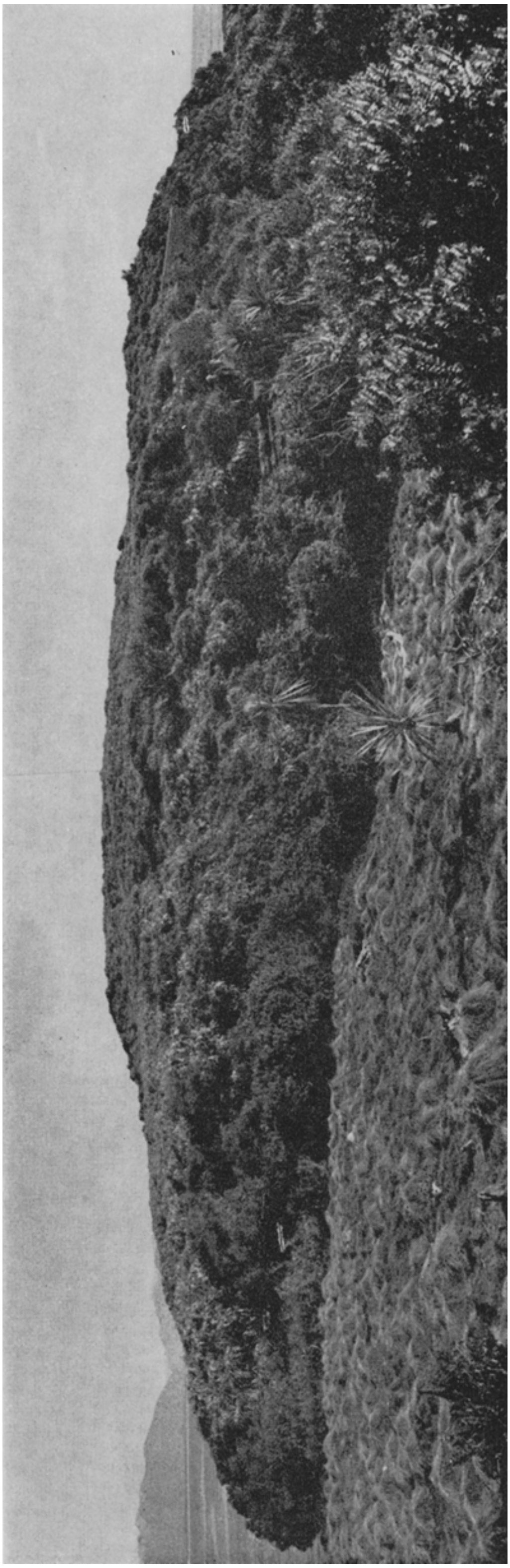

FIG. 1.—**View at northern end of Taumaka, looking south.** *Carex comans* vegetation in foreground; *Hebe elliptica* and some *Muehlenbeckia australis* along edge of ravine in middle ground and in right foreground; *Freycinetia banksii* vegetation in background except for patch of "forest" near hut (upper right).

TABLE 1.—Climatic Data for South Westland

	Ann. av. rainfall (in.)	Mean no. raindays per year	Mean daily max. temperature (°F)	Mean daily min. temperature (°F)	Mean temperature (°F)
Haast	143.2	200	59.6	44.8	52.2
Jacksons Bay	176.5	205	58.0	45.3	51.7

	Lowest min. temp. (°F)	Mean no. days ground frosts per year	Mean no. hours bright sunshine per year
Haast	25.3	59.3	1816
Jacksons Bay	25.0	52.9	not recorded

The climate probably resembles that of the Haast settlement or Jacksons Bay (Table 1). The total annual precipitation and number of rain days on the Open Bay Islands are likely to be less and minimum temperatures higher than these values. It is unlikely that temperatures of more than one or two degrees below 32°F occur. Winds are likely to be somewhat stronger than on the mainland, however. The strength and persistence of wind may be gauged from its effects on the form of the vegetation and the mildness of the climate from the presence of somewhat frost-tender plant species such as *Hebe elliptica, Freycinetia banksii,* and *Asplenium lucidum.*

Human occupation of the islands is only partly documented. The islands are known to have been inhabited by a party of marooned sealers who were there for a total of about two years and five months between January 1810 and November 1813 (May, 1967, p. 25). Nothing is known of Maori occupation nor of visits by other Europeans in the nineteenth century. Leonard Cockayne paid a short visit to the islands in 1903 during a cruise of the Government steamer "Hinemoa". He published a brief description of the vegetation, and a floristic list of the vascular plants (Cockayne, 1904).

Occasionally fishermen go ashore, and there have been recent visits by personnel of the Wildlife Branch, Internal Affairs Department. No rats, mice, or other introduced land mammals have reached the islands, but wekas were introduced about 1910 (D. Merton, in litt.).

During 1968–70 the Zoology Department, University of Canterbury, has been active in studies of the seals and other wildlife of the area. Stirling and Johns (1969), in an account of the birdlife, briefly described the vegetation; their paper includes a map of the islands. In November 1969 a small hut was built near the northern end of Taumaka. I made two visits of about five days each in November 1969 and April 1970 and carried out a botanical survey of Taumaka and its two main outliers. I could not visit Popotai but scanned it with binoculars and thus have a partial knowledge of its flora. Plant collections, complete for vascular plants but probably incomplete for non-vascular plants, are housed in the herbarium of the Botany Department, University of Canterbury.

The islands are a Wildlife Refuge and permission to visit them must be obtained from the Wildlife Branch, Department of Internal Affairs.

TABLE 2.—FLORA

NON-VASCULAR CRYPTOGAMS*

BROWN ALGAE

Carpophyllum sp.
Colpomenia sinuata
Cystophora scalaris
Ecklonia radiata
Glossophora kunthii
Halopteris spicigera
H. cf. *congesta*
Hormosira banksii
Landsburgia quercifolia
Lessonia variegata
Sargassum cf. *sinclairii*
Scytothamnus australis
Splanchnidium rugosum
Xiphophora chondrophylla var. *maxima*
Zonaria turneriana

* The authorities for the species are indicated on herbarium sheets. The specimens are housed in the herbarium of the Botany Department, University of Canterbury.

RED ALGAE

Arthrocardia sp.	cf. *Lithophyllum* sp.
Bostrychia arbuscula	cf. *Melobesia* sp.
Corallina sp.	*Microzonia velutina*
Gelidium pusillum	*Plocamium* sp.
Jania rubens	*Pterocladia capillacea*

GREEN ALGAE

Codium adhaerans	*Ulva* sp.

FUNGI

	Habitat
Auricularia sp.	dead tree-branches
Trametes sp.	dead tree-branches

LICHENS

Collema laeve	trees in moist gully
cf. *Leptogium* sp.	trees in moist gully
Physcia elaeina	exposed shrubs
Xanthoria parietina (two forms)	rocks, exposed shrubs

LIVERWORTS

Chiloscyphus coalitus	shaded bank
C. lingulatus	ravine, on rock
Hymenophytum flabellatum	shaded bank
cf. *Kurzia calcarata*	ravine, on rock
Lophocolea biciliata	shaded bank
L. cf. *bispinosa*	base of tree
L. subporosa—lenta complex	peaty soil
Marchantia berteroana	peaty soil
Metzgeria cf. *hamata*	tree trunk, shaded bank
Telaranea cf. *dispar*	shaded bank

MOSSES

Astomum austro-crispum	soil
Bryum argenteum	peaty soil
B. dichotomum	soil
B. truncorum	soil
Calyptopogon mnioides	soil
Campylopus introflexus forma	peaty soil
Distichophyllum crispulum	shaded bank
Fissidens leptocladus	shaded bank, cliff
Hypnodendron arcuatum	shaded bank
Plagiothecium denticulatum	shaded bank
Porotrichum ramulosum	base of tree
Pterygophyllum dentatum	shaded bank
Rhacopilum robustum	shaded bank
Tortula bealeyensis	peaty soil
T. papillosa	soil
T. princeps	peaty soil
Zygodon menziesii	soil

VASCULAR PLANTS

FERNS

	Present Study	Recorded by Cockayne*	Remarks
Asplenium bulbiferum	×		
A. lucidum	×		
A. obtusatum	×	×	
A. lucidum × *A. obtusatum*	×		
Blechnum banksii	×		
B. durum	×	×	
B. banksii × *B. durum*	×		
B. vulcanicum	×		
Dicksonia sp.	×		a few young plants
Histiopteris incisa	×	×	
Hymenophyllum flabellatum	×		
Phymatodes diversifolia	×		

* See note at end of Table.

