1886 eruption also blocked the valley leading from Rotomahana to Tarawera lake and brought into existence a much larger and more elevated Rotomahana. The dome building and associated explosive eruptive phase of the Okataina Volcanic Centre activity presumably still continues.

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VULCANICITY AND INDIGENOUS VEGETATION IN THE ROTORUA DISTRICT:

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INTRODUCTION

Although most of the country round Rotorua is climatically and edaphically suitable for forest, only a third was covered by about the middle of last century. There was one major tract on high land between the coastal lowlands and the upper Thames (Waihou) and Waikato valleys; and a few outliers on high ground within inland valleys. The Kaingaroa plateau was nearly devoid of forest. Throughout the district there were small patches of forest in the gorges flanking the uplands, in folds of the hills in generally open country, and clumps of swamp forest on the plains. Apart from deep swamps, sand dunes, and the nearly bare summits of Mt. Tarawera, the rest was mainly scrub and fern, with heath and tussock in the south.

This pattern suggests that a nearly universal forest had been reduced by fire, probably by the Polynesians living in middle Waikato valley, along the Bay of Plenty, and about the Rotorua lakes. Fire was their only means of clearing land, but they could not control it. Frequent burning was necessary for a shifting cultivation, to retain fern land for the staple fern root, and to maintain communications. In recorded local traditions large fires are rarely mentioned, but early Europeans commented on them and on the natives' casual attitude towards them.

The recent dating of the last violent eruptions from the east Taupo volcanic centre at only 1,800 years ago suggested that the then forest had been devastated and had not since returned. But there is pedological evidence of former more widespread forests on soils of the Taupo suite (Vucetich, unpub.). Furthermore, forests now in this area are on southerly (the wetter) faces: the aspect expected from fires, but not from volcanic blasts from the direction of Taupo. A general "post-Taupo" forest would probably have been densely stocked with rimu, miro, matai, totara, and maires (*Dacrydium cupressinum, Podocarpus ferrugineus, P. spicatus, P. totara,* and *Gymnelaea* spp.); it would have grown largely on coarse soils in the driest parts of the district, and so have been the readiest to burn and the least likely to return in the face of continual wildfires. Commonly throughout the district, secondary forest or tall scrub has developed on the margins of these forest remnants during the last 100 years, dating the waning of indiscriminate burning. Hence I conclude that the scrub, fern, heath, and tussock communities of a century ago were not the direct result of volcanic action.

On the other hand, the formerly large swamps of the upper Thames valley, the coastal plains, and some tributaries of the Waikato River were largely due to overloaded rivers after volcanic eruptions. Fires in swamps in Polynesian times probably made no permanent difference to the vegetation, apart from some lasting destruction of stands of kahikatea (*P. dacrydioides*) and of totara on levees, but in the last 50 years most swamps have been drained and made farmland.

Hence only in forest can one now study the relationships of indigenous vegetation patterns to the volcanic events of the late Pleistocene and the Holocene.

THE BROAD FOREST PATTERN

The forests of the Rotorua district were sampled by the National Forest Survey (Masters, Holloway & McKelvey 1957) between 1945 and 1955, and later by the Forest Research Institute. I distinguish 25 forest types (exclusive of logged types), but for simplification I have grouped them more broadly and shall consider them as they were 100 years ago.

