

ART. XXXI.—*The Vegetation of the Tarawera Mountains, New Zealand.*

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Plates XIX–XXII.

INTRODUCTION.

ON the 10th June, 1886, New-Zealanders were startled from their quiet lives by a volcanic eruption, the sounds of which reached from three to four hundred miles north and south from the seat of the outburst, while the ashes fell over an area variously estimated at from four thousand to six thousand square miles. The greatest depth of the matter ejected, measured at the lip of the great vent, was 170 ft., the top of the range being increased by this amount. It has been estimated that from two-fifths to one cubic mile of material was thrown out. The eruption took place along a flat-topped range, 3,600 ft. altitude, composed of rhyolitic lava-flows, known as Tarawera Mountains, and comprising the peaks Wahanga (northernmost), Ruawahia, and Tarawera (southernmost). This range is situated on the eastern side of Lake Tarawera, in the thermal district of the North Island, where are situated Lakes Rotorua and Taupo, well known as tourist resorts.

A gigantic rent opened along the axis of the range, running roughly north-east and south-west, commencing at the north end and extending to Tarawera, thence in a line more westerly to Lake Rotomahana, the waters of which are thought to have caused further explosions. This rent finally ended at Lake Okaro in the south, taking but three or four hours to form. Along this immense chasm in the earth, nearly nine miles long, 900 ft. deep at its greatest and 300 ft. at its least depth, and a mile and a half to an eighth of a mile wide, were no fewer than seventeen points of eruption. The fissure is not continuous, but is bridged in several places by the original surface remaining in position. This titanic feature of the North Island thermal district is at the highest points certainly the most impressive of the sights, and probably the least visited by tourists.

The north-western face of the Tarawera Range at present rises from the shores of Lake Tarawera (which is 1,032 ft. above sea-level) to a height of 2,738 ft. above it, the summit of the range being 3,770 ft. above the sea. S. Percy Smith (2, 4, and 23), who had the advantage of thoroughly exploring the mountain both before and after the eruption, describes the contour of the mountain as being unlike any other in the district, with the plateau-like summit sloping down to, say, 400 ft., the steep "mural crown" below descending for, say, another 400 ft.; the sharply inclined talus at an angle of 30° extending 1,000 ft. below the rock-faces forming the "mural crown"; and the beautifully easy slopes, lowest of all, grading down to the lake-margin as a pumice beach or ending in low cliffs at the water's edge. This is a fair average of the aspect it presents on every side, except towards the east, where a range of less elevation joins it and spoils its symmetry. The forests which once clothed the slopes of this mountain, according to the above authority, were of considerable extent, especially over the south-eastern flanks—that is, on the opposite side of the range to those described in this paper. The eruption has utterly destroyed these forests. Instances of a totara (*Podocarpus totara*) and rimu (*Dacrydium cupressinum*) standing on the edge of the chasm are given (2, p. 52).

A. P. W. Thomas (11) has written perhaps the most comprehensive report of the eruption, although he had not the advantage of having visited the

mountain prior to that event. He states that forests composed of large trees grew upon the sides of the Tarawera Mountain, and these, of course, were wholly wrecked by the eruption. Those on the site of the chasm disappeared altogether. Fortunately, T. Kirk had ascended the mountain in 1872, and his published papers (1 and 27) make it plain that where favourable to plant-life the surface of the mountain was clothed with vegetation, though on the highest parts it was scanty and stunted. A dwarf shrubby vegetation was found on the very summit of Tarawera, in sheltered places affording cover for a luxuriant growth of mosses and lichens, in which the orchids *Caladenia bifolia*, *Thelymitra longifolia*, and *Orthoceras Solandri* occurred. Elsewhere on the summit were *Metrosideros hypericifolia*, *Corokia buddleoides*, *Coprosma lucida*, *Olearia furfuracea*, *Raoulia tenuicaulis*, *Dracophyllum strictum*, *D. Urvilleanum*, *Polypodium serpens*, *Tmesipteris tannensis*; while near the summit were noticed *Lycopodium volubile* (2,800 ft.), *Astelia trinervia* (3,300 ft.), *Cyathodes empetrifolia*, and *Gaultheria oppositifolia* (3,200 ft.).

On the margins of Tarawera Lake Kirk noticed abundant trees of *Metrosideros tomentosa* of large size, and also *Astelia Cunninghamii*, *Scirpus maritimus*, *Ranunculus acaulis*, and *Chenopodium glaucum* var. *ambiguum*. At the entrance to the gorge separating Ruawahia from Wahanga were observed large terrestrial specimens of *Metrosideros robusta*, and elsewhere he saw *Panax Colensoi*, the most prominent shrub, forming handsome dwarf bushes sheltering *Hymenophyllum bivalve*, *H. multifidum*, and other ferns; *Danthonia* sp., *Deyeuxia quadriseta*, and *Pittosporum tenuifolium* were also observed. He states that the total number of species collected above 3,000 ft did not exceed seventy, and considered that the vegetation of the mountain comprised a remarkably limited number of species.*

It would be too much to assume that all vegetation was entirely killed out at the base of the mountain by the eruption of 1886. The dead stumps of large *Metrosideros tomentosa* trees may still be found standing at the lakeside, and many species of the family *Myrtaceae* are so tenacious of life that stumps with several feet of mud or scoria round them might have sprouted and produced seed. Moreover, seed might have become uncovered by the rain cutting gulches in the soft mud and sand, and have found the absence of competition from other plants a factor favourable to growth.