	Present Study	Recorded by Cockayne*	Remarks
Pteridium esculentum (Forst. f.) Diels	×		
Pyrrosia serpens	×		
Trichomanes venosum	×		
	ANGIOSPERMS		
RANUNCULACEAE			
Clematis paniculata	×		one stand seen
CARYOPHYLLACEAE			
Sagina procumbens L.	×		Ad†
Stellaria media (L) Vill.	×		Ad
S. sp. cf. *parviflora*	×		
URTICACEAE			
Urtica ferox	×		
CRASSULACEAE			
Tillaea moschata	×	×	
POLYGONACEAE			
Muehlenbeckia australis	×	×	
M. complexa		×	
Rumex neglectus	×	×	called *R. flexuosus* by Cockayne
Rumex sp.	×		Ad—one plant not flowering
HALORAGACEAE			
Haloragis erecta	×		
CRUCIFERAE			
Cardamine debilis	×	×	
Lepidium oleraceum	×	×	
ONAGRACEAE			
Fuchsia excorticata	×		
MONIMIACEAE			
Hedycarya arborea	×		one plant seen
VIOLACEAE			
Melicytus ramiflorus	×		
MYRSINACEAE			
Myrsine australis	×		
CORNACEAE			
Griselinia littoralis	×		a few plants
ARALIACEAE			
Schefflera digitata	×	×	
UMBELLIFERAE			
Apium filiforme		×	
A. prostratum	×	×	
Hydrocotyle americana	×	×	
PRIMULACEAE			
Samolus repens	×	×	
PLANTAGINACEAE			
Plantago media L.	×		Ad
RUBIACEAE			
Coprosma propinqua	×		one plant seen
APOCYNACEAE			
Parsonsia heterophylla	×		
CONVOLVULACEAE			
Calystegia tuguriorum	×	×	
SCROPHULARIACEAE			
Hebe elliptica	×	×	
COMPOSITAE			
Cirsium vulgare (Savi) Ten.	×		Ad—one plant seen
Gnaphalium luteo-album			
Sonchus littoralis	×	×	
PANDANACEAE			
Freycinetia banksii	×	×	
AGAVACEAE			
Cordyline australis	×	×	
Phormium tenax	×	×	
LILIACEAE			
Astelia fragrans	×	×	
JUNCACEAE			
Juncus tenuis Willd.	×		Ad

	Present Study	Recorded by Cockayne*	Remarks
CYPERACEAE			
Carex comans	×	×	
C. coriacea	×	×	a large form
C. solandri	×		
Cyperus ustulatus	×		
Scirpus cernuus	×		
S. nodosus	×	×	
GRAMINEAE			
Agrostis sp.		×	
Cortaderia (probably *richardii* (Endl.) Zotov)		×	
Deyeuxia sp.	×		possibly the *Agrostis* mentioned by Cockayne
Poa annua L.	×		Ad
P. cf. *breviglumis* Hook. f.	×		

* Names amended according to modern usage. Authorities as in Allan (1961) or Moore and Edgar (1970) unless otherwise indicated.
† Ad—adventive.

Metrosideros umbellata was listed by Cockayne, on the basis of a supposed sighting some years before by another person, but the species was not seen after careful searching during the present study, and I exclude it from the flora.

VEGETATION AND ECOLOGY

An attempt was made to record the more important aspects of the vegetation and associated habitat conditions. Because of the impenetrable nature of much of the vegetation a quantitative survey was not attempted. The description of the broad pattern of the vegetation given by Cockayne (1904) is accurate as far as it goes but he did not see some of the important components of the vegetation. I conclude that he paid a very brief visit, probably only to one part of the islands. There appears to have been little change in the general nature of the vegetation since 1904. The present account elaborates on Cockayne's description by outlining the general situation and describing particular cases more fully. It applies specifically to Taumaka and its outliers.

Macrophytic Algal Communities

Brief examination of the macrophytic algal communities was made but further, more critical, work is required. The places attainable at low tide (high-water mark to just below low-water mark) include three main habitats: channels with deep water (greater than two or three feet), pools with shallow water, and surfaces exposed at low tide. The last consists of a variety of horizontal to vertical or overhanging slopes on the rocks. The deep channels tend to have water movement through them most of the day. No doubt there is habitat differentiation in them, but no attempt can be made to describe this. The prominent algae are the large brown seaweeds *Ecklonia radiata, Glossophora kunthii, Lessonia variegata, Landsburgia quercifolia, Cystophora scalaris,* and *Sargassum* sp. Smaller red and brown algae are also present. Shallow pools are variable in their flora. Encrusting coralline algae are common and *Cystophora, Ulva* sp., *Zonaria turneriana, Hormosira banksii,* and *Codium adhaerans* may be present. *Jania rubens* is often present and *Pterocladia capillacea, Plocamium* sp., and *Corallina* sp. also occur in the pools. On the surfaces exposed at low tide there is a gradation in algal distribution from the flat platforms just above low-water level to the zone near high-water level, which is usually distributed on steeper slopes. This gradation also occurs, much condensed, on surfaces sloping steeply into the water at low tide. The flat platforms, broken here and there by channels and pools along the joint systems in the limestone, are usually densely covered by *Hormosira banksii,* with some *Splanchnidium rugosum, Ulva* sp., and abundant *Corallina* sp. The *Corallina* may form pure stands on slight eminences and on slopes just above the *Hormosira* limit. A little higher, usually on the steeper slopes, there may be a narrow band of one or more small algae including *Bostrychia arbuscula* and *Microzonia velutina,* marking the lower limit of the zone affected by wave splash at high tide. The limestone above this is lacking in macrophytic algae.

Terrestrial Cryptogamic Plant Communities

Only a very brief account will be given here, because my knowledge of the plants is not deep and it is clear that more critical study is required. However, except in a few places, the non-vascular cryptogams are not prominent in the vegetation. Several broad habitat types may be distinguished. On exposed rocks the only abundant macrophytic cryptogam is the lichen *Xanthoria parietina*. The same species is common as an epiphyte on twigs of shrubs and so is *Physcia elaeina*. Some open habitats frequented by seals carry an abundance of the liverwort *Marchantia berteroana* and some mosses, particularly species of *Bryum* and *Tortula*. Shaded tree trunks and branches have abundant *Metzgeria* sp. as almost the only cryptogamic epiphyte, though a few mosses inhabit the bases of trees in shaded gullies. The other habitats are moist ravines or shaded cliffs, where a variety of mosses and liverworts grow in shallow soil on the rock faces, or shaded banks of glacial till where similar kinds of community are present. The species present may be seen from the habitat information given with the species list.

FIG. 2.—Vegetative reproduction by *Melicytus ramiflorus*. A branch from the tree on the right has reached the ground, taken root, and sent up numerous new branches.

Terrestrial Vascular Plant Communities

"Forest"

Round the margins of Taumaka, especially on its north-western end, there are stands of low trees, seldom more than 4.5 m high but occasionally reaching 6 m or more. The most abundant tree is *Melicytus ramiflorus*, but *Schefflera digitata* is common and there are some specimens of *Griselinia littoralis*, *Fuchsia excorticata*, *Myrsine australis*, and occasional *Cordyline australis* (which are usually taller than the other species and project above the canopy). *Muehlenbeckia australis* and *Freycinetia banksii* scramble in the canopy in places. There are few straight, erect stems of the tree species. Stirling and Johns (1969) called the bent, gnarled vegetation "broken forest". The contorted form may have resulted in part from wind breakage or breakage caused by the weight of *Freycinetia* and *Muehlenbeckia* tangles. Usually it is because of the considerable age of the plants. Especially near the centre of the island, bent limbs of the trees, mainly *Melicytus* and *Schefflera,*