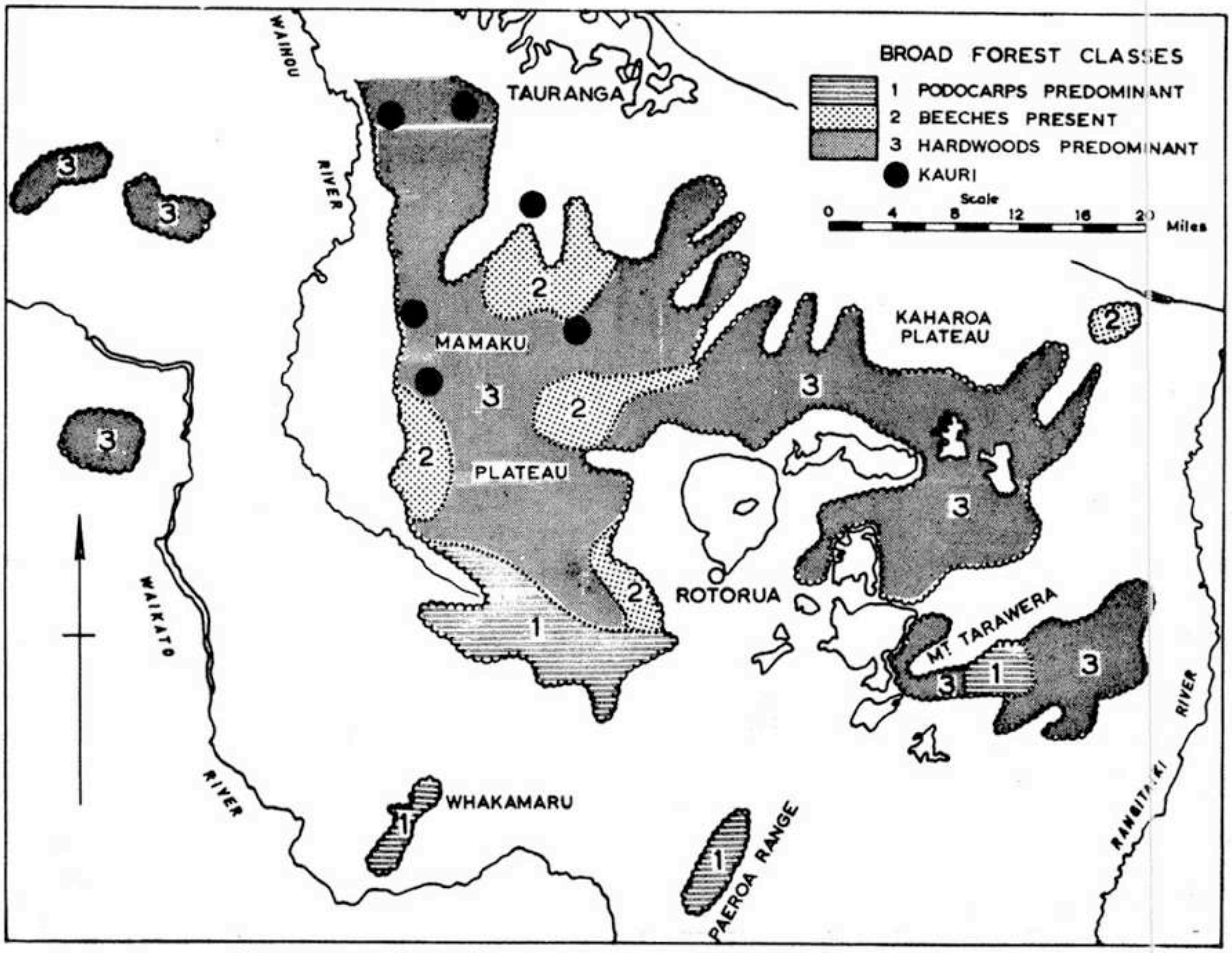

FIGURE 1. *The indigenous forest pattern, Rotorua district*

Commonest is the rimu-rata (*Metrosideros robusta*) / tawa (*Beilschmiedia tawa*) class, covering much of Mamaku Plateau, Kaharoa Plateau, the hills about the lakes, and the crest of Matahina Plateau (E. of Mt. Tarawera). On high ground this grades into the Hall's totara (*P. hallii*) / kamahi (*Weinmannia racemosa*) - scrub hardwoods class, and in the gorges of Mamaku Plateau into rimu - tanekaha (*Phyllocladus trichomanoides*) / tawa forest. As a rule here, podocarps and rata are scattered emergents, over abundant hardwoods.