Thus, on account of the volcanic origin of Tarawera Mountain and the isolated position of the north-west face, the foot of which, save for one narrow isthmus, is washed by the waters of Lakes Rotomahana and Tarawera, and on account of the eruption of 1886, this area presents peculiar facility for the study of the spread of species on new ground, since only an infinitesimal fraction of the plants could have survived the 1886 eruption.†

THE NORTH-WEST FACE.

In the spring of 1913 the author twice visited Tarawera, on the first occasion (14th September) ascending to the summit of the range by the

* Kirk instances other sea-littoral plants, such as *Convolvulus Soldanella*, *Juncus maritimus* var. *australensis*, *Leptocarpus simplex*, *Carex pumila*, *Zoysia pungens*, and *Bromus arenarius*, which are found in this thermal district, as supporting the theory of the submarine origin of the lowlands of the central portion of the North Island; but when one considers that wild water-fowl, such as shags, black swans, and wild duck, travel frequently between coast and lakes, and that shags nest in the *Metrosideros tomentosa* trees on the coast, a simpler explanation of the presence of these sea-littoral plants in fresh-water littoral situations far inland becomes apparent.

† A lithographed reproduction of a photo of Tarawera seen from the south-west before the eruption, in A. P. W. Thomas's report (*loc. cit.*), shows dense forest to about one-third of the height above Lake Tarawera.

broad valley shown in Plate XIX, fig. 1, lying to the north of the landing for Rotomahana Lake, and on the second visit landing on Kuaehape Beach, and, after examining the *Metrosideros* forest, proceeding to a point about 1,700 ft. above sea immediately above the beach.

In the midsummer of 1915-16 the author again twice visited Tarawera, on the first occasion ascending the range by the route taken in 1913, traversing the summits of Tarawera and Ruawahia, and returning from the sand crater by the scoria slope separating Ruawahia from Wahanga, and on the second occasion visiting the area called for convenience the northern face, which is separated from the area called the north-west face by a comparatively unbroken scoria slope which was traversed on the previous visit, descending from the sand crater to the lake *

At Kuaehape Beach within a chain of the lake there are two beach-levels, the lower consisting of white pumice, barren of plant-life, but mixed with driftwood, and the upper beach, a few feet higher, composed of red pumice and sand with patches of *Raoulia australis* dotted about, while growing at the edge of the beach are bushes of *Veronica salicifolia* var and *Cornaria ruscifolia*. Scattered about are young plants of a naturalized *Erigeron*. Shrubs of *Myrsine Urvilleri*, *Cyathodes acerosa*, and *Muehlenbeckia complexa* are near at hand, and the herb *Hydrocotyle asiatica* also occurs. A little to the right of the beach are lava cliffs about 250 ft high, which are covered with a growth of young *Metrosideros tomentosa* forest, fringed at its margin with *Cornaria ruscifolia* and *Veronica salicifolia* var., and containing also the following: *Knighia excelsa*, *Coprosma lucida*, *Leptospermum ericoides*, *Panax arboreum*, *Pittosporum tenuifolium*, *P. Colensoi*, *Geniostoma ligustrifolium*, *Leucopogon fasciculatum*, *Gaultheria antipoda* var., *Cyathodes acerosa*, *Halorrhagis erecta*, *Poa anceps*. Where the forest reaches the shore there are many dead stumps of *Metrosideros tomentosa* which had been killed by the eruption. Plate XX, fig. 2, gives a very good idea of the vigorous young growth on the lake-side.

In the broad valleys of the lower slopes, where the soil is better, the dominant plant is *Cornaria ruscifolia*, forming pure shrubberies, 15 ft to 20 ft. high, the plants having numerous trunks, 6 in to 8 in in diameter, springing from the ground. On the gravels of temporary watercourses patches of *Raoulia australis* are attempting to form a covering. In the more exposed situations, where the soil is poorer and not so moist and the altitude greater, the *Cornaria* is replaced wholly or in part by *Leptospermum scoparium* (see Plate XXI, fig 1).

Ascending a deep gully above Kuaehape Beach, where surface waters had cut the beds of ash into a vertical-walled ravine, the following were noticed between lake-level (1,040 ft) and 1,500 ft above sea-level. Shrubs or young trees—*Metrosideros tomentosa*, *Weinmannia racemosa*, *Pittosporum tenuifolium*, *Leptospermum scoparium*, *Veronica salicifolia* var, *Olearia furfuracea*, *Fuchsia excorticata*, *Meliccytus ramiflorus*, *Grisebina littoralis*, *Leucopogon fasciculatus*, *L. Fraseri*, *Gaultheria oppositifolia* (in large masses 6 ft. across on the walls of the gorge), *Pimelea laevigata*, *Solanum anculare*, *Coprosma robusta*, *Meliccytus ramiflorus*, *Muehlenbeckia axillaris*; lianes—*Rubus australis*, *Muehlenbeckia australis*; herbs—*Anagallis arvensis* (naturalized), *Epilobium rotundifolium*, *Dianella intermedia*, *Gahnia pauciflora*, *Cladium Vauthneri*, *Acena Sanguisorbae* var, ferns—*Pteris esculenta*, *P.*

* The author is much indebted to Judge Brown, Mr Tai Mitchell (Government Surveyor), and Mr. L. D. Foster for their company and assistance in one or more of these journeys, and to Mr Warbrick (in charge of the tourist traffic on the lake) for assistance in landing at different points.