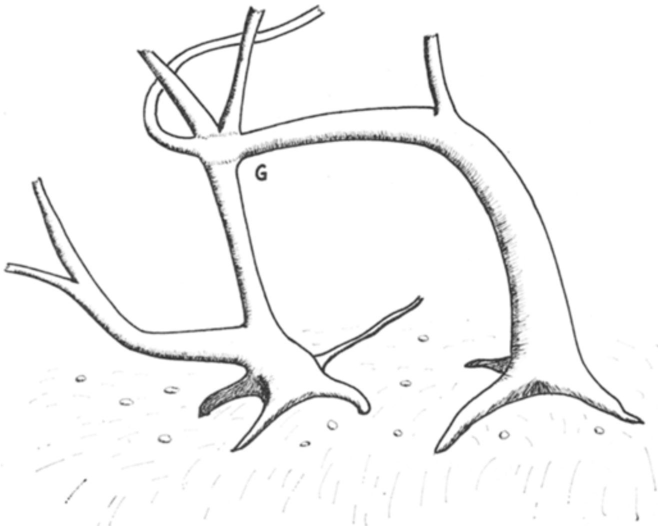

FIG. 3.—Sketch of natural shoot graft of *Melicytus*. G, graft.

have met the ground surface, produced adventitious roots, and developed further branches from this point (Fig. 2). Old stems often are partly rotted and hollow, but new coppice shoots are produced from them. Suckering from roots of *Melicytus, Schefflera, Fuchsia, Myrsine,* and *Griselinia* was seen. In one moist gully, natural shoot grafts of *Melicytus* branches were observed (Fig. 3). The impression gained

FIG. 4.—" Forest " near western side of Taumaka, dominated by *Melicytus*. Heavy seal use maintains the bare ground.

is that vegetative reproduction is adequate to maintain the " forest ", if competition from *Freycinetia* is not too severe. Seedlings of *Schefflera* (fairly common), *Melicytus, Myrsine,* and *Fuchsia* (not common) were seen. Few saplings of any species are present. Near the western edge of Taumaka, in depressions, the trees, in the larger stands of " forest " are straighter and more upright, but usually several stems arise from the same base (Fig. 4).

The distribution of the denser and taller stands of trees is apparently related to the presence of sheltered habitats below banks (on the west), or in sinkholes and shallow gullies. In such sites they can develop without projecting too far above a fairly smooth canopy and thus are protected from the wind and spray. The distribution of " forest " may also be dependent on a reliable moisture supply. The trees are usually rooted in the glacial till or in deep soil among broken limestone blocks. Although the deeper soils are absorbent of water there may be short periods when water is limiting and the limestone or shallow soils are less likely to maintain a water supply at these times.

Ground species are few in the " forest ". In many places this is because seals have penetrated beneath the trees, destroyed the established cover, and continue to maintain the ground bare. *Asplenium obtusatum* and *A. lucidum* occur in some protected sites, and *A. bulbiferum* is present in a few moist, shady gullies. *Asplenium lucidum* is also occasionally present as an epiphyte, and *Pyrrosia serpens* and *Phymatodes diversifolium* creep on the branches of trees in a few places.

Freycinetia Tangle

The " forest " described above grades into a dense tangle of *Freycinetia banksii* with scattered individuals of *Melicytus, Schefflera,* occasional *Hebe elliptica,* and emergent *Cordyline.* Superficially the canopy consists of continuous *Freycinetia,* but over much of Taumaka the *Freycinetia* is partly supported by stunted trees 3 to 4.5 m high. In places where the woody species are missing *Freycinetia* is able to support itself and forms a canopy 2.5 to 3 m high. Scattered through the almost continuous stand of *Freycinetia,* sending stems up to the canopy, are plants of *Histiopteris incisa* and *Pteridium esculentum.* Scrambling in the canopy are *Calystegia tuguriorum, Muehlenbeckia australis,* occasional *Parsonsia heterophylla,* and scarce *Clematis paniculata.* It appears that vigorous growth of the *Freycinetia*

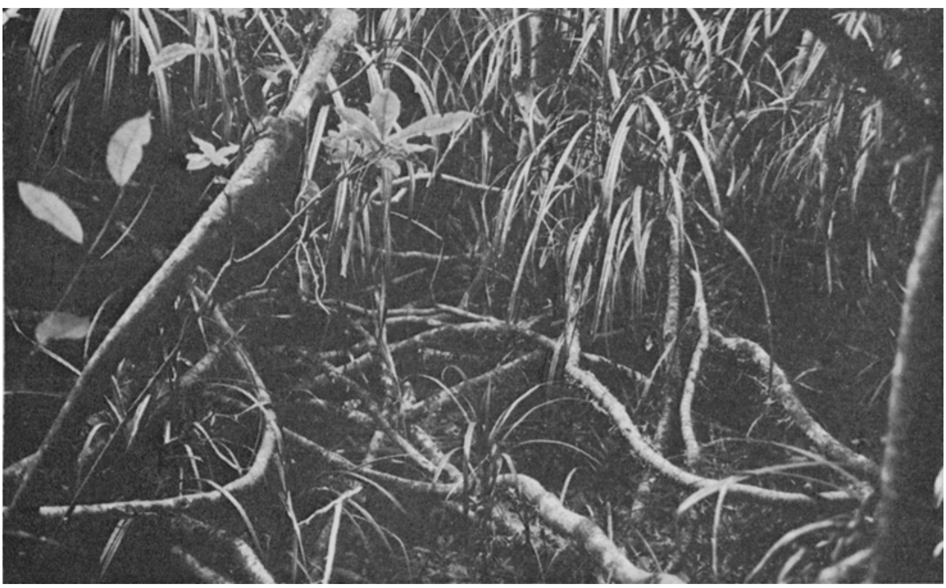

FIG. 5.—Tangle of *Freycinetia* stems beneath canopy. *Melicytus* and *Schefflera digitata* on left.

has supplanted woody species in many places. Logs of dead trees are present on the ground but there is no indication that they have been burnt. Beneath the very dense *Freycinetia* canopy there is an extremely intricate tangle of its sprawling stems (Fig. 5). This is quite impenetrable on foot at ground level but can slowly be traversed by climbing across the canopy. There is no ground cover, except stems of *Freycinetia* and other canopy species.

The *Freycinetia* seems to reproduce entirely vegetatively, although both male and female inflorescences were seen. No independent young plants were observed. Adventitious roots are produced along the stems, and where stems cross, root tangles surround them, holding them firm. Strong support is achieved in this way.

The influence of wind and salt spray as a control of canopy height is noticeable. When one is climbing in the canopy, a clear trim-line is evident, parallel with the general height of the *Freycinetia* canopy, above which projecting branchlets of *Melicytus* or *Schefflera* are killed (Fig. 6). *Freycinetia* seems to be more resistant

FIG. 6.—Spray-trimmed canopy of *Melicytus* surrounded by taller *Freycinetia* canopy.

to salt spray, and the height it can reach when supported, probably determined by wind pressure, thus controls the height the trees attain. That it is able to climb higher than 3 m if support other than trees is available is apparent from its coverage of several large erratic boulders, forming hummocks about 3 m above the general canopy level. Nevertheless, very exposed *Freycinetia* branches were observed to be trimmed, presumably by salt spray. *Hebe* crowns and *Cordyline* trees project above the *Freycinetia* canopy in various places so that they appear to be more resistant to spray than are the other trees.

Freycinetia, like the trees, is almost restricted to the crest of the island, rooted in the till, and was seen rarely on the limestone. It is absent from Popotai and the small southern segment of Taumaka.

Hebe Scrub

A band of *Hebe elliptica* scrub extends almost right round Taumaka (Fig. 7) and is also prominent on Popotai. The widest stands are on the west side of Taumaka and a narrow band is present at the top of the cliffs on the east. It is distributed at the margins of the dense *Freycinetia* vegetation and "forest", and is rooted on till or on limestone, often with shallow soil. *Hebe* appears to be limited in