There are hard beech (*Nothofagus truncata*) stands in some gorges on the western, northern and eastern flanks of Mamaku Plateau, and on the north-eastern "corner" of Kaharoa Plateau. Roughly in the centre of Mamaku Plateau is the only tract of rimu - red beech (*N. fusca*) / tawa - hard beech - silver beech (*N. menziesii*) forest. In the north-western quarter of Mamaku Plateau are a few, widely separate, small stands of kauri (*Agathis australis*). Groves of pohutukawa (*M. excelsa*) are frequent in the Tarawera valley, and occasional about the lakes.

On the southern fall of Mamaku Plateau and from north to south in the outlying forest along Paeroa Range, the rimu-rata / tawa class gives way to rimu-matai / tawa. Nearer Waikato River, tawa becomes rare; any forest is in the rimu-matai / kamahi class. Concomitantly, in this southern part of the district podocarps generally become increasingly abundant. Close to Mt. Tarawera there is an unusual totara/tawa forest.*

MAIN FOREST TYPES: CONTRASTS BETWEEN EAST AND WEST

Before discussing further the restricted occurrence of beeches, kauri, pohutukawa, and podocarp-rich forests, I shall describe the composition of the typical forests in which hardwoods as a rule predominate, and which may be regarded simply as three phases of a great continuum.

Within the extensive rimu-rata / tawa class, those first two bulky trees and a few smaller kinds, e.g. hinau (*Elaeocarpus dentatus*), occur consistently. Though tawa is present throughout, its density varies considerably; kohekohe (*Dysoxylum spectabile*), pukatea (*Laurelia novae-zelandiae*), mangeao (*Litsea calicaris*), rewarewa (*Knightia excelsa*), and tawari (*Ixerba brexioides*) are restricted and there are clear differences between specific ranges of all these trees in the east and in the west. The distribution of kohekohe seems to be controlled mainly by climate (frosts); there is relatively little of it as there is so little lowland forest left. The other hardwoods extend beyond the maximum altitude of kohekohe, here about 1,300 ft. above sea level.

Pukatea and mangeao are common (outside gorges) on the flanks of Mamaku Plateau below 1,500 ft., rare by 1,700 ft. and absent from the crest (1,800 to 2,100 ft.). Rewarewa ascends further but is rare on the crest. Tawa is far more general, but patchy on the crest; tawari, rare lower down (except in gorges), becomes plentiful. On the hills of the lakes district and the Rotorua basin (Mt. Ngongotaha), pukatea, mangeao, rewarewa, and tawa are common to about 2,000 ft. This may be partly because hilly country gives more shelter and receives more direct insolation than a plateau top; but more volcanic ash and lapilli beds, mainly of fine grade and well weathered, accumulated on the slopes of the eastern hills than on the plateau; so drainage is improved and soils thereby are warmer, providing greater scope for root systems. These effects of a deep veneer of ash upon altitudinal distribution of species are very marked on Rotoroniu Dome, rising to just over 3,000 ft. in the centre of the lakes district. On its gently convex summit, mangeao and rewarewa flourish up to 2,400 ft., and tawa persists to 2,700 ft. In all this eastern area tawari is rare, with the lack of rocky ground.

On the few low salient ridges in the north-western quarter of Mamaku Plateau, characteristic trees are scattered, stunted Hall's totara and abundant short kamahi and tawari, over small scrub hardwoods. Generally the soil is shallow and rock outcrops common. In contrast, on the summit of Rotoroniu Dome at 3,000 ft., Hall's totara is frequent, tawari is confined to ridge crests, and with common large kamahi are large broadleaf (*Griselinia littoralis*), *Psittosporum eugenioides*, *Carpodetus serratus*, *Aristotelia serrata*, and *Fuchsia excorticata*.

