

AN ACCOUNT OF THE VEGETATION OF MAYOR ISLAND

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INTRODUCTION

Both scenically and geologically Tuhua or Mayor Island must rank as one of New Zealand's most interesting off-shore islands. The vegetation, though not unique, is nevertheless sufficiently distinct to warrant greater attention than it has so far received.

The present study was carried out with the following aims:

1. The construction of a vegetation map.
2. The description of the more important communities, with particular attention paid to those of the crater.
3. A preliminary enquiry into the history of the vegetation.

For an account of the island's recent history, physiography and floristic analysis, the reader is referred to the paper by Sladden (1925). A more detailed investigation of the geology of Tuhua is the subject of a forthcoming paper by Dr R. N. Brothers of the Geology Department, A.U.C.

THE VEGETATION PATTERN

The vegetation, except where interrupted by cliffs and crater lakes, is a continuous plant covering composed primarily of three species populations: *Metrosideros excelsa* (pohutukawa), *Knightia excelsa* (rewarewa) and *Leptospermum ericoides* (kanuka). Each has its own particular pattern of distribution.

1. *The Metrosideros population*—On marine cliffs, headlands and coastal valleys, pohutukawa is the dominant plant, often forming dense stands. On the steeper slopes and ridges approaching the crater rim, however, it is less frequent. Within the crater,* pohutukawa is often the sole constituent of the canopy though sometimes co-dominant with *Knightia*, or emergent above *Leptospermum*.

2. *The Knightia population*—Near the coast this species is almost invariably absent. With increasing distance from the shore, *Knightia* becomes more frequent and forms dense stands on the ridges below the crater rim. Emergent *Knightia* trees are scattered over the tholoid whilst on parts of the crater floor it forms pure stands.

3. *The Leptospermum population*—*Leptospermum ericoides* is generally distributed over the island, forming an even canopy on parts of the crater floor. *L. scoparium* is only important on the drier parts of the tholoid and crater rim.

The generalised picture of the vegetation is that of a pattern of three species populations which, growing together in varying proportions, may be classified into the vegetation types listed below. Many other species are

also present but are not of general physiognomic importance.

1. *Leptospermum scrub* which occurs on the crater floor and parts of the outer slopes and crater rim.

2. *Leptospermum/Emergent Knightia forest* which is characteristic of many of the higher slopes.

3. *Leptospermum/Emergent Pohutukawa forest* which is present on many of the lower slopes and large areas of the tholoid.

4. *Pohutukawa forest* which is best developed on the headlands and parts of the tholoid.

The distribution of the three main species populations is shown on the accompanying map (fig. 1) which is based on the following sources of information:

1. Aerial photographs (stereoscopic pairs) taken by the New Zealand Aerial Mapping Company in 1943.

2. Oblique aerial photographs taken by Whites' Aviation in 1954.

3. Numerous photographs taken by Field Club members during 1952 and 1955.

4. Field observations carried out during two 10-day trips: November 1952 and November 1955.

Following is a more detailed account of the structure and composition of the main communities recognised within these vegetation types. For ease of description communities have been delimited by topographic and geological discontinuities. (See fig. 2.)

MARINE CLIFF COMMUNITIES

Two geologically distinct types of cliff occur. The marine cliffs cut in rhyolite lava flows are often eroded into deep caves and natural arches. Scattered pohutukawa plants have established wherever there is sufficient roothold. In more exposed situations, as for example the north-east coast, the rhyolite cliffs are bare.

Much of the coastline is occupied by high pumice cliffs, the steepest of which are devoid of vegetation. Slips, brought down by undermining wave action, are frequent. Grasses, *Mesembryanthemum australe*, *Phormium colensoi* with pohutukawa make up the vegetation of these cliffs.

Within the last twenty years a fire has swept the cliffs between Opo Bay and 'Oatua Point'. The vegetation here consists of *Phormium*, *Blechnum procerum* and grasses through which are scattered young pohutukawa 8-12 feet in height.