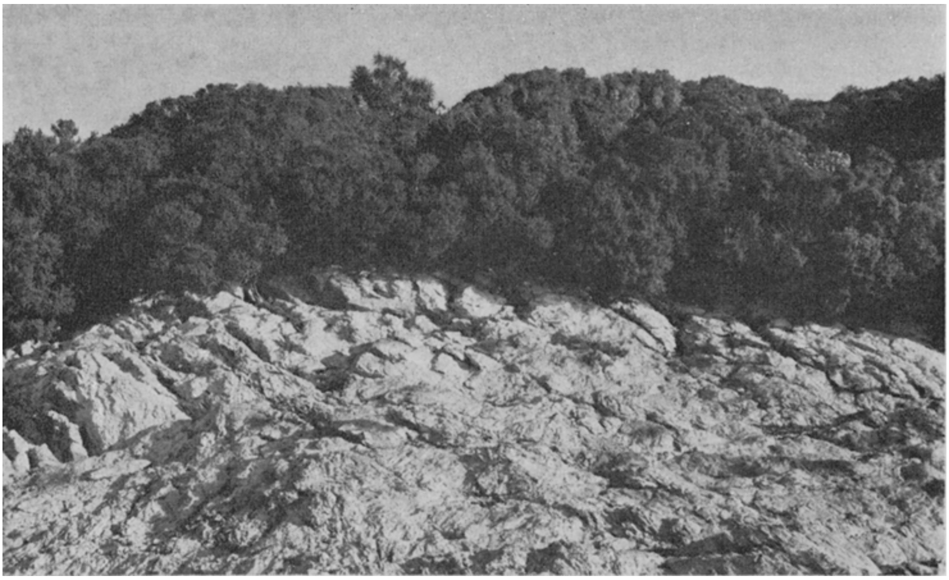

FIG. 7.—Limestone with sparse herbaceous plant cover in foreground, band of *Hebe* scrub in middle ground, and " forest ", with projecting *Cordyline australis* in background; west side of Taumaka.

distribution mainly by competition from taller, more vigorous plants. That it could grow over most of Taumaka in the absence of *Freycinetia* is clear from scattered occurrences amongst the *Freycinetia,* from the abundance of its seedlings in artificial clearings, and from its prominence on Popotai and the southern end of Taumaka where *Freycinetia* is absent. Nevertheless, *Muehlenbeckia australis, Schefflera digitata,* and other species are also prominent in the absence of *Freycinetia,* and their vigour appears to limit the *Hebe* to some extent. Another main limitation for the *Hebe* is the difficult substrate. Particularly on the west it is notable that small,

FIG. 8.—Interior of *Hebe* scrub. Note seal pup in centre.

stunted *Hebe* plants occur, rooted in crevices, on exposed rocks with little accumulation of soil. The main *Hebe* stands, however, are generally close to the base of the till sheet. Seepage water is available here, and there is more soil-forming material and a less severe microclimate because of proximity to other vegetation. Salt spray and wave wash during severe storms may also be important determinants of the outer limit of the shrub belt. In places drift logs were found washed right up into the *Hebe* zone on the west side of Taumaka. The difficulty of the environment is compounded by seal activity (as described later).

The structure of the scrub is simple. It usually consists of *Hebe* alone, 1.5 to 3 m high, but with leaning, twisted branches. Few erect branches are to be seen (Fig. 8). The branches lying along the soil often produce adventitious roots, which are also produced in other situations. For example a hollow stem, when cut open, was found to contain a mat of roots. Roots were also observed emerging from a dead, rotting side-branch. Vast numbers of *Hebe* seedlings grow on open sites protected from seals, so that it appears that there is a strong potential for its reproduction in this way.

Beneath the *Hebe* canopy, in places open to seals, there is often no ground vegetation, but elsewhere *Asplenium obtusatum, Carex comans, Poa annua,* and other species grow, and, on steep banks, *Blechnum banksii* and other shade-loving ferns.

Other Scrub

Hebe scrub grades into or forms mosaics with other kinds of scrub, of which the most abundant is a tangle dominated by *Muehlenbeckia australis,* often associated with *Calystegia tuguriorum* and stands of *Histiopteris.* On the west side of Taumaka, on its southern outlier, and, as far as could be seen, on Popotai, *Hebe elliptica* and *Muehlenbeckia* do not seem to be compatible. In the form of pure stands on Taumaka they occupy a marginal position in relation to other vegetation, but *Muehlenbeckia* is found on deeper soils, often on steep slopes formed at the edge of the till sheet and not occupied by "forest". These *Muehlenbeckia* stands sometimes have a fringe of *Hebe* below them. In shallow gullies there are often quite large stands of *Histiopteris. Astelia fragrans* is present, quite commonly, among the

FIG. 9.—Looking north across the ravine, south end of Taumaka. *Astelia fragrans, Muehlenbeckia,* and *Hebe* are prominent. On the level ground is an area of *Carex comans* and patches of *Histiopteris incisa,* and, on the cliff below the *Astelia,* is a band of *Asplenium obtusatum.*

Muehlenbeckia stands (Fig. 9). A few patches of *Urtica ferox* scrub about 1.2 m high are present on the west side of Taumaka. On the east side of the island, forming mosaics with *Hebe* scrub, are small patches of scrublike vegetation containing *Phormium tenax* and *Pteridium esculentum*.

Fern Banks

Conspicuous, fern-dominated communities are present adjacent to the *Hebe* zone. *Asplenium obtusatum* is the commonest species, sometimes accompanied by *Histiopteris incisa* and *Phymatodes diversifolia*. *A. lucidum, Blechnum durum* and *B. banksii* occur in shaded places. On the most shaded banks *B. vulcanicum, Trichomanes venosum* and various mosses and liverworts may be present. The ferns are usually rooted in till or in a considerable organic accumulation above till.

Herbaceous Communities

Herbaceous communities are present on sites where conditions are too severe for development of taller vegetation. The limitation may be lack of soil, inadequate moisture, exposure to radiation or salt spray, or intense seal activity. The exposed rock of the northernmost islet of Taumaka and the westernmost rocks of Taumaka itself carry only very sparse *Tillaea moschata*, rooted in crevices. *Samolus repens* is also present in places on the exposed rocks on the west. Where conditions of exposure and seal usage are a little less severe, on the western side, mats of *Tillaea* become larger and more frequent and species such as *Scirpus nodosus* and *Lepidium oleraceum* appear. There is a gradation then to a denser cover of *Lepidium* and *Tillaea* and a variety of other species, including *Poa annua, Rumex neglectus, Sonchus littoralis, Scirpus cernuus, Carex comans, Plantago media,* and others (Figs. 10, 11). The cover is hardly ever complete. The plants are rooted in

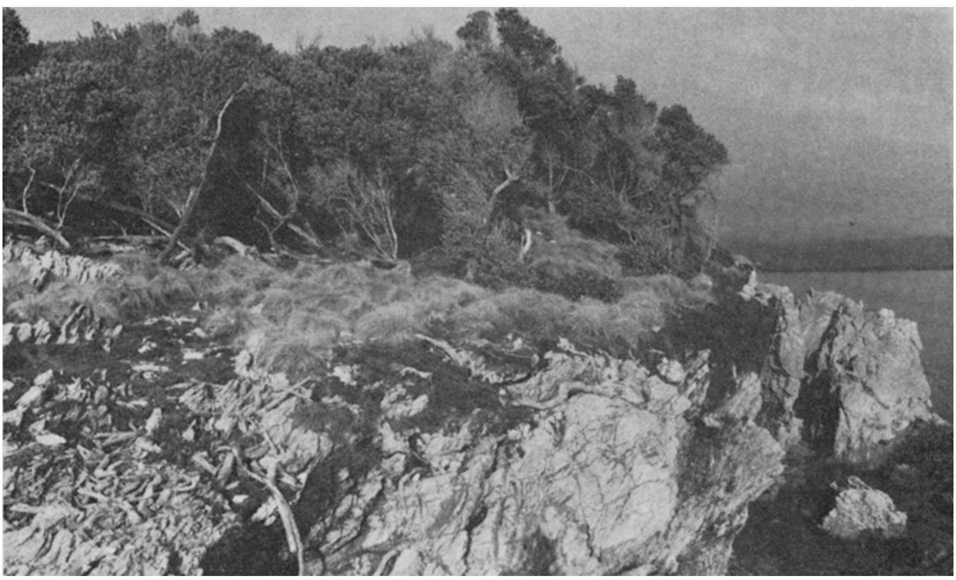

FIG. 10.—*Tillaea moschata* and *Samolus repens* at top of cliff at south end of Taumaka, merging into a band of *Carex comans,* then a wind and spray-blasted shrubbery of *Hebe*.

shallow limestone gravel and in crevices, and the broken nature of the terrain causes exposed, unvegetated sections of rock to project. This kind of assemblage, developed mainly in depressions, abuts on to *Hebe* or *Muehlenbeckia* stands in various places. In some particularly sheltered places almost surrounded by scrub, where a little deeper soil is present and where there is some seepage of water, a similar community occurs, with the addition of *Haloragis erecta, Carex solandri, C. coriacea, Hydrocotyle americana, Stellaria media,* and a few plants of *Cyperus ustulatus*.