Through the heading gullies and down the long gorges and narrow valleys of the northern fall of Mamaku Plateau, rata, pukatea and mangeao disappear and rewarewa and tawa become fewer; tanekaha, miro and tawari become increasingly preponderant, and toatoa (*Phyllocladus glaucus*) comes in. In the extreme, the forest is composed of "pole type" podocarps, and kamahi, tawari and *Quintinia serrata*, over a sparse underwood typical of infertile sites — notably *Cyathodes fasciculata*, *Dracophyllum* spp., and *Gahnia* spp. Soils, albeit largely derived from volcanic ash, are so shallow that rock is often exposed or covered only by mor litter, and clear, shallow streams flow over clean ignimbrite pavements. Valley-bottom forests are very different in the corridors between the eastern domes, as well as in the many shallow gullies on the crest of Matahina Plateau — so choked by accumulated ash that floors are flat and streams have gone underground. The usual forest type (in the rimu-rata / tawa class) is characterised by frequent, very tall rimu, unusually plentiful pukatea, some matai and kahikatea, and a very dense underwood of large-leaved shrubs and luxuriant ferns.

These differences between the eastern and western forests probably result from many thousands of years of soil changes as ash and lapilli, periodically erupted from the Okataina volcanic centre, accumulated far deeper in the eastern than in the western zone. Disruptions of forest patterns (there must have been some near vents now located only by coarse block beds) have long since

* These short titles include only the "diagnostic species".

become obscured, if they were not indeed simply passing phases. None of these variations can be attributed to any one shower or set of showers; nor to differences in present climate between the eastern and western areas, for broadly speaking there are none.

RELIC SPECIES: VULCANICITY AND SUBSEQUENT SOIL CHANGES

In the Rotorua district beeches probably are relic species, once widespread but now confined to a few localities. Vulcanicity, directly in the east and indirectly in the west, was apparently a more important influence in this than were climatic changes since or even during the last secular glacial period.

On geological grounds the beeches must at some time have reached Mamaku Plateau from outside the Rotorua district. Since they disperse very slowly indeed except by waterways, of which there are none favourably aligned here, they must also have been distributed virtually continuously across the whole district when either a harsher climate than the present or generally infertile soils reduced competition from other plants. Perhaps infertile soil was the more important, for hard beech as well as red and silver reached the crest of the plateau. Consequently the beeches must have attained the plateau before the Rotorua ash fell there, before the loamy soil suited to existing forests had evolved; this would put their time of arrival at least 20,000 B.P. Indeed, they must have become established long enough ago for red and silver beech (now found only on the plateau) to disappear from the rest of the district, and for hard beech to have become only a little less restricted. If beeches dwindled only because it has been milder during the last 15,000 years than immediately before, it is rather extraordinary that they do not now grow above 1,800 ft. on the plateau, and are absent from high ground elsewhere.

The lack of beeches eastward to southward of Rotorua may be due to catastrophic volcanic events there during the late Pleistocene and early Holocene. Many rhyolite domes were formed so recently that beeches probably have never grown on them. The late Pleistocene pyroclastic flows in the same zone were eruptions of the *nuée ardente* type, violent and numerous enough to have wiped out forest over a wide fringing area; other species could have reoccupied the territory rapidly, but not beeches (unless severe climate precluded "rival" vegetation). The small area of forest with hard beech on the coastal edge of Kaharoa Plateau may have been just beyond the range of volcanic avalanches. There is some evidence of former beeches nearer the volcanic centre: pollen of red and silver beech has been found in ancient ash beds immediately above ignimbrite but overlain by 200 ft. of Waitahanui breccia, in Kaituna valley, middle Kaharoa Plateau (W. F. Harris & B. N. Thompson pers. comm.).