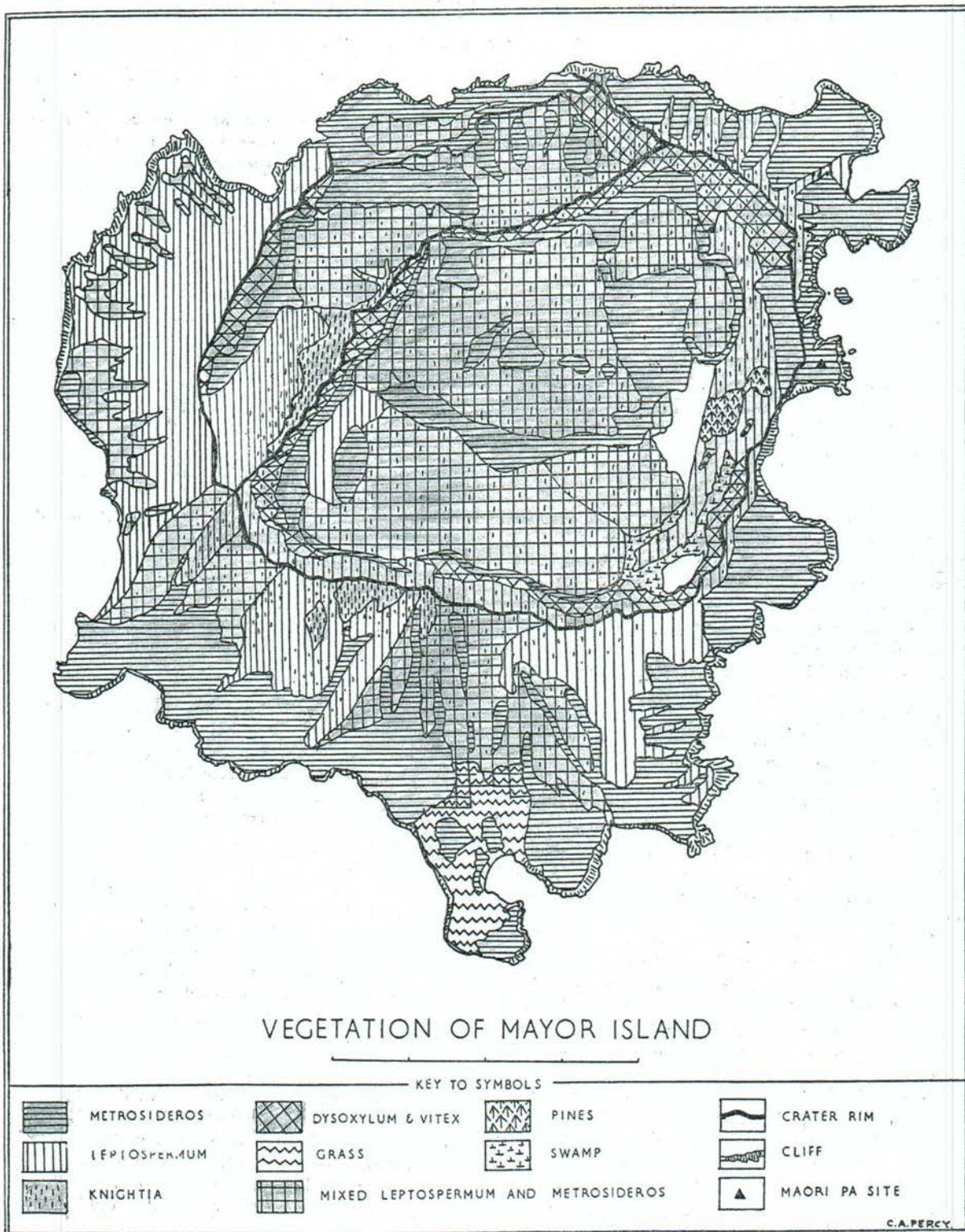
HEADLAND COMMUNITIES

The headlands are almost invariably dominated by pohutukawa forest which in structure is remarkably similar to a tall Kanuka forest. The pohutukawa trunks, 1-2 feet in diameter,* rise unbranched to a densely interwoven canopy at 40-50 feet. The whole appearance suggests strong competition for light among the seedlings which

* Strictly, the Mayor Island crater is an explosion-caldera, i.e. a crater enlarged by 'explosion-collapse'. (See Cotton, 1944, p. 302.)

* Diameter measurements are based on eye estimates only.

All Shaded areas are



are presumed to have sprung up following a fire or abandonment of a cleared site by the Maori.* *Litsaea calicaris* (mangāo) is also present in the canopy, while below is a shrub layer of *Geniostoma ligustrifolium*, *Macropiper excelsum*, *Brachyglottis repanda*, *Nothopanax arboreum*, and the tree fern *Cyathea dealbata*. A ground vegetation of scattered ferns (mainly *Pteris comans*, *Adiantum hispidulum* and *Asplenium adiantoides*) and *Litsaea* seedlings grows amongst an often dense litter of fallen pohutukawa twigs and branches.