FIG. 11.—North end of Taumaka. Young bull seal and open vegetation of *Carex comans, Poa annua, Lepidium oleraceum,* one *Hebe* plant, and, right of it, *Rumex neglectus.*

The ledges on the cliffs to the east and at both ends of Taumaka carry a sparse cover of plants in which *Tillaea, Apium prostratum, Lepidium, Sonchus,* and *Carex comans* are the most important species. In the shaded chasm at the south end of Taumaka, *Hydrocotyle, Tillaea, Scirpus cernuus,* and *Lepidium* are common, but a few plants of *Stellaria* cf. *parviflora* and *Poa* cf. *breviglumis* also occur on the vertical cliffs.

Flat areas, much frequented by seals, are present on top of the till sheet at both ends of Taumaka (Figs. 1, 9, 10). Apart from the cryptogamic plants mentioned earlier, there is abundant *Carex comans* on these, together with *Poa annua, Sagina procumbens,* and (at the north end) *Juncus tenuis.* Where sufficient light penetrates below the scrub and tree cover, *Poa annua, Hydrocotyle,* and *Sagina* are present in places under the taller vegetation.

ECOLOGICAL INFLUENCES OF ANIMALS

One of the dominant influences on the vegetation and particularly on its regeneration, in areas reasonably open and accessible, is the use of such areas as lying-up places by seals. The survival of some of the herbaceous ground species beneath the "forest" and scrub is dependent on the degree of protection from this disturbance, but protection is often achieved at the expense of available light. Most of the western side and the northern and southern tips of Taumaka are strongly affected by seals and, as far as could be ascertained, the influence is also strong on the lower parts of Popotai.

The low and often sparse vegetation of the open, rocky areas is reasonably resistant to seal activity. However, areas of *Tillaea moschata, Lepidium oleraceum,* and *Poa annua* were observed to be suffering ill-effects from prolonged seal-lying and defaecation. Small patches of some species of plants, observed in November 1969, were missing or much reduced in April 1970. Patches of *Carex comans,* on peaty soil, are likewise resistant to seal activity, though, again, they suffer ill-effects if use is prolonged. It is likely that the more extensive stands of this sedge, interspersed with *Poa annua, Marchantia berteroana,* and a few other species, at the extremities of Taumaka, have been induced and maintained by the destruction of other shrubby vegetation by seal activity. *Carex comans* is otherwise confined to marginal habitats near the *Hebe* zone, on cliff-tops, and in crevices in cliffs. Near the hut the area used as a helicopter pad carries an induced stand of the *Carex*. Of the *Hebe* stumps still present on it, some have been cut, but others have been killed, apparently by prolonged seal-rubbing. Leaning trunks of shrubs and trees are commonly used as perches by seals, and plants in various places were observed to be suffering ill-effects from this.

A patch of *Carex comans* on the southern end of Taumaka has increased greatly in area in the last few years, having supplanted *Hebe* scrub (Mr R. Marley, pers. comm.).

The *Hebe* zone is everywhere penetrated by seals, except on the cliffed eastern side of Taumaka. In areas in the *Melicytus* " forest " which are regularly used as seal dormitories there is complete destruction of ground vegetation except for tree bases (Fig. 4). Seedlings or suckers of species such as *Melicytus, Myrsine,* and *Schefflera* are confined to inaccessible places, and so are ground species such as *Asplenium bulbiferum*. In some places the seals have pushed into the denser *Muehlenbeckia* scrub and even into the dense *Freycinetia* on top of Taumaka. Some damage has occurred to the latter and the leafy crowns of low growing branches may be killed. It appears that some of this penetration is quite recent because the vegetation is comparatively little modified. Such evidence of recent damage suggests that growth of the seal population is putting increased pressure on the vegetation. The higher part of Taumaka is used most extensively by immature seals.

Former seal influences may be inferred to some extent. The soils of Taumaka (described more fully in Appendix I) have well-rounded pebbles, 1.3 to 6.5 cm in diameter, distributed throughout the profiles. Clearly the pebbles have been deposited as the soils formed. Careful observation revealed that freshly deposited clusters of pebbles were accumulating on areas frequented by seals and there was direct evidence (the presence of roundworms on a group of pebbles) that they had been ingested and then voided. To my knowledge there is only one other record of the occurrence of gastroliths in the southern fur seal in New Zealand (Street, 1964), although Fleming (1953) recorded sea lion (*Phocarctos hookeri*) gastroliths from the Snares and Mr J. Campbell (pers. comm.) has found them on islands in Cook Strait. The Snares sea lions regurgitate their gastroliths, which are larger than those voided by fur seals, but the mode of voiding stones was not observed during the present study. It is believed that seals take up the stones deliberately, but the reasons for this are not clear (King, 1964).

The stones present in the soils of Taumaka vary in their lithology. Many are white or yellow quartz pebbles presumably derived from schist, others are gneiss, quartzite, or sandstone-like.

Although similar stones are present in the till on the island they are not concentrated to the same degree that they are in the soils. No agency other than seals is known to transport similar stones on the Open Bay Islands. They are, thus, able to be used as evidence for former complete occupation of the top of Taumaka by seals. No larger stones such as are ingested by sea lions were seen in the soils. The soils may have been accumulating for a very long period, possibly since the sea level rose around the islands after the last glaciation. The presence of gastroliths in them reveals that the island once had a more open vegetation than at present. This raises the question of the total seal population that might be supported if the whole of the island was accessible to them. The records of sealing early in the nineteenth century give some indication of a much larger seal population than at present. The marooned party from the brig " Active " in two years and five months took a total of 11,200 seal skins (May 1967). Allowing for one season's crop of pups the seal population in 1810 must have been at least twice the present peak number (about 2,800; D. Brown, pers. comm.). The sealers' activities, spread over more than three years, probably almost annihilated the population. There are no later records of sealing, probably because it was no longer economic. The effects of such a large seal population on the vegetation of the islands at that time must have been severe. It may be that the vegetation was open enough then for them to penetrate most of the summit area of Taumaka. They would necessarily have required much more space than is available to them at present (about half the surface of the island above high-tide level).

Little evidence of adverse influence by man on the vegetation of the island was seen. Charcoal was found, buried in the soil in three places at the north-western corner of the island near the present hut, but this probably originated from cooking fires. The sealers' hut and skin depot may have been in this neighbourhood. A broken glass jar was found associated with the charcoal in one place. There is no evidence for fire having swept over the whole island, and the sealers were probably careful to see that this did not occur. Among the dense tangle of *Freycinetia* in various places on top of the island, dead, rotting (but not charred) tree or shrub trunks are present. They may represent a period when the vegetation was more open, before the present period of dense *Freycinetia* dominance. The long period taken by the seal population to recover would have given the vegetation time, in an unprecedented absence of seals, to expand vigorously. It may be that *Freycinetia* reached its peak between 1813 and 1904 at the expense of *Hebe, Melicytus, Schefflera,* and other woody species. Once densely established, the *Freycinetia* is resistant to seal inroads and inimical to regeneration of the woody species.

There are some other noticeable animal influences. Wekas are ubiquitous on Taumaka, even in the most densely vegetated areas and on the shore platforms at low tide. They probably have indirect effects on regeneration of the shrubby vegetation by disturbance of the soil as they scratch and dig for food. A very noticeable effect is the disturbance of *Tillaea moschata, Lepidium,* and other rock plants. Quite extensive areas of these were observed to be severely harmed by weka activity, even on inaccessible ledges on the cliffs.

Shags probably influence the cliff vegetation by faecal enrichment. The immediate vicinity of penguin caves is usually devoid of vegetation.

Petrel burrows are abundant in the softer soils, especially in the fern zone at the margin of the till sheet but also in banks on the top of the island. The ground is often undermined by burrows but though this may have effects on the plants (probably causing shrubs to fall over) it is not a dominant influence.