Mamaku Plateau forests would hardly have been affected by lava and pyroclastic flows in the east to south. Reduction of beech forest on the plateau may have been due to the deposition of Rotorua, Rotoma and Mamaku ash greatly improving drainage of the soil. The present common restriction of hard beech to steep gorge walls or their rocky rims is thus explainable. And red and silver beech remain on the plateau proper only at the head of Mangaorewa Stream, where frequent swampy ground, lagoons and gleyed soils testify to long-standing unusually poor drainage perhaps due to an impervious sheet of ignimbrite below the ash. The presence of red and silver beech down the Mangaorewa Gorge but in no other indicates a very long time interval since they became confined to that one sector of the plateau crest. Hard beech is there too, on rocky ridges and craggy ignimbrite pinnacles: this is an anomaly, for it is absent from like sites nearby on the plateau.

Kauri is also very slow to disperse. Are the few small stands on Mamaku Plateau to be accounted for as have been the beech stands? Its normal thriftiness and reproductive capacity here, and its occurrence up to 1,300 ft. above sea level, strongly suggest that this is not the true southern limit of the species modern climatic range. On the plateau kauri, like hard beech, is almost entirely confined to shallow soils, along gorges, or on gully sides. Throughout its range over the northern North Island kauri is on infertile soils, skeletal or old, leached, acidic. Hence its present distribution on Mamaku Plateau may be an outcome of late Pleistocene and Holocene depositions of ash and subsequent soil improvement.

Since the climate of the Rotorua district very probably cooled during the last glaciation, could kauri have survived, as the beeches did? It is generally assumed that kauri is not a hardy tree: Bieleski (1959) mentions 600 m. (*ca.* 2,000 ft.) as the upper limit in Northland, though he notes the stunted, semi-prone kauri at 800 m. (*ca.* 2,600 ft.) at the northern end of Coromandel Range (Cranwell & Moore 1936). However, unpublished records of the National Forest Survey mention thrifty kauri at several points between 2,300 and 2,500 ft. along the Coromandel Range, growing in sodden, peaty basins with yellow-silver pine (*Dacrydium intermedium*), and on a bleak upland east of Mt. Te Aroha, at 2,500 ft. with red and silver beech. It is hardy enough to grow higher than it does on Mamaku Plateau; perhaps were it not for competition with more "gross feeding" plants on relatively good soils it would do so. Also it could grow in the east and south of the Rotorua district, and may once have done so but been forced out by drastic volcanic events, as were apparently the beeches.

While pohutukawa is much less hardy than kauri, it colonised the bare lower slopes of Mt. Tarawera after the eruption of 1886, just over 1,000 ft. above sea level and 30 miles inland. So on climatic grounds pohutukawa is not anomalous in the lakes district and the Tarawera valley: what rather needs explaining is its restriction otherwise to coastal cliffs and low, off-shore islands of the northern quarter of New Zealand. Pohutukawa may be primarily a rock-dwelling tree, and was perhaps widespread in the Okataina volcanic zone when late Pleistocene and early Holocene lava flows provided a suitable environment; it is abundant on Rangitoto Island colonising a field of *aa* lava (Millener 1953).

SOUTHERN PODOCARP FORESTS AND TAUPO DEPOSITS

South-westward and southward of Rotorua, the composition of the podocarp-hardwood forests varies according to the depth and nature of Taupo soils, developed over old "brown ash" beds since the eruptions of ash, lapilli, and coarser pyroclastics from the east Taupo volcanic centre about A.D. 120.

Immediately southward is a transition zone between the typical northern forests and those of the south, marked by a consistent occurrence of matai, rare in the north. This is not due to a difference in climate; for matai grows at all altitudes from 800 to 2,500 ft. above sea level as Taupo soils deepen and become more or less universal.