VALLEY COMMUNITIES

The outer slopes on all sides of the island are deeply furrowed by radially arranged valleys and divides. Little flow of surface water takes place due to the porous nature of the underlying rock. Near the coast the valleys carry a pohutukawa forest similar to that described above. With increasing altitude and steepness, other species enter the canopy, particularly *Knightia*, *Melicytus ramiflorus* (mahoe), *Dodonaea viscosa* (akeake) and the tree ferns *Cyathea medullaris* and *C. cunninghamii*.

RIDGE COMMUNITIES

Pohutukawa forest is dominant on ridges near the coast. Further inland, the ridges are dominated by a *Leptospermum*-emergent *Knightia* vegetation, structurally similar to communities of the same composition found on the mainland. A dense undergrowth is composed of *Suttonia australis* (matipo), *Cyathodes acerosa* (mingimangi) and *Leucopogon fasciculatus* which, were it not for the occasional tracks left by pigs, would be nearly impenetrable. This community extends onto the dry inner slopes of the crater rim where it terminates abruptly.

CRATER CLIFF COMMUNITIES

Plant life is sparse in this habitat where, during the summer, surface temperatures on the black glassy obsidian and columnar rhyolite must rise very high. There are, however, a number of interesting plants growing in the more protected crevices and joints, notably *Psilotum triquetrum* in dense tufts and *Senecio banksii*.

ROCK-FALL COMMUNITIES

At the foot of the crater cliffs there is generally found a talus pile of immense blocks of rhyolite and obsidian, intermingled with debris and detritus of finer texture. A major collapse of the cliff can completely bury a large area of vegetation, and boulders, often prised off by the wedging effect of growing tree roots, may sometimes bounce down the steep slope leaving a trail of torn and barked vegetation.

Immediately below the cliff face is a zone of much finer detritus weathered from the cliffs. Here *Mesembryanthemum* and sometimes *Senecio lautus* are the only colonisers. Lower down the slope, *Leptospermum* is often found colonising the sites of former debris falls. Most of the talus heap is covered by a tall forest with giant specimens of pohutukawa, *Vitex lucens* (puriri) and *Dysoxylum*

spectabile (kohekohe). In some areas puriri is the sole dominant, while elsewhere mahoe, mangāo, *Hedycarya arborea*, *Knightia*, *Weinmannia racemosa* (kamahi), *Sideroxylon novo-zelandicum* (tawapou) and *Rhipogonum scandens* (supplejack) form a very heterogeneous forest canopy. The shrub-layer consists of *Suttonia*, *Geniostoma*, *Macropiper*, *Pittosporum umbellatum* and *Hymenanthera novae-zelandiae*. *Pteris comans*, *Peperomia urvilleana*, *Asplenium lamprophyllum*, *Blechnum filiforme* and *Oplismenus undulatifolius* characterise the ground vegetation.

In canopy gaps caused by recent tree-falls, *Leptospermum scoparium* and *L. ericoides*, *Aristotelia racemosa*, puriri, *Entelea arborescens* (whau), *Brachyglottis repanda* (rangiora), *Geniostoma* and *Suttonia* are present.

CRATER-FLOOR COMMUNITIES

Parallel to and adjacent to the eastern bank of Lake Aroarotamahine, there is a flat strip of land.* In the south-western sector of the crater, there is a crescent-shaped, but otherwise similar area. These two areas are termed here the crater-floor.

The present vegetation of the crater-floor is a *Leptospermum* scrub, 10-20 feet in height, with a shrub layer of *Suttonia*, *Cyathodes* and *Leucopogon*. The *Leptospermum* here, as over much of the island, is heavily coated with a sooty black fungus belonging to the family Capnodiaceae. A ground layer of *Pteris comans*, *Polypodium diversifolium* and *Blechnum procerum* has in many places been damaged by pigs.

Alongside Lake Aroarotamahine the scrub is interrupted by a tall forest (50-60 feet) of *Pinus pinaster*. This area may have been the site of the old Maori clearing mentioned by Bell (1914). Seedling *Pinus* plants were observed wherever the *Leptospermum* canopy had opened to allow increased illumination. *Pinus* seedlings were also found on the crater-rim and marine cliffs adjacent to Okawa Point.

North of the pine forest, *Knightia*, emergent above the *Leptospermum* canopy, becomes more important; and in places has completely replaced the latter species.

The vegetation of the south-western crater-floor area forms a rather dryish community, not unlike a gumland scrub of North Auckland. Both *L. scoparium* and *L. ericoides* are present, with *Lycopodium densum* and *Blechnum procerum* on the ground.