COLONISATION OF THE ISLANDS BY PLANTS

Cockayne (1904) was of the opinion that the islands were joined to the mainland comparatively recently. As the sea is a maximum of about 25 fathoms (45 m) deep between the mainland and the islands, this assumption is probably correct, inasmuch as the seafloor would have been dry land during the last Pleistocene glaciation, but there is no indication of when the islands were cut off by the Aranuian rise in sea level. Some of the plant life could have predated this time, but many of the land plants could have been transported to the islands by birds, wind, or flotation more recently. During April 1970 flotsam round the islands, following a storm and flooding of the mainland rivers, was observed to include foliage of *Potamogeton cheesemanii, Myriophyllum propinquum, Griselinia littoralis, Olearia avicenniaefolia, Metrosideros umbellata,* and *Nothofagus menziesii.* Under the most favourable circumstances seeds of many species could be similarly transported and washed up on the islands and would need only to resist soaking in seawater for a few hours. The shore plants *Tillaea, Lepidium, Scirpus nodosus, Samolus, Rumex neglectus, Cyperus,* and *Hebe* are likely to have been transported in the sea. Wind transport could account for the presence of the ferns, mosses, fungi, lichens, liverworts, and vascular plants such as *Clematis, Parsonsia,* and *Sonchus,* although the prevailing winds blow towards the mainland. The presence of young *Dicksonia* plants and a solitary *Cirsium* show that this process still occurs. Some of the larger vascular plants (*Melicytus, Myrsine, Fuchsia, Schefflera, Muehlenbeckia, Hedcarya, Astelia*) may have reached the islands by being transported by birds. At present no fruit-eating birds, except one blackbird, have been seen to inhabit the islands, but occasional visits by species such as pigeons may have been sufficient to allow gradual colonisation. At present those of the plants which produce fleshy fruits have their seed transported on the islands mainly by gravity. Most of them also reproduce vegetatively as was noted earlier. Some dry-fruited species may also have been transported to the islands by birds on their plumage or feet. The inability of *Freycinetia* to colonise Popotai or the small southern segment of Taumaka may indicate that only a single immigration occurred, and that its spread has subsequently been vegetative. As already stated both male and female flowers were seen on the island, but it is not known whether viable seed is produced.

The role of man in the colonisation of the islands by plants is probably restricted to species adventive in the New Zealand flora. Cockayne recorded only *Poa annua* as an adventive. He may have missed some of the others, but *Sagina, Stellaria media,* and *Plantago media* are so abundant now that they are almost certainly introductions since 1904. The first three probably came in accidentally on clothing or footwear, but the *Plantago* probably came by flotation. Single occurrences of *Cirsium* and *Rumex* sp. suggest very recent entry. *Juncus tenuis* was introduced accidentally to the *Carex comans* community near the hut between November 1969 and April 1970. By the latter date it had seeded, making attempts at eradication probably futile. The rapidity of this introduction stresses the need for great care to avoid carrying other adventive plants or animals to the islands. Unauthorised visits should be discouraged for this reason.

ACKNOWLEDGMENTS

I would like to acknowledge my sincere appreciation to Mr R. Marley and his crews for transporting our parties to and from the islands. This was often done at considerable inconvenience to Mr Marley. I am also grateful to Mrs E. A. Hodgson (liverworts), Mr K. W. Allison (mosses and some liverworts), Mr D. Galloway (lichens), Dr E. Edgar (Cyperaceae), and Dr Lucy B. Moore (algae) for identifications of plants. Dr Moore also kindly read the script and made useful suggestions for improvements, as did also Messrs E. Miller and D. Brown.

REFERENCES

See after Appendixes—p. 42.

APPENDIX I

EXCLOSURE PLOTS

To test the degree of influence of seals on the vegetation of areas accessible to them a programme of installation of small exclosures, fenced with wire netting, has been started. In April 1970, J. A. Burrows, W. H. Burrows, and I built two exclosures near the hut at the northern end of Taumaka. One (A) is in a stand of *Hebe elliptica*. The other (B) is in a small opening in *Melicytus—Schefflera—Griselinia* " forest ".

Photographs were taken from fixed points and a rough sketch of the distribution of plants made for each plot, but there was not time to map the plots accurately. On a future visit this will be done and some further plots installed.

Records of distributions of plants in the plots are indicated in Figs. 12 and 13, and Figs. 14–18 are photographs from the fixed points. The fences, 0.9 m high, had to be stretched round tree trunks so that the plots are rather irregular in shape.

To examine the effect of removal of *Freycinetia* from an area not accessible to seals, a clearing was made about 3 m × 4.5 m about 27 m south of the hut. At present this contains three *Hebe elliptica* plants and some *Histiopteris* and is overhung by a *Melicytus* tree.

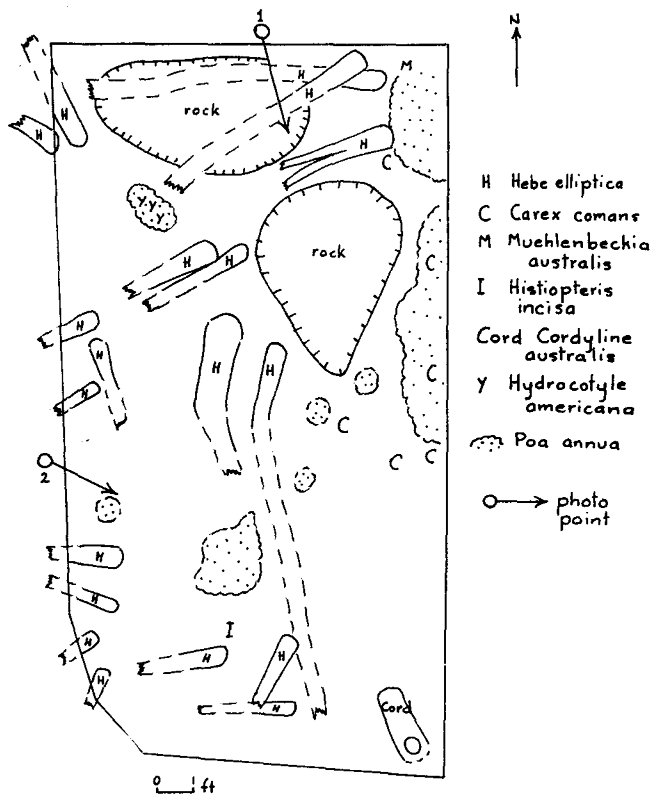

FIG. 12.—Plan of exclosure A, showing photo points and distribution of plants. (See Figs. 14, 15.)

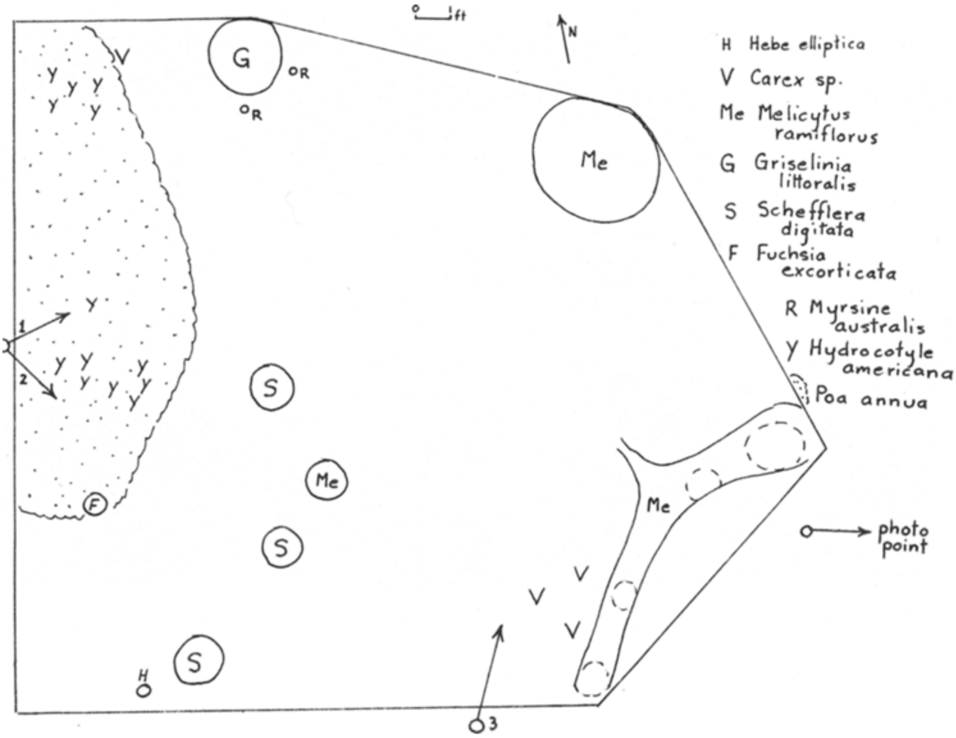

FIG. 13.—Plan of exclosure B, showing photo points and distributions of plants. (See Figs 16–18).