On the southern quarter of Mamaku Plateau, on most of Paeroa Range, and in remnants of forest in between, the rimu-matai / tawa class is general. Major differences from the northern rimu-rata / tawa class are: wide absence of rata; many more rimu, matai and miro; sparse tawa in shallow gullies; scarce tawari (even at high altitudes); and occasional to locally common huge totara (mostly as long-fallen logs). It is quite obvious in the field that Taupo silty sands and "gravelly" sands are generally deeper here than further north. The totara indicate a greater difference in forest composition immediately after the falls of Taupo lapilli, then ash, when deep drifts of "raw" mineral soil were common. With rocky ground well covered, tawari has declined; where old loams are deeply buried, tawa has not since become well established.

Mangeao and rewarewa are generally common in this class, though far more prominent on hillsides than on the plateau crest, as further north; and pukatea grows in the few places where there is forest below 1,500 ft. These occurrences, and the Hall's totara / kamahi-tawari or broadleaf forest along high ridges (*e.g.*, crest of Paeroa Range) and rimu-tanekaha / tawa stands on forested cliff faces do not suggest anything like complete forest destruction during the last Taupo eruptions.

In the bottoms of gorges cleaving the south-western edge of Mamaku Plateau, on top of Whakamaru Dome, and on the southern aspects of Paeroa Range and hills near by, are rimu-matai / kamahi forests. These are mosaics of dense rimu, matai, totara, and miro stands and sparser podocarps over huge kamahi and frequent maires, hinau, rewarewa and mangeao. The gorge bottoms have received ash eroded from above, the dome and the range are closer to the eruption centre than the plateau, and the lower slopes of hillsides facing the origin of *nuées ardentes* received the heaviest deposits of pyroclastics. Geological and pedological evidence makes it clear that a great area, perhaps all, of a forest near Waikato River was overwhelmed or blasted down 1800 years ago, but it is not known how long the forest took to return nor what specific succession took place; but already all the common trees of the Rotorua district are present, except rata and tawa, and seedlings, saplings and poles of tawa occur locally. I postulate that the rate of forest re-establishment depends upon the rate of soil maturation and that this has largely determined the re-establishment of any forest grossly disturbed by falls of ash or overthrown by pyroclastic flows in the Rotorua district.

TARAWERA TOTARA FOREST AND KAHAROA DEPOSITS

About 900 years ago rhyolitic ash and lapilli erupted from Mt. Tarawera showered over much of the eastern half of the Rotorua district. These deposits, known as the Kaharoa ash beds, are distributed fanwise N.N.W. and S.S.E. of the mountain (C. G. Vucetich pers. comm.). Broadly, there are 6 to 24 in. of ash and lapilli (now a soil) on Kaharoa Plateau, the lake-district hills, Matahina Plateau and the northern end of Kaingaroa Plateau. Nearer the source, the depth increases so that there is an area about six miles across (east-west) and 12 miles long (north-south) immediately south of Mt. Tarawera, where Kaharoa deposits are up to 60 in. deep.

Outside the zone of deepest beds the forest does not suggest disturbance during falls of Kaharoa ash. But below the south-eastern sides of the three domes forming the crown of Mt. Tarawera, there is extensive forest different from any other in the district. (Unlike forests on the other faces of the mountain, it was not destroyed by the eruptions of 1886.) At the upper limits there is the Hall's totara / kamahi-scrub hardwoods type, but most of it is dense mature mixed-hardwoods forest with frequent to locally abundant totara and Hall's totara and only occasional large rimu, matai, kahikatea and rata.

I conclude that the sudden provision of a generally-deep skeletal coarse sandy to "gravelly" soil 900 years ago resulted in an abnormally "high strike" of totara which still stand instead of the other scattered podocarps usually present in Rotorua mixed-hardwoods forests.

MT. TARAWERA LAVA FIELD

Rhyolitic lava extruded from the crown of Mt. Tarawera after the Kaharoa eruptions apparently was colonised by vegetation very slowly. The new ground was volcanic rock, not loose detritus of ash and lapilli grade fallen on a previous soil with a forest cover; and most of the mountain crest is between 3,000 and 3,600 ft. high. Hence few plants of the indigenous flora of the Rotorua district were likely to become established.