Flanking the eastern edge of this last-mentioned community is an elliptical steep walled hill, believed by Brothers (personal communication) to be an upstanding rhyolite remnant of the original volcano (see map). Here, the soil is deep with few exposed outcrops, and the vegetation is a tall forest of *Knightia* and pohutukawa overtopping senescent kanukas, structurally very different from the true crater-floor communities already described. Conditions for plant growth are apparently more favourable here than on the tholoid.

* Many of these headlands are known to have been fortified by the Maori (Gold-Smith, 1884).

* This is known to have been cultivated by the Maori (Gold-Smith 1884)

THOLOID COMMUNITIES

The tholoid (or cumulo-dome; Cotton 1944) is covered by a mass of tumbled pumiceous obsidian blocks, formed through cooling of the successive lava flows which welled up in the crater during the later stages of volcanic activity. The topography is typical of lava fields, with numerous narrow ridges and gullies running parallel with the direction of lava flow. Approximately half-way up the tholoid there is an abrupt increase of slope where the upper tholoid lava flows came to rest on the lower. From this point the upper slopes rise very steeply to the rounded summit which has a very broken and uneven topography.

On the lower tholoid slopes, pohutukawa (1-2 feet in diameter and 30-40 feet in height) is the physiognomic plant. *Knightia*, *Weinmannia racemosa* and kanuka (6-12 inches in diameter) are common canopy species which, however, assume complete dominance only in localized areas. *Suttonia*, *Coprosma robusta*, *Nothopanax arboreum* and *Astelia banksii* form an undergrowth of varying density. The most frequent forest seedlings are those of *Knightia* and *Litsaea*.

Coinciding with the abrupt change of slope between lower and upper tholoid flows, there is a marked change in the vegetation. *Leptospermum scoparium* (manuka), 4-10 feet in height, together with *Leucopogon*, *Gyathodes*, *Nothopanax* and *Coprosma robusta* form a discontinuous canopy. Pohutukawa and *Knightia* are present as scattered emergent trees up to 30 feet in height. In places where the canopy is broken, pohutukawa seedlings with fruticose and foliose lichens may be found growing on the otherwise bare rocks. Where the canopy is more dense, *Astelia banksii* forms a thick undergrowth. On the tholoid summit the community grades imperceptibly into a forest similar to that already described for the lower tholoid flows.

Extending around the perimeter of both the upper and lower tholoid lava flows is a zone of pohutukawa forest.

At the northern end of L. Aroarotamahine, many of the pohutukawa trees (2-4 feet in diameter) rise to a height of 30 feet without branching. These, together with *Knightia* (2-3 feet in diameter) give the impression of a forest of much greater age than that described above.

SWAMP COMMUNITIES

LAKE COMMUNITIES

These are fully discussed in the study of Bayly, Edwards and Chambers. (See *Tane*, this volume.)

HISTORY OF THE VEGETATION

It must be pointed out that neither *Leptospermum* nor pohutukawa normally regenerate under a closed canopy, so that much of the Mayor Island vegetation is unstable and replacement by other populations may be expected. Since insufficient quantitative data was collected, the dynamics of the various communities will not be discussed. Some discussion, however, on the history of the island's vegetation will be attempted. Although the story, at present, can only be fragmentary, some lines of investigation worth following may be indicated.

Embedded high up in the south-eastern crater wall are the charred remains of logs. These have been buried by an eruption of pumice and subsequently compressed by a more recent lava flow. Estimation of the age of these logs, and hence the eruption which buried them, may be possible by use of the radioactive carbon technique. Identification of the species would be extremely interesting. Celloidin peels were attempted without success, since the material is almost pure charcoal with little impregnation by calcium carbonate or silica. Mr W. Crossman of the Geology Dept., A.U.C., is at present experimenting with various sectioning techniques which, it is hoped, will show sufficient structure to enable identification to be possible. The presence of these logs shows that Mayor Island was colonized by vegetation at least once, and possibly several times, between periods of volcanic activity.

The present vegetation of the island's outer slopes does not appear to be a primeval forest. On these slopes there are few trees greater than 24 inches in diameter, the majority ranging between 12 and 18 inches. The 9ft. diameter specimen of pohutukawa near Opo Bay (Sladden, 1925) is almost certainly a survivor from an older population. That most of the vegetation of the island's outer slopes is less than 150 years in age seems certain. Gold-Smith (1884) giving a general description of the island's vegetation, says:

'Common fern, tutu, tea-tree (very thick), koromiko, and a little grass, form the ordinary vegetation, whilst the few clumps of trees consist of pohutukawa, mapou, manuka, rewarewa, akeake, whau or corkwood, pukapuka, and a few puriri, which, however, is of little value, being very scattered and ruined by fire.'