[B. C. Aston, photo.]

FIG. 1.—Valley of ascent to summit, looking west. Foreground, scoria slopes; middle distance, scattered *Coriaria* bushes; background, almost pure *Coriaria* association on mud-covered hills deeply furrowed by surface waters; distance, Lake Tarawera.



[G. D. Valentine, photo.]

FIG. 2.—Tarawera Mountain, looking north-east, from site of Te Ariki Village (destroyed), showing Green Lake crater and mud-covered hills. Taken shortly after the eruption.



[B. C. Aston, photo.

FIG. 1.—Looking south-east across deepest part of Tarawera chasm, showing on opposite wall the lavas which compose the scoria slopes—the lighter, rhyolitic; the darker, andesitic.



[B. C. Aston, photo.

FIG. 2.—Taken from boat on Lake Tarawera, looking south-east, near Kauchape Beach. Fringing lake are dead stumps of *Metrosideros tomentosa*. On the beach is a fringing shrubbery of *Coriaria* bushes merging into a tangled mass of shrubs and lianes. Higher is young forest of *Metrosideros tomentosa* and *Knightia excelsa* of conical habit.



[B. C. Aston, photo.]

FIG. 1.—At 1,700 ft. above sea, looking south-east. Foreground of light and dark scoria, dotted with patches of *Pimelea laevigata* near walking-stick stuck in ground. Scattered shrubbery of *Leptospermum ericoides*, *Coriaria ruscifolia*, and *Veronica salicifolia* var. extending up the easy scoria slopes to the steeply inclined unstable slopes below the “mural crown” of stable lavas. On the highest point of Tarawera may be seen a cap of red scoria. In the distance is the gully separating the range into Ruawahia (left) and Tarawera proper (right).



[B. C. Aston, photo.]

FIG. 2.—At 1,500 ft. above sea, the broad valley separating the portion called “north-west face” from that called “northern face,” and more northerly to the view in fig. 1 above. Foreground, *Muchlenbeckia axillaris* and *Pimelea* patches with *Leptospermum scoparium* var. growing out of them, and scattered plants of *Oenothera*; middle distance, scattered *Coriaria* and *Leptospermum* bushes, with background on either side of forest showing dead stumps of *Metrosideros robusta*; distance, unstable slopes of steeply inclined scoria becoming stabilized by *Raoulia* and other patch-plants. On the extreme left of the picture, skirting the young forest, is the track to the sand crater.



[B. C. Aston, photo.

FIG. 1.—Taken near view shown in Plate XXI, fig. 2. Foreground, white and black scoria mixed. Slopes becoming stable by growth of *Raoulia* patches and *Coriaria* association developing, showing individuals growing from *Raoulia* patches.



[B. C. Aston, photo.

FIG. 2.—At 1,700 ft. above sea, looking north. Young forest on northern face, showing dead stumps of trees killed by the eruption.

tremula, *Lomaria capensis*, *Asplenium flaccidum*, *A. adiantoides*, *A. lucidum*, *Polypodium Billardieri*, *P. pennigerum*, *P. serpens*, *Hemitelia Smithii*, *Cyathea dealbata*, *Pellaea rotundifolia*.

Now succeed scoria flats which support a sparse growth, 2 ft. to 6 ft. high, of *Coriaria ruscifolia*, *Pteris esculenta*, *Veronica salicifolia* var., *Olearia furfuracea*, *Coprosma robusta*, *Weinmannia racemosa*, *Leptospermum scoparium*, while *Pimelea laevigata* in patches a foot or more in diameter are closely appressed to the pumice-gravel.

Finally, at 1,550 ft., open stony slopes are reached where the rise is so gentle as to be hardly perceptible. Here the growth of shrubs is still scantier. The *Pteris* disappears, and the vegetation is *Leptospermum ericoides*, *Coriaria ruscifolia*, *Veronica salicifolia* var., *Pimelea* patches, and numerous young plants of the naturalized *Oenothera odorata*, evidently seedlings from last year's old plants. From this point to the "mural crown," which can be seen in Plate XXI, fig. 1, the vegetation was not inspected, the journey to the summit being made by a more southerly route, where, by avoiding the "mural crown," and by travelling for a while on the edge of the crater, the top of the range is more easily approached (see Plate XIX, fig. 2). On this route, in addition to many of the species already mentioned, the following were seen up to 1,800 ft.: Shrub—*Aristolelia racemosa*; giant reed—*Arundo conspicua*; herbs—*Epilobium nummularifolium*, *Raoulia australis*, *Gnaphalium luteo-album*, *Wahlenbergia gracilis*, *Thelymitra* sp., *Danthonia semiannularis* var., *Raoulia glabra*, *Carex* sp., *Erechtites scaberula*, and naturalized plants of *Hypochoeris radicata*, *Sonchus oleraceus*, *Trifolium repens*, *T. pratense*; ferns—*Pteris esculenta*.