Kirk (1872) described the western upper faces of the mountain as very steep talus slopes almost devoid of vegetation. The bases of these cliffs are a little over 2,000 ft. above sea level, beyond the altitudinal range of pohutukawa; but about that level Kirk saw rata of terrestrial origin growing on heaps of fallen rocks. On the broad, rocky tops, the only plants greater than lichens, mosses, ferns, raoulias, and small dracophyllums mentioned by Kirk were dwarfed shrubs growing in sheltered hollows, notably *Corokia buddleoides, Cyathodes juniperina, Gaultheria oppositifolia, Neopanax colensoi*, and *Olearia furfuracea*.

THE TARAWERA-ROTOMAHANA ERUPTIONS OF 1886

Early on 10 June 1886, basaltic lapilli and ash, and shattered country rock, were ejected in paroxysmal outbursts from great fissures opening along the tops of Mt. Tarawera. Toward the close of those eruptions, a vast amount of comminuted, hydrothermally weathered rhyolite was blown from the site of the present Lake Rotomahana, just south of the mountain, and fell as a rain of hot mud. The significant compass of the lapilli and ash fall was about 10 miles N. and S. of the mountain and about 15 miles to the N.E. Very little was blown to the W., but it was to the N.W., again for about 10 miles, that most of the Rotomahana mud fell.

Over the combined ranges, the pattern of indigenous forest, scrub, and fern land was much as it was only ten years ago, before extensive conversion of scrub and fern to pastures was begun. The only major difference in the pre-eruption pattern was the widespread high forest on the lower western and southern slopes of Mt. Tarawera, which probably resembled existing forest on the eastern side: a mixture of tawa, mangeao, rewarewa, hinau and kamahi, with more scattered large totara, rimu and rata. Pohutukawa were abundant along cliffs at the edge of Lake Tarawera.

Those forests were destroyed during the eruption of the mountain; and scrub and small forests between Lake Rotomahana and Rotorua were buried or wrecked by the mud shower. Vegetation has long since reclothed those areas, but the process has not been studied comprehensively. The following short account is drawn from occasional references in the geological and botanical literature between 1886 and 1928 (refs. in Nicholls 1959).

The hail of lapilli and ash from the Tarawera eruption had no apparent marked effect on forests more than two or three miles away. All vegetation was destroyed on the western and southern flanks, where very heavy falls of lapilli and ash (150 ft. deep on the summits) were supplemented by the rain of hot mud, and a bombardment of red to white-hot boulders rolling down the steep summit faces, whilst close to the mountain for several hours there raged a blasting storm of hot air, steam and lightning.

The devastated area remained barren for about 10 years. Thirty years after the eruption, young pohutakawa, rata, rewarewa, and kamahi were common along the lake shore and scattered throughout patches of scrub which had sprung up on the western lower mountain slopes. On ridges the scrub consisted mainly of *Coriaria, Cyathodes, Leptospermum* and *Olearia* spp., but in gullies there were thickets of *Fuchsia excorticata, Hedycarya arborea, Melicytus ramiflorus* and *Schefflera digitata,* and tree ferns and supplejack, with some saplings of tawa, mangeao and hinau. Some tawa and *Melicytus,* at least, had sprouted from stumps. Fourteen years later, closed pole stands of hardwoods had developed; but above 1,500 ft. (beyond half-way from the lake to the mountain crown) there was still only sparse low vegetation, mainly gaultherias, dracophyllums, and raoulias. On the southern face of Mt. Tarawera, dense tall scrub today reaches almost to the lip of the Tarawera Chasm, the southernmost fissure.