The occurrence of extensive fires in the past is also suggested by the wide distribution of the *Leptospermum*/emergent *Knightia* vegetation type which is characteristic of vegetational succession after fires on the mainland.

This secondary status of the vegetation is not surprising, since the island is thought to have been densely settled by the Maori (Gold-Smith, 1884). Pa have been built at many strategic points on the island and cutting of timber for stockades and firing of vegetation for cultivation areas, would have greatly modified the original vegetation. Furthermore, fires may have occurred in pre-European times when attacking war parties were attempting to oust the inhabitants from their defensive positions.

A more recent fire (after 1900) is mentioned by Bell (1914) who records that a large area of the western portion of the island was swept by a fire which, however, did not enter the crater. The younger vegetation now growing in this area can be distinguished in the aerial photographs.

Within the crater, the *Leptospermum* vegetation of the eastern crater floor may be a regeneration stage after fire. Ring counts gave figures ranging from 40 at the southern to 56 at the northern end of this forest; a change which is paralleled by a gradient of increasing *Knightia* dominance. It is possible that this gradient of increasing community age is a result of progressive abandonment of the

less accessible land for cultivation, as the Maori population dwindled.

Elsewhere in the crater there is evidence of widespread fire. Charred stumps and pieces of charcoal are to be found at many widely scattered points through the forest of both the upper and lower tholoid lava flows. Tissue macerations prepared from four different samples of better preserved logs showed fibres similar to those of pohutukawa. Ring counts of *Leptospermum*, *Weinmannia* and pohutukawa taken at widely distributed points on the lower tholoid flows indicated ages between 40 and 70 years. The previous vegetation was therefore probably a pohutukawa forest, much of which was damaged or destroyed by a fire or fires which occurred at least 80 to 100 years ago. A remnant of this forest is probably represented by the small area of large diameter trees mentioned at the northern end of Lake Aroarotamahine. Some parts of the rock-fall forest may also be of remnant status, although here it is possible that the larger trees are a reflection of improved growth conditions rather than greater age. Available moisture may be greater in this community, where drainage from the tholoid water-table is perhaps supplemented by seepage from the cliffs. Similarly, it may be tentatively suggested that the peripheral zone of vigorous pohutukawa growth on the margins of the upper and lower tholoid lava flows is also caused by increased water-supply from the tholoid water-table.

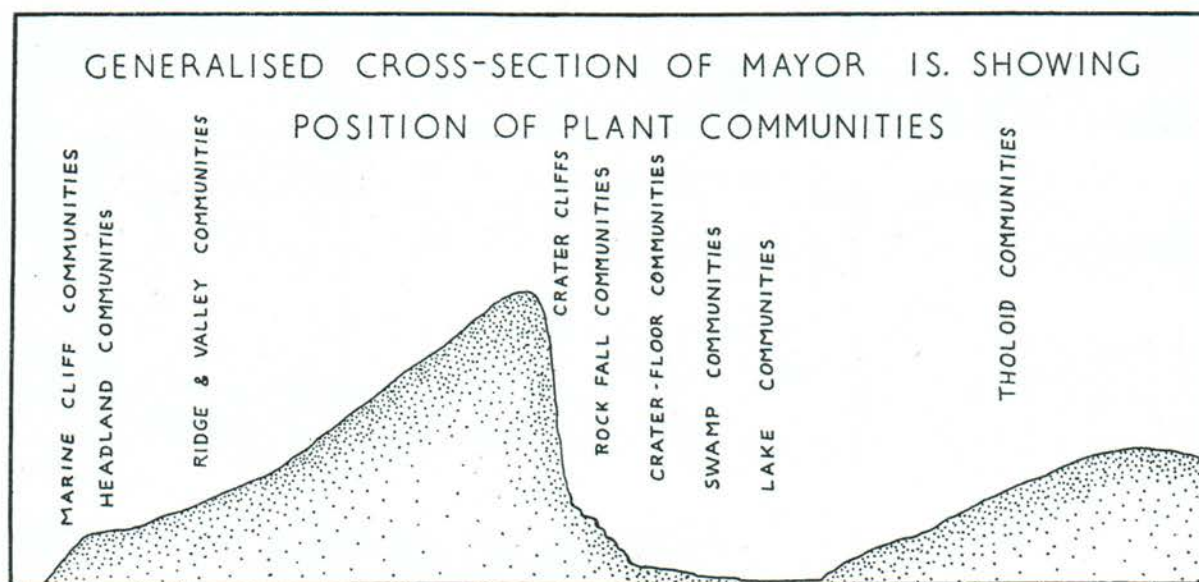
The difference between the vegetation of the upper and lower tholoid flows may be a result of a more recent fire than that already discussed. Ring counts on the upper tholoid indicated an age of 35 to 40 years. The lower boundary, coinciding with the sudden change of slope, is sharply defined. This is not the case, however, with the upper boundary, where the *Leptospermum*-emergent pohutukawa vegetation grades imperceptibly into the