At 1,800 ft. there were noted a few stunted shrubs of *Weinmannia racemosa*, *Gaultheria oppositifolia*, *G. antipoda*, *Leucopogon fasciculatus*, *L. Fraseri*, *Dracophyllum subulatum*, *Muehlenbeckia axillaris*, *Cyathodes empetrifolia*, *Metrosideros robusta*, *Griselinia littoralis*, *Dodonaea viscosa*, and *Lycopodium densum*; the herbs *Raoulia australis* and *Drosera auriculata*; and the ferns *Lomaria penna marina*, *L. capense*, *Polypodium Billardieri*.

On compacted scoria slopes at 3,000 ft. patches of *Raoulia tenuicaulis* (in flower), *R. australis*, *Danthonia semiannularis* var., and *Hypochoeris* seedlings were the higher plants, while occasionally in a damper cavity than usual a fern would be found, and patches of moss.

On the summit of the range there is a cap of red scoria, on which the only growth at present is patches of silvery *Raoulia australis*.

On account of the Tarawera Mountain-range having been built up by successive outflows of lava, ashes, and mud, and also on account of its isolated position, its flora might be expected to show species which are specially adapted to spreading easily by means of wind and water and birds; and this we find to be the case. Practically the whole of the plants found on the mountain are those the seed of which is thus spread. The species having succulent edible fruits—e.g., *Coriaria*—and therefore which are spread by means of birds, in the number of individuals hold first place on the lower slopes, while those which have light seeds, or seeds furnished with special structures enabling them to float in the wind, and capable of travelling long distances in the air, are a good second, and on the higher slopes are dominant—e.g., *Raoulia* and *Leptospermum*. And this is true of the plants observed by Kirk in 1872, before the eruption in 1886, as well as of those recorded by me in 1913, twenty-seven years afterwards.

The following are the principal forest-trees of the Rotorua district, which should, of course, be growing on the lower western slopes of Tarawera;

but those which are not probably lack a means of transport for their heavy seeds:—

Beilschmiedia tawa Benth. & Hook. f. This tree constitutes 75 per cent. of the millable timber in some parts of the Rotorua district. The berry is 1 in. long, and solitary-seeded. Its distribution is effected probably entirely by rare large birds (pigeons and kaka parrots)

Kirk records the following as "chief trees of Ngongotaha (a forest-clad mountain, 2,554 ft., seven miles west of Rotorua) and the adjacent hills" (1, p 327).—

Dacrydium cupressinum Sol. Nut ovoid, about $\frac{1}{2}$ in. long

Metrosideros robusta A. Cunn.

Beilschmiedia tawa Benth. & Hook. f

Knightria excelsa R. Br. Pubescent folicles $1\frac{1}{2}$ in. long, tapering into the persistent style, ultimately splitting into two boat-shaped valves containing 3 or 4 winged seeds.

Litsaea calcaris Benth. & Hook. f Solitary-seeded berry, $\frac{3}{4}$ in. long.

Laurelia novae-zelandiae A. Cunn. Achenes hairy, narrowed into long plumose styles. (This tree is common in the forests on the west side of Lake Tarawera)

Abundant in the forest at the north end of Lake Rotorua, according to Kirk, are the following trees:—

Elaeocarpus dentatus Vahl. Drupe about $\frac{1}{2}$ in. long, oblong, ovoid, stone rugose, 1-celled, 1-seeded.

Metrosideros robusta A. Cunn. Capsule coriaceous, 3-celled, 3-valved, or irregularly dehiscent, seeds densely packed, numerous, linear

Podocarpus spicatus R. Br Drupe $\frac{1}{3}$ in. in diameter

Podocarpus ferrugineus D. Don Drupe $\frac{3}{4}$ in. long.

Knightria excelsa R. Br.

Litsaea calcaris Benth. & Hook.

Much less frequent, he says, are—

Wernmannia racemosa Linn. f. Capsule $\frac{1}{2}$ in. long, 2- to 3-valved, seeds hairy, minute, and numerous.

Fusanus Cunninghamii Benth. & Hook. f. Drupe $\frac{1}{3}$ — $\frac{1}{2}$ in long.

Ixerba brexioides A. Cunn. Capsule $\frac{3}{4}$ in. diameter; seeds large, oblong, compressed.

Carmichaelia sp., probably *C. juncea* Col. Common in many parts of the Rotorua district Leguminous seeds.

In addition to those given by Kirk might be mentioned from my own observations—

Persoonia toru A. Cunn. Common on Karamea (Rainbow Mountain).

Drupe $\frac{1}{2}$ — $\frac{1}{3}$ in. long; 1- or 2-celled, with single seed in each cell

The forest near Te Wairoa, the Maori village buried at the time of the eruption, now contains—

Laurelia novae-zelandiae A. Cunn. This species, which exhibits a decided preference for swampy land, may require soil-conditions which do not occur on Tarawera.

At the Te Ngae forest, about ten miles farther away, I noticed—

Podocarpus dacrydioides A. Rich. Fruit a black ovoid nut, about $\frac{1}{6}$ in long, seated on a red fleshy receptacle

- Carpodetus serratus* Forst. Fruit globose, size of small pea, almost fleshy, indehiscent 3-5-celled, seeds numerous, pendulous.
Clematis indivisa Willd. Achenes with a plumose tail often more than 2 in. long.

List of Species found on Tarawera Mountain, North-western Face, in September, 1913, and the Summer of 1915-16.

[A letter "B" prefixed to the name of the species denotes the probability of its being spread by birds, and "W" by wind. "?" before a name denotes that the method of disposal is doubtful, but possibly wild animals (rabbits or hares), or floated across by water, or carried by water-fowl.]