FIG. 14.—View from photopoint 1, exclosure A (Fig. 12).

FIG. 15.—View from photopoint 2, exclosure A (Fig. 12).

FIG. 16.—View from photopoint 1, exclosure B (Fig. 13).

FIG. 17.—View from photopoint 2, exclosure B (Fig. 13).

FIG. 18.—View from photopoint 3, exclosure B (Fig. 13).

APPENDIX II

SOILS

Although it is true that soils and vegetation develop together, soils are less transient than vegetation and often are useful in gauging the history of a site. The earlier discussion about seal gastroliths is a case in point. Cockayne (1904) described the soil of the Open Bay Islands as consisting of " coarse, dark-coloured peat containing a considerable percentage of imperfectly decayed vegetable matter. This soil is extremely loose, both from its texture and from being honeycombed with the holes of muttonbirds. It is also saturated with water so that when dug into, moisture from all sides flows into the newly made cavity ".

Only one small area of true peat such as Cockayne describes was discovered during the present survey, and although other soils are usually strongly organic, and sometimes peat-like, they always have a large component of mineral material including seal gastroliths. It is doubtful whether peat could have been eroded off the whole island since 1904, and indeed, under the dense *Freycinetia* stands there has been no disturbance notwithstanding the introduction of wekas. It is more likely that Cockayne's impression of the peaty nature of the soil was gained from a limited examination, possibly in the same site as was studied by me.

Several common kinds of profile of the more mature soils are described below (Table 3). There are various other, not fully developed, soils present, some of them where mature soils have been disturbed by seals or petrels, others on steep slopes where run-off or gravity have prevented development of deep profiles and others on bedrock where the hardness of the rock and scant vegetation have prevented profile development.

Where the soil is undisturbed it may be seen that an organic horizon is accumulating, in places, over a mineral horizon weathered from the till. The absence of a deep litter layer demonstrates that breakdown of raw litter is rapid and thus the soils are mulloid. Breakdown of litter is assisted by the very large number of amphipods present. The well developed structures present in many places suggest that organic activity is vigorous. Further study is required to determine the degree of fertility of the soils.

In the areas most disturbed by seals (and also possibly by wekas) the spongy organic horizon is eroded from the surface and whitish quartz sand is concentrated on top of the truncated profile. Seals appear to contribute to the build-up of soils in a few places. Profiles 5 and 6 are both from places where vegetation has been flattened by seals until some of the plant material is incorporated into the soil. Faecal material may contribute to the soil matrix, and gastroliths are continually being added.

Some relatively well drained soils in the fern zone are strongly influenced by petrel burrowing.

TABLE 3.—Soil Profiles

1. East side of Taumaka, opposite hut.
Slope nil.
Freycinetia tangle 2.4 m high, some *Muehlenbeckia, Pteridium* and *Histiopteris.*
Sparse litter of *Freycinetia* leaves. Rounded pebbles scattered on surface.
5.0 cm brown, mull humus, spongy, medium crumb structure.
35.5 cm dark brown, peaty humus with rounded pebbles (quartz and schist) distributed throughout. Coarse crumb to nut structure. Large worm casts present. Friable. Becoming wetter and structure poor near bottom. Some weathered schist stones at botton.
On till.

2. Middle of Taumaka near hut.
Slope nil.
Melicytus 3.6 m high with *Schefflera, Griselinia, Myrsine, Freycinetia, Muehlenbeckia.*
Sparse litter, mainly *Melicytus* leaves.
12.6 cm dark grey-brown, organic sandy loam with a few rounded pebbles (quartz) distributed throughout. Weak fine crumb structure, friable.
20.3 cm pale yellow-brown, sandy silt with weathered schist stones. Weak fine crumb to single grain structure but compact. Grading through 10.0 cm into somewhat weathered (rusty) till.

3. West side of Taumaka half-way along island from hut.
Freycinetia tangle 2.4 m high with some *Melicytus, Calystegia, Histiopteris.*
Sparse litter.
15.0 cm dark brown, mull humus with well developed medium to coarse crumb structure. Fairly friable. Some coarse, quartz sand present. Rounded pebbles near bottom.
15.0 cm dark yellow-brown, sandy, stony silt with moderately weak medium crumb to nut structure. Stones mainly schistose, weathered.
Not bottomed.

4. West side of Taumaka, one-third of the way along island from hut.
Slope nil.
Freycinetia tangle, 2.4 m high, with *Muehlenbeckia, Pteridium,* and some *Melicytus* and *Schefflera.*
Sparse litter. Rounded pebbles on surface.
15.2 cm dark-greyish-brown, organic, stony sandy silt, the stones rounded. Medium crumb structure, very friable.
On till.

5. Shallow gully at top of ravine near landing.
Slope 2–4°.
Bare, but adjacent are *Freycinetia* and *Muehlenbeckia.*
2.5 cm dull brown, fibrous peat with a few pebbles and dead fern rhizomes.
10.0 cm red-brown fibrous peat with wood and leaves of *Histiopteris, Freycinetia, Carex.* A few pebbles.
10.0 cm dull brown, slightly silty peat with a few stones and one small piece of charcoal. Grading into
15.2 cm pale grey, stony sand, structureless.
On till. Hole filled with water after excavation.

6. Helicopter pad.
Slope nil.
Carex comans, Poa annua, Marchantia.
15.0–22.0 cm dark-brown, firm, dense peat with rounded pebbles distributed throughout.
On till.

APPENDIX III

GLACIAL TILL

The presence of glacial deposits on the islands was mentioned by Cockayne (1904) and again by Stirling and Johns (1969). The thickness of the till sheet was described in the introduction. The fabric of the till ranges from subangular or well-rounded cobbles and pebbles to coarse and fine sand, the latter often in lenses. Sorting is not evident except for the presence of these sand lenses. Rock flour or other very fine material was not seen except at the base of the till sheet. The dominant stony material is schist, some large boulders of which are included in the till. Other stones are quartz, sandstone, and coarse-grained gneiss. A few large, angular, erratic boulders (up to 3 m high and 6 m long) sit on top of the main sheet of till, which forms a flat to gently rolling plateau on top of Taumaka. All but one of these boulders examined is schistose the exception being quartzose. Other large schist boulders, either eroded from the till, or erratics left after the till has been eroded from beneath them, are commonly found on the limestone on the west side of Taumaka. Others are present on the submerged rock platforms between Popotai and Taumaka. Fig. 19 shows an exposure of the till.

In places, near the middle of Taumaka, the till sheet is up to 12 m thick over limestone which rises 9 m above sea level. As far as could be seen the same applies to Popotai. The till thins out at both ends of Taumaka, at the northern end there having clearly been losses by erosion from the upper surface. It is not known whether material has been similarly eroded over the whole island. The till sheet has obviously been more extensive than at present because of the steep banks at its edges. Erosion of these banks appears to have been slow, as the till is strongly cemented, but has been aided by penguin burrowing. The birds nest in various places where it is possible for them to make horizontal burrows, usually in the weaker lenses of sandy material in the banks. Erosion of the till sheet has probably been enhanced by Aranuian high sea levels. The cliffing on the eastern side may have originated then, but appears to be enhanced by the dip of bedrock strata toward the west (10°–45°), although the strata are much contorted and, locally, dip and strike directions are variable.

The form of the till sheet suggests that it is composed of ground moraine laid down when a piedmont ice sheet extended out from the mainland. Some contacts of till and bedrock on the eastern side of Taumaka show that the till has been forced into pre-existing cracks in the rock. It is likely that the terminus of the former ice sheet was some distance west of the islands. The till could have been derived from nearby on the mainland because, as far as could be ascertained, all the rock types in it are present there. Ice may have extended as far as the islands early in the Otira Glaciation but is unlikely to have done so during the late Otira Glaciation. The cemented condition of the till suggests a greater age, possibly middle Pleistocene. The till is neither strongly weathered nor deformed and so is probably not as old as the Cascade Conglomerate (Lower Pleistocene) (Mutch and McKellar, 1964).