tholoid summit pohutukawa forest, comparable in structure to the forest of the lower tholoid flows. It seems probable that the vegetation of the upper tholoid is actually a stunted vegetation caused by the reduced water-supply conditions of the steep portions of the upper tholoid flows.

Pohutukawa does not regenerate under its own canopy, presumably because the light intensity is too low. No juvenile stages of pohutukawa were seen under a forest canopy at any place on the island. For a pohutukawa forest to establish, one primary requirement is an open area with full light conditions. Such requirements may be brought about by slips or rock-falls, as on coastal cliffs; by fire, as in the Mayor Island crater; or by volcanic activity, as with the lava fields at Rangitoto Island. What then, is the status of the remnant forest at the northern end of L. Aroarotamahine? Judging by the unweathered appearance of the lava and the scanty soil and humus, forest growth has not proceeded for any great length of time at any place on the tholoid. Does the Aroarotamahine forest represent a primary colonizing forest on the bare lava flow, or is it a regeneration forest after some fire which occurred prior to any of those already discussed?

Study of the growth-form of the individual trees is often helpful in evaluating the habitat conditions and indicating the mode of colonization. It might be argued that the 3-4 ft. diameter trees of the Aroarotamahine forest were of larger growth-form because their roots reached the water-table at lake level. The remnant nature of this forest is apparent, however, when it is compared to the adjacent similarly situated pohutukawas, 1-2 feet in diameter, on the northern shore of the lake. The 3-4 feet diameter trees reflect an age difference rather than a growth-rate difference.

Except when overhanging the lake, these trees are tall and straight, with lateral branching restricted to the



canopy. Stand density is high and it is possible to envisage colonization by the establishment and growth of numerous seedlings with strong competition for light.

On the tholoid the scanty soil has mostly been washed down among crevices and in many places the trees appear to be growing on bare rock. This rock is mostly pumiceous obsidian of a porous spongy structure which is readily weathered. Water-holding measurements show that when such rock is saturated it can hold up to its own weight in water. It seems possible that these edaphic conditions may have allowed a more rapid establishment of forest than the 'island' mode of colonization which has been described by Millener (1953) at Rangitoto. This conclusion would not necessarily apply to the upper tholoid flows, where water-supply conditions are likely to be limiting to plant growth.

Soil samples from the Aroarotamahine remnant forest contained some charcoal, but the possibility exists that this had been blown into the stand from the adjacent burnt area. Further work is needed to clarify this point and the primary or secondary status of this forest must at present remain an open question.

A more intensive investigation of the forest structure and examination of the edaphic conditions on the tholoid will be necessary before any clear picture of forest development in this area can be obtained. The key to the forest history of Mayor Island may lie buried in the pollen profile of the crater swamps.

CONCLUSION

The most important point emerging from this account is that little, if any, of the present vegetation of Mayor Island can be considered primeval. Its history is seen to be complicated by fires, and a more complete picture will

only be obtained by using every method which may throw light on the sequence of events which produced the present vegetation. Some lines of approach have been indicated but soil information is noticeably lacking. Present successional trends in the various communities have not been touched upon. It is not yet possible to assess the extent to which forest development on the rhyolite lava flows of the tholoid, has been altered by fire; nor is it possible to estimate the effect that pigs (which are widespread over the island) will have on forest succession.

In the Mayor Island vegetation, we have a wonderful opportunity for the study of vegetation dynamics. Its scientific value and obvious scenic qualities would justify the eradication of pigs and protection from further fires. Considering, as well, the unique nature of the crater lakes and the extraordinarily abundant bird life, there is a strong case for setting aside at least the crater portion of the island as a national wild life sanctuary.

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