- B. *Meliccytus ramiflorus* Forst. Small berry, $\frac{1}{5}$ in.
 B. *Pittosporum tenuifolium* Banks & Sol. Capsule woody and seeds sticky.
 B. — *Colensoi* Hook. f. Capsule woody and seeds sticky.
 B. *Aristolochia racemosa* Hook. f. Berry size of a pea.
 W. *Dodonaea viscosa* Jacq. Above 1,400 ft. Membranous compressed capsule, very broadly 2-3-winged; wings membranous.
 B. *Coriaria ruscofolia* Linn. Above 1,400 ft. Crustaceous achenes invested by juicy petals.
 B. *Rubus australis* Forst. Many succulent 1-seeded drupes crowded upon a dry receptacle.
 ? *Acaena Sanguisorbæ* Vahl. var. Achenes attached to fruiting calyx provided with 4-barbed bristles.
 ? *Wenmannia racemosa* Linn. f. Above 1,400 ft. Capsule containing small hairy seeds.
 W. *Drosera auriculata* Backh. Above 1,400 ft. Seeds minute.
 W. *Halorrhagis erecta* Schindl. Seed small, dry, 2-4-seeded, nut $\frac{1}{10}$ in. long with 4 ribs dilated into wings.
 B. *Gunnera monoica* Raoul. Small fleshy drupe.
 W. *Leptospermum scoparium* Forst. Above 1,400 ft. Woody or coriaceous capsule, containing numerous linear seeds.
 W. — *ericoides* A. Rich. Above 1,400 ft. Linear seeds.
 W. *Metrosideros florida* Smith. Above 1,400 ft. } Coriaceous or woody capsule; seeds numerous,
 W. — *robusta* A. Cunn. Above 1,400 ft. } linear.
 W. — *tomentosa* A. Rich. }
 W. *Epilobium punceum* Sol. }
 W. — *rotundifolium* Forst. } Capsule 4-angled, seeds numerous, furnished with a tuft of long hair at the summit.
 W. — *pubens* A. Rich. }
 W. — *nummularifolium* R. Cunn. }
 W. — *melanocarilon* Hook. }
 W. — *microphyllum* A. Rich. }
 W. — *glabellum* Forst. }
 B. *Fuchsia excorticata* Linn. f. Fleshy, many-seeded berry.
 ? *Hydrocotyle asiatica* Linn. 2 dry, indehiscent, cohering carpels.
 B. *Panax arboreum* Forst. 2-4-celled succulent exocarp.
 B. *Griselinia littoralis* Raoul. Above 1,400 ft. Small 1-seeded berry.
 B. *Coprosma lucida*, Forst. 2-seeded fleshy drupe.
 B. — *robusta* Raoul. Above 1,400 ft. 2-seeded fleshy drupe.
 W. *Celmisia longifolia* Cass. var. Composite linear achene.
 W. *Olearia furfuracea* Hook. f. Above 1,400 ft. Composite; achenes small with pappus hairs.
 W. *Gnaphalium japonicum* Thunb. } Achene minutely papillose.
 W. — *luteo-album* Linn. }

- W. *Vittadinia australis* A. Rich. Linear pubescent achene; pappus copious.
 W. *Raoulia australis* Hook. f. var. *lutescens* T. Kirk. Achenes with numerous extremely slender pappus hairs.
 W. — *tenuicarpus* Hook. f. Above 1,400 ft. Achenes with copious pappus hairs.
 W. — *glabra* Hook. f. Puberulous achenes.
 W. *Erechtites scaberula* Hook. f. Achenes with many series of copious soft slender pappus hairs.
 W. *Senecio latus* Forst. Achenes linear, pappus copious.
 W. *Sonchus oleraceus* Linn. Achenes with many series of copious soft slender pappus hairs
 ? *Wahlenbergia gracilis* A. DC. Capsules 2-5-celled; seeds numerous, small, compressed.
 B. *Gaultheria antipoda* Forst. var. Above 1,400 ft Capsule included in large and succulent calyx and lobes, seeds minute.
 W. — *oppositifolia* Hook f Above 1,400 ft Capsule dry; seeds minute.
 B. *Cyathodes acerosa* R. Br. A baccate succulent drupe.
 B. — *empetrifolia* Hook f Above 1,400 ft 3-5-celled small drupe.
 B. *Leucopogon fasciculatus* A. Rich. Above 1,400 ft. Small baccate drupe.
 B. — *Fraseri* A Cunn Above 1,400 ft. Small baccate drupe
 W. *Dracophyllum subulatum* Hook f Above 1,400 ft. 5-celled capsule with numerous seeds. Rare.
 B. *Myrsine Urviller* A DC Fruit small, globose, drupaceous, dry or fleshy
 ? *Geniostoma ligustrifolium* A Cunn. Capsule splitting into 2 boat-shaped valves; seeds numerous
 B. *Solanum aviculare* Forst. Large many-seeded berry.
 W. *Veronica salicifolia* Forst var Above 1,400 ft. Capsule.
 B. *Muehlenbeckia australis* Meissn. }
 B. — *complexa* Meissn. } Small nut enclosed in a succulent
 B. — *axillaris* Walp Above 1,400 ft. } perianth
 ? *Knightsia excelsa* R Br Coriaceous 1-celled, 4-seeded follicles, 1½ in. long, tapering into a persistent style, ultimately splitting into 2 boat-shaped valves; seeds winged at the top.
 B. *Pimelea laevigata* Gaertn Above 1,400 ft Fruit usually baccate.
 W. *Thelymitra longifolia* Forst Orchid; seeds very minute.
 W. *Microtis porrifolia* R. Br Orchid; seeds very minute.
 B. *Dianella intermedia* Endl. Berry.
 ? *Juncus* sp Capsule, small-seeded
 ? *Typha angustifolia* Linn. var. Aquatic.
 ? *Gahnia pauciflora* T Kirk Hard and bony nut
 ? — *Gaudichaudiana* Steud Above 1,400 ft. Nut small.
 ? *Carex* sp. Nut
 W. *Deyeuxia filiformis* Petrie Caryopsis
 W. *Danthonia semannularis* R. Br. var. Above 1,400 ft. Caryopsis.
 W. *Dichelachne crinita* Caryopsis
 W. *Arundo conspicua* Forst Caryopsis.
 W. *Poa anceps* Forst Caryopsis
 W. *Cyathea dealbata* Swartz Spores.
 W. *Hemitelia Smithii* Hook Spores.
 W. *Pellaea rotundifolia* Hook Spores.
 W. *Pteris aquilina* Linn. var. *esculenta*. Above 1,400 ft. Spores.
 W. — *tremula* R. Br. Spores