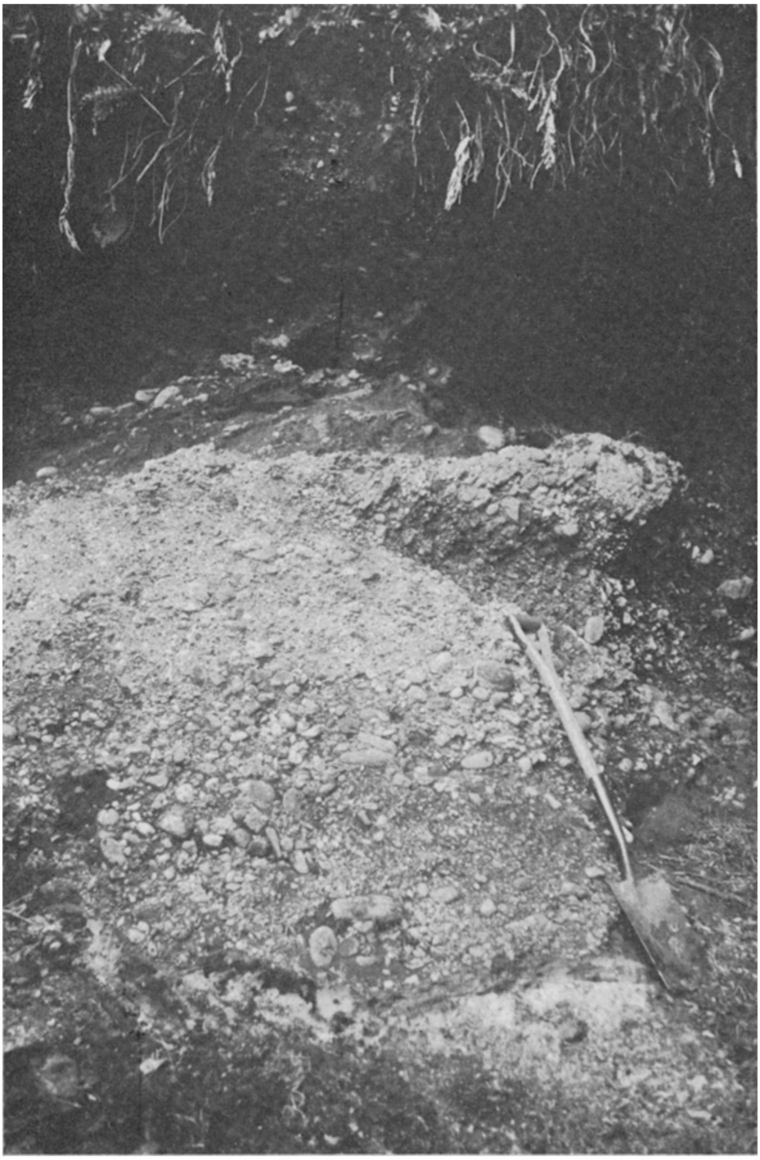

FIG. 19.—Section of cemented glacial till below hut, Taumaka. Blade of spade is at contact of till and limestone. 25 cm soil, dark brown, organic, with sand and stones. 76 cm cemented till composed of stones and coarse sand. 25 cm fine semi-stratified sand in the form of a lens 3 m long, with included stones. 122 cm cemented till with cobbles, small stones and sand. 10–15 cm yellowish-brown, semi-stratified clay-like material with imbedded stones. On smooth limestone surface.

APPENDIX IV

BIRDLIFE AND SOME OTHER ANIMALS

Of the birds listed by Stirling and Johns (1969) all but white heron and morepork were seen on the visits in November 1969 and April 1970. No crested penguins were seen in April whereas they were abundant in November. About 300 spotted shags were seen leaving the islands at dawn in the direction of the mainland in April. Only eight to ten starlings were present in November, but a large flock of about 200 were seen wheeling round the islands in April. Small numbers of gulls and white-fronted terns were present in April but larger numbers of black-backed gulls bred on Taumaka in November. A flock of about 20 black oyster-catchers and a few pied oyster-catchers were present in both November and April. No sooty shearwaters were seen on the islands, but they were observed in flight nearby and some burrows appeared to have been recently inhabited. A small prion, probably a fairy prion (*Pachyptila turtur*), was seen at night in November, and two badly deteriorated dead specimens were also found. The *Checklist of New Zealand Birds* records this species as breeding on the islands, but there seemed to be few of them and few shearwaters present, compared with the impression given by Cockayne (1904). It may be that predation by wekas has limited their numbers.

Other birds present, not recorded by Stirling and Johns, were reef heron, *Egretta sacra,* one pair; black shag, *Phalacrocorax carbo,* three individuals; white-throated shag, *P. melanoleucos,* one; blackbird, *Turdus merula,* one; harrier, *Circus approximans,* one.

In April, two geckos, probably *Hoplodactylis granulatus,* were found, one on the ground and the other in *Freycinetia* foliage. The latter changed colour from cocoa brown to pale greenish-grey when placed in a jar.

Also in April several red admiral butterflies, *Vanessa gonerilla,* were observed. Their occurrence on the island seems surprising in view of the exposure to westerly winds and the limited food supply (*Urtica ferox*) for larvae.

APPENDIX V

ADDITIONAL CRYPTOGAMS

These cryptogams were collected for a study of the associated Metazoa, especially Tardigrada or water bears. All collections were made by Donald S. and Carol J. Horning, 17–24 August 1970, on Taumaka Island.

The liverworts and mosses were identified by Mr K. W. Allison, Dunedin, and the lichens by Mr T. W. Rawson, Botany Division, D.S.I.R., Lincoln. A synoptic collection of these plants is housed in the Department of Zoology, University of Canterbury, with the following New Zealand collection numbers. Species marked * are previously unrecorded from this island.

GREEN ALGA

**Prasiola* sp. (NZ–344). Rocks on shore.

LICHENS

Leptogium sp. (NZ–334). On rock in a shaded area.
**Mastodia antarctica* (NZ–343). On rocks on top of the sea cliffs at the north-east end of the island. This is the most northerly record for this species and is the first record for New Zealand (T. W. Rawson, pers. comm.).
**Parmelia cristifera* (NZ–320, 339). On shaded ground just above the sea cliffs and on branches of live *Myrsine australis*.
**P. olivetorum* (NZ–339). On branches of live *Myrsine australis*, growing with *P. cristifera*.
**P. perlata* (NZ–337). On dead branches of *Hebe elliptica*.
Physcia elaeina (NZ–313, 321). On live branches of *Hebe elliptica*.
**P. tribacia* (NZ–321). On live branches of *Hebe elliptica* growing with *P. adglutinata*.
Xanthoria parietina forma *albicans* (NZ–332). On small twigs of *Hebe elliptica* at the south end of the island.
X. p. forma *chlorina* (NZ–314, 331, 340). On dead twigs of *Hebe elliptica*, on shore rocks just below the *Hebe* zone, and on supra-littoral rock at the north-east end of the island.
Immature thallus only (NZ–322). On roots, rocks, and ground at the edge of the helicopter pad.

LIVERWORTS

Lophocolea biciliata (NZ–324). On rotten *Hebe elliptica* in a shaded area just above the shore rocks.
Lophocolea subporosa (NZ–316). On dead root of *Hebe elliptica*.
Marchantia berteroana (NZ–312). On peat at the helicopter pad.
**Metzgeria decipiens* (NZ–319, 327, 330). On trunk of live *Hebe elliptica* and on live *Freycinetia banksii*.
**Telaranea remotifolia?* (NZ–341). On ground and rotten wood near the helicopter pad.

MOSSES

Bryum dichotomum (NZ–310). Rocks on shore.
B. truncorum (NZ–317, 318). On ground at the edge of the helicopter pad.
**Campylopus clavatus* probably (NZ–315). On ground on an exposed point above the sea cliffs at the north-east end of the island.
**Distichophyllum rotundifolium* (NZ–323). On ground under a very wet embankment.
**Homalia punctata* (NZ–328). On rocks next to a freshwater stream.
**Macromitrium microphyllum* (NZ–325). On branch of live *Hebe elliptica*.
**M. weymouthii* (NZ–325). On branch of live *Hebe elliptica* growing with *M. eucalyptorum*.
**Philonotis pyriformis* small form (NZ–336). On rock in a seepage near the south end of the island.
Porotrichum ramulosum (NZ–326). On branches of dead *Hebe elliptica*.
P. ramulosum slender form (NZ–329). On trunk of *Schefflera digitata* in a dense, heavily shaded area near the head of a freshwater stream.
Rhacopilum robustum (NZ–333). On rock in the *Hebe* zone.
**Thuidiopsis furfurosa* (NZ–335). On rock.
Tortula princeps (NZ–311). Rocks on shore.

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