The low scrub and fern clothing most of the land between Lake Rotomahana and Rotorua was buried under Rotomahana mud. About 1,000 acres of forest along the shores of the small lakes a few miles west of Lake Tarawera at first appeared devastated: the undergrowth overwhelmed, hardwoods stripped of foliage and small branches, and large rimu and rata overthrown by a gale during the eruption period. Next summer, standing trees put forth fresh shoots, and four years later most trees and shrubs were flourishing. The clumps of forest today appear normal, apart from a scarcity of large trees; fringing belts of tall scrub may be an outcome of the eruption damage to the previous stands. Outside the forests, within a year bracken fern had penetrated wherever the mud was no more than 2 ft. Four years later, scrub was again general, though for a time dominated by *Arundo conspicua* and *Coriaria* spp. rather than by *Leptospermum* spp. as it had been. Within 20 years of the eruption those first two species had also covered very deep deposits of mud, sculptured into "badlands" by erosion, hard by Lake Rotomahana.

CONCLUSIONS

One general conclusion is that a hail of volcanic lapilli upon indigenous high forest will have scant effect unless more than a few feet deep or hot enough to kill vegetation outright. The temperature of the Tarawera basaltic lapilli and ash falling more than two or three miles from its source cannot have been high. Since the general composition of the new forest on the western mountain flank so quickly came to resemble the former forest, the plants most likely seldom grew from seed brought on the wind or by birds but mainly from seed already in the ground. Probably, though, no plants appeared until much ash had been eroded away; possibly there was more sprouting from stumps or roots than is recorded. (An important question is whether podocarps have appeared in the young Tarawera forest: until 1928 none was mentioned.)

The Rotomahana shower was a most unusual volcanic event, but nevertheless strikingly demonstrated the resilience of indigenous vegetation.

Ash *showers* may not always have been catastrophic for vegetation, and even where forest may have been obliterated by ash *flows* a return may not invariably have involved a long time and protracted plant successions. Long-lasting changes may be considered probable only where soils were radically changed.

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ASH BEDS AND SOILS IN THE ROTORUA DISTRICT

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INTRODUCTION

During the Late Quaternary, volcanic eruptions of the explosive or paroxysmal type (Taylor, 1953) occurred in the central North Island about centres, which for convenience, are designated Okataina, Waitahanui, Maroa, and Tokaanu (Fig. 1). The resulting ejectamenta formed thick layered beds largely of rhyolitic pumice. Most is known about the distribution of beds from the Okataina and Waitahanui eruptive centres where named beds have been mapped in the Rotorua, Bay of Plenty, and Gisborne districts (Vucetich and Pullar, *in press*). Little is known about the Maroa and Tokaanu centres except that they are considered to have been important contributors earlier in the Holocene and that they were also active contemporaneously with the Taupo Pumice eruptions.

STRATIGRAPHY

The following ash beds have been recognised; the age where known is given in years before 1950:

Named Beds

Tarawera scoria (and Rotomahana mud) erupted 1886	
Kaharoa Ash	810±70[1]
Taupo Pumice	1700±150[2]
Taupo Subgroup, members 9–13	
Waimihia Ash	3420±70[3]
Rotokawau Ash	
Whakatane Ash	
Mamaku Ash	
Rotoma Ash	
Taupo Subgroup, members 16–18	8850±1000[4]
Waiohau Ash	
Rotorua Ash	
Rerewhakaaitu Ash	

Unnamed Beds

"'X' Beds"; (Ash and lapilli) three in number in Rerewhakaaitu locality and believed of restricted distribution; not mapped because of few exposures.

*"Pinkish-brown Beds"; multiple, of ash grade, weakly weathered; mainly northern part of Kaingaroa Forest, Wairakei, Waiotapu and Rotorua.

*"Mauve Beds"; three in number mainly on Mamaku Plateau.

"Yellow-block Bed"; mainly along Bay of Plenty and in Gisborne District; not traced south and west of Rotorua.

* The "pinkish-brown" and "mauve" beds are not seen in stratigraphical order in one section and may be coeval. Mapping of these together with lower beds is proceeding.