- W. *Lomaria lanceolata* Spreng. Above 1,400 ft. Spores.
 W. — *penna marina* Trev. Above 1,400 ft. Spores.
 W. — *capensis* Willd. Above 1,400 ft. Spores.
 W. *Asplenium adiantoides* C. Chr. Spores.
 W. — *lucidum* Forst. Spores.
 W. — *flaccidum* Forst. Spores.
 W. *Polypodium pennigerum* Forst. Spores.
 W. — *serpens* Forst. Spores.
 W. — *Billardieri* R. Br. Spores.

Naturalized Plants.

- ? *Trifolium repens* Linn. Possibly introduced by rabbits, hares, horses,
 or pigs.
 W. *Erigeron canadensis* Linn.
 W. *Hypochaeris radicata* Linn.
 W. *Anagallis arvensis* Linn.
 W. *Oenothera odorata* Jacq.
 ? *Erythraea Centaurium* Pers.
 ? *Rumex Acetosella* Linn.

If the above list be analysed it will be seen that of ninety-one species observed on the isolated north-western face, twenty-four (or 26 per cent.) may be called bird-distributed, fifty-three (or 58 per cent.) wind-distributed, and only fourteen (or 15 per cent.) are difficult to account for.

The absence of certain species may be noted. Perhaps, of forest-trees, the absence of all species of *Nothofagus* would be dismissed lightly, as few patches of *Nothofagus* forest are known in the Rotorua area; but on looking more carefully into the matter it is certainly singular that the highest mountain in that neighbourhood should not have been peopled by *Nothofagus*, were it not that its seeds are not obviously spread by birds or wind. Indeed, a knowledge of how *Nothofagus* seed is distributed may perhaps help to solve many points in the distribution of the genus at present a puzzle to ecologists. The genus occurs at Waimarino and on the volcanic mountain Ruapehu (four species), on the lower slopes of the Kaimanawa Mountains (three species), on Mount Hikurangi, on Te Aroha Mountain (volcanic), in the Mangorewa and Omanawa Gorges, and on the Matai Road near Te Puke.

Buchanan (29) in 1866 noted that the forest on Mount Egmont (an isolated volcanic mountain more distant from any *Nothofagus* forest on non-volcanic mountains than as Ruapehu, Tarawera, or Ngongotaha, and rising from sea-level to 8,200 ft) is chiefly peculiar through the absence of *Nothofagus*, and his observations, which related to a limited portion of the mountain, have been confirmed for the remainder of the area by subsequent observers.* On the other hand, Ruapehu (9,175 ft.) and Te Aroha (3,126 ft.) are not many miles distant in an air-line from *Nothofagus*-clad geologically ancient mountains, and therefore, judging from analogy, *Nothofagus* should some day appear on Tarawera.

Dracophyllum is a genus which occurs very sparingly on this portion of Tarawera, and *Ixerba*, *Dacrydium*, *Podocarpus*, *Melicope*, *Carmichaelia*, *Carpodetus*, *Phyllocladus*, *Fusanus*, and *Parsonsia*, all plentiful in the

*The author ascended Mount Egmont to the summit by the Inglewood track on the 14th February, 1901, and again on the 20th March, 1910.

Rotorua district, have not been observed on any portion of the north-west or northern faces. They are large-seeded plants, although some have fleshy fruits, and are no doubt distributed by large birds. One of the two naturalized rosaceous species may possibly have been spread by wild horses, which are said to fatten on the fruits.

THE NORTHERN FACE.

From the sand-crater which separates the northernmost peak (Wahanga) from the middle peak (Ruawahia) after a few hundred feet of steep scoria descends a beautifully easy slope of scoria down to the lake-edge. This slope is comparatively bare of continuous scrub growth until near the 40 ft. terrace above the lake, when a shrubbery of *Leptospermum*, &c., is encountered. This slope, where it descends without a break, forms a natural boundary separating what may be called the north-western area from the northern area. The area north of this boundary has been visited on two occasions. Numerous dry vertically walled ravines about 40 ft. deep run roughly parallel to each other, making progress across country slow. Landing near the eucalypts at the north end of the lake, several aquatic and semi-aquatic plants were noticed. In small stagnant pools was the submerged *Nitella* (two species), *Potamogeton Cheesemanni*, and *Myriophyllum* sp., while on the margins were *Glossostigma elatimoides* (with pinkish flowers) and *Typha angustifolia* var.

Progress on to the 40 ft. terrace (the lake rose 40 ft. at the time of the eruption and afterwards subsided, this may be the beach formed at that time) was made easy by the tracks of wild horses. Several naturalized plants were noticed—e.g., *Rumex crispus*, *Oenothera* (in beautiful yellow flower), *Anagallis arvensis*, *Rumex Acetosella*, *Carduus pycnocephalus*, *Sonchus arvensis*, *Erigeron canadensis*, *Verbascum Blattaria*, *Bartsia viscosa*, and, what is lamentable, *Rosa rubiginosa* and *Rubus fruticosus*. There is no doubt if these latter two get thoroughly established on the mountain they will be a fearful curse in days to come. The *Oenothera* seems to be able to thrive on the bare scoria without the aid of any humus, and is rapidly travelling up the mountain. A most interesting fact is that the great *Coriaria* association is here dying out. The tree form of *Coriaria ruscifolia*, 15 ft. high, with many large trunks springing from one root, as described above, are now dead. This accords with an observation of Mr C. Way, of the Warroa accommodation-house, that, although the *Coriaria* is the first shrub to take possession of volcanic ejectamenta, it is comparatively short-lived. Here, where it is obviously dying out from old age, it is giving place to vigorous thickets of *Aristotelia racemosa* and *Fuchsia excorticata*. *Aristotelia* is entirely dominant in places, and is 20–25 ft high, but associated with it are *Solanum aviculare*, *Melicytus ramiflorus*, *Cyathodes acerosa*, *Muehlenbeckia complexa*, *Asplenium flaccidum*, and *A. adiantoides*. Some 50–60 ft above the lake the open scoria slope is reached, which leads to the sand-crater arete of Tarawera. Here a most remarkable change is going on, which is unfolded to one as the gradual ascent is made. The gentle slope is covered in places with uneven patches of *Raoulia australis* and *R. glabra*. These are the dominant patch plants. Others are *Pimelea laevigata*, *Muehlenbeckia axillaris*, and even *Leucopogon Fraseri*. *Olearia furfuracea*, the dominant composite shrub of the mountain, in full flower is a fine sight. Occasionally, where the water-supply is favourable, lichens and moss may perform their usual function of transforming the barren rock into fertile soil, but the *Raoulia* must be accounted the great humus-maker of this mountain.

As it languishes in vigour, owing to age, from it grow other plants, the chief woody ones being *Coriaria* and *Leptospermum*, and sometimes *Pittosporum*, but also herbaceous plants such as *Trifolium* and *Rumex Acetosella*. Four stages may thus be predicted for the re-peopling of the plant-covering of this open area (excluding the ravines, which are able to jump the first and possibly the second stages): First, the patch plants; secondly, the *Coriaria*; thirdly, the *Aristolelia*, with possibly *Fuchsia* and *Meliccytus*; fourthly, forest

The scoria slope is now left at about 150 ft. above the lake, where the track towards the spur is found overgrown with *Aristolelia*, *Rubus australis*, *Coprosma lucida*, *C. robusta*, *Veronica salicifolia* var., and *Coriaria*.

A densely wooded ridge on the north of the scoria slope is investigated. It consists of *Weinmannia racemosa*, which is perhaps the dominant growth, but the composition is very varied. *Knightria excelsa* stands out above all the other young growth in cylindrical or slightly conical tops. A patch of tree-ferns is noticed. Giant *Fuchsia* and *Weinmannia*, with *Meliccytus ramiflorus*, all about 30 ft. high, with a bare floor, form a subassociation of their own, supplanting the dying *Coriaria*, nearly as high. Higher on the spur, 500 ft. above the lake, the growth is more varied, being a thick mass of *Panax arboreum*, *Olearia Cunninghamii*, *Brachyglottis repanda*, *Lomaria capensis*, *Veronica salicifolia* var., young *Weinmannia*, *Gaultheria oppositifolia*, *G. antipoda* var., *Carex Gaudichaudiana*, and *Cyatodes acerosa*. At 675 ft. above the lake numerous dead stumps of *Metrosideros* occur. These may either be *M. tomentosa* or *M. robusta*, young plants of both being common in flower on the open slopes at this altitude and higher. The ravines, four or five of which were crossed diagonally in returning to the scoria slope, yielded some valuable information as to the composition of the forest before the eruption. One dead *Beilschmiedia tawa* with a broken trunk 15–20 ft. high was 3 ft. in diameter, and springing from its side was a young tree about 18 in. in diameter 4 ft. from the ground, where it forked into a tree 35–40 ft. high. Close to this was a dead giant *Litsaea calicaris* stump 4 ft. in diameter at the surface, and 9 ft. from the ground, where broken, 3 ft. in diameter; and attached to it was a young living shoot. Other dead *Litsaea* stumps showed that there had been a forest containing many of these, and young thickets of saplings showed that it was being re-established. *Meliccytus* was also found springing from old dead stumps. Only two *Beilschmiedias*, both with young live growth springing from the dead stump, were, however, seen. Other plants not hitherto met with on the mountain are *Rhipogonum scandens*, *Schefflera digitata*, *Hemitelia Smithii*, *Hedycarya arborea*, *Asplenium bulbiferum*, *Lomaria lanceolata*, *Gaultheria rupestris*, *Astelia Cunninghamii*, *Elaeocarpus dentatus*, *Cyathea dealbata*, *Lycopodium volubile*. Also present were *Fuchsia excorticata*, *Asplenium lucidum*, *Polypodium Billardieri*, *P. pennigerum*, *Myrsine Urvilleani*, *Dianella intermedia*, *Metrosideros robusta*, *Gunnera monoica*, *Vittadina australis*.

On the northern face of the mountain the following additional species were noted: *Elaeocarpus dentatus* Vahl, *Olearia Cunninghamii* Hook. f., *Gaultheria rupestris* R. Br., *Hedycarya arborea* Forst., *Beilschmiedia tawa* Benth. & Hook., *Litsaea calicaris* Benth. & Hook., *Cyathea dealbata* Swartz, *Hemitelia Smithii* Hook., *Lomaria lanceolata* Spreng., *Asplenium flabellifolium* Cav.; together with the following naturalized species—*Rubus fruticosus* Linn., *Rosa rubiginosa* Linn., *Sonchus arvensis* Linn., *Carduus pycnocephalus* Linn., *Verbascum Blattaria* Linn., *Bartsia viscosa* Linn., *Rumex crispus* Linn.

BIBLIOGRAPHY.

1. "Notes on the Flora of the Lakes District of the North Island." T. Kirk. Trans. N.Z. Inst., vol. 5, 1873, p. 322
2. "The Eruption of Tarawera." S. Percy Smith Wellington, 1886.
3. "Phenomena connected with Tarawera Eruption as observed at Gisborne." W. L. Williams. Trans. N.Z. Inst., vol. 19, 1887, p. 380
4. "Tarawera Eruption." J. A. Pond and S. Percy Smith. Trans. N.Z. Inst., vol. 19, 1887, p. 342.
5. "Tarawera Eruption as observed at Opotiki." E. P. Dumerque. Trans. N.Z. Inst., vol. 19, 1887, p. 382.
6. "Tarawera Eruption as seen from Taheke, Lake Rotoiti" W. G. Mair Trans N.Z. Inst, vol. 19, 1887, p. 372
7. "Observations on Tarawera Eruption" J Hector. Trans N.Z. Inst., vol. 19, 1887, p. 461.
8. "Tarawera Eruption Criticism of Explanations of its Causes." J Hardcastle. Trans N.Z. Inst, vol. 20, 1888, p 277.
9. "The Geology of New Zealand." James Park. 1910, p. 166.
10. "Geology of New Zealand" P. Marshall. 1912, p 106.
11. "Report on the Eruption of Tarawera and Rotomahana" A. P. W Thomas. Wellington, 1888.
12. "The Great Tarawera Volcanic Rift, New Zealand" J. M Bell. Geog Journ, vol 27, 1906, p. 369.
13. "A Visit to Mount Tarawera" H. M. Cadall. Scott. Geog Mag., xiii, 1897, p. 246
14. "A Visit to the New Zealand Volcanic Zone." Trans. Edin Geol. Soc., v, 1897, p 183.
15. "The Recent Volcanic Eruption in New Zealand." A Geikie. *Nature*, vol. 34, 1886, p 320
16. "Preliminary Report on the Recent Volcanic Eruptions, with Appendix" W Skey, Wellington, 1886; also, *Nature*, vol. 34, 1886, p. 389.
17. "On the Recent Volcanic Eruptions at Tarawera: Prehminary Report." J. Hector 1886-87
18. "The Volcanic Eruption in New Zealand." H S Johnston-Lavis. Geol Mag, 1886, iii, p 523
19. "Volcanic Ash from New Zealand." J. Joly. *Nature*, vol. 34, 1886, p 595 Note J. W Judd, Brit. Assn., 1886, p 644
20. "The Volcanic Eruption in New Zealand." J. H Kerry-Nicholls. Journ. Soc. Arts, 1887, p 174.
21. "The Volcanic Eruption of Tarawera." T. W Leys Auckland, 1886.
22. "History of Volcanic Action in New Zealand." P. Marshall. Trans. N.Z. Inst., vol. 39, 1907, p 542.
23. "On the Tarawera Eruption and After" James Park, Geog. Journ., vol 35, 1910, S Percy Smith, Proc Roy. Geog. Soc Lond, 1886, p. 783.
24. "Tarawera" *Nature*, vol. 34, pp 275 and 301.
25. "Volcanic Eruption in New Zealand." Amer. Journ. (iii), vol. 22, 1886, p 162.
26. "Volcanic Eruption in New Zealand." Proc. Roy. Geog. Soc. (n.s.), 8, 1886, p 783.
27. "Official Report on the Flora of the Lake District." T Kirk. *New Zealand Gazette*, No 43, 4th September, 1872
28. "New Zealand Plants and their Story" L Cockayne, 1910 p 54
29. "Botanical Notes on the Kaikoura Mountains and Mount Egmont." John Buchanan N.Z Geological Survey Report, 1866-67.