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NEW ZEALAND.

DEPARTMENT OF LANDS:

REPORT ON A BOTANICAL SURVEY OF THE WAIPOUA KAURI FOREST.

By L. COCKAYNE, Ph.D.

Presented to both Houses of the General Assembly by Command of His Excellency.

Sir,— Department of Lands, Wellington, 23rd June, 1908.

I have the honour to submit herewith Report on a Botanical Survey of the Waipoua Kauri Forest (reserved under "The New Zealand State Forests Act, 1885") which was carried out in 1907 by Dr. Cockayne under your instructions.

This is the first attempt that has been made to minutely describe the conditions of plant life and formation of a kauri forest, and the report is consequently of a unique and interesting nature and adds considerably to our knowledge of the indigenous vegetation of New Zealand, possessing in addition great scientific value through being the outcome of original research and the most careful investigation.

Taken in conjunction with Dr. Cockayne's previous report on Kapiti Island, and his subsequent exploration of the Tongariro National Park, the botanical history of New Zealand has received a gratifying and valuable recognition through the investigations that have been carried out by your direction.

I have, &c.,

William C. Kensington,
Under Secretary of Lands.

The Hon. Robert McNab, Minister of Lands.

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PART I.—INTRODUCTION.

A. GENERAL REMARKS.

Among the varied forest communities of New Zealand, that of the kauri stands supreme. This is in part because of the majestic character of the dominant tree, and in part from the great number of species therein to be found, together with their diverse systematic affinities and different forms. Strange to say, up till now no detailed account has been published of this formation. Indeed, it is not going too far to assert that the kauri forest, which for so many years has supported a most important industry, is less known to the majority of New-Zealanders than is any other indigenous tree-association. Moreover, this same forest, owing to the value of its timber and more still to the loss in the past through fires, now occupies an extremely limited area, daily becoming smaller, and so a plant-formation, one of the most rare, beautiful, and at the same time scientifically interesting to be met with, not only in New Zealand, but in the world at large, bids fair at no distant date to become altogether a thing of the past. It is true that by reading between the lines in the existing Floras and those botanical papers which deal with northern New Zealand some idea may be gathered as to the species composing such a forest, while in his fine work "The Forest Flora of New Zealand," and also in his "Report on Native Forests," Kirk devotes a few lines to its description. The most important account, however, is that of Hochstetter (14), but this is quite short and general. Finally, in general works dealing with New Zealand, short but not infrequently misleading accounts are given of kauri forests, as where, for instance, mention is made of the profusion of lianes passing from kauri-tree to kauri-tree (13). But so far as I know no attempt has been made to describe this formation, most characteristic of primeval northern New Zealand, so as to give some idea of its appearance as a forest; nor have any details whatsoever been published as to its ecology as a whole or that of its members.

A stay of some two months in the neighbourhood of a large area of virgin forest—the largest indeed now in existence—the Waipoua—enables me in this report to attempt in some degree to supply the above distinct want. Unfortunately my investigations were hindered by an abnormally wet season, notwithstanding which a portion of every day, at any rate, was passed within the forest, while its close proximity to my camp provided fresh botanical material in plenty. Especially was this wet weather adverse to photography, and in consequence numerous typical features of the formations have not received adequate representation.

The Waipoua Reserve is not an isolated patch. On the contrary, it forms part of a still extensive forest-mass extending to the north, east, and south-east, but which originally was of much greater extent, covering as it did a large part of northern Auckland with a mantle of trees.

The forests of New Zealand fall naturally into two categories—viz., those in which one tree is dominant, and those where there are numerous forest-trees together with a rich and varied undergrowth. Notwithstanding the term "kauri" as applied to the formation, this belongs to the second class, the mixed forest, its designation arising rather from the commercial value of the tree and its striking appearance than from its being dominant. On the contrary, it is unusual for large numbers of kauris to occur together, though in certain forests now destroyed this was more or less the case. Usually the tarairi is a much more abundant tree, and were dominance the only consideration the term "tarairi forest" would be more proper.

B. TOPOGRAPHY AND PHYSICAL FEATURES.

The Waipoua Forest is situated in the Hokianga County, some nine miles distant in a bee-line from Hokianga Harbour, and lies between the two small rivers Wairau and Waipoua, which form respectively its northerly and southerly boundaries, excepting two small portions which pass beyond them, one at the extreme south and the other on the north. The approximate area of the reserve is 23,000 acres. On the east it is distant only a few miles from the sea, certain portions being less than two miles, whilst on the west it ascends to the so-called table-land over which the Kaihu-Opanake coach-road winds, there reaching a height of almost 2,000 ft. The country occupied by the forest is hilly, and consists of long, mostly level-topped, ridges running usually in an easterly and westerly direction, broken by gullies, and having somewhat rounded sides, and their faces by no means steep. Many of the ridges are more than 1,000 ft. in altitude. Streams abound, and these, though usually of small dimensions, rise quickly, and soon become uncrossable. The Waipoua itself is a true mountain-torrent. On the south-west of the forest, where it passes behind the high ridge of which Toetoehatiko, 1735 ft., is the culminating point, it has cut for itself a gorge some hundreds of feet deep and having precipitous sides, and here the scenery is of a fine character. The Wairau Stream is in some places of a more sluggish nature and has deeper and muddier waters. Between the forest and the sea the country is still hilly and much broken, and in many places sand-covered, the land having evidently been much lower at one time.

The whole of the forest reserve is not occupied by trees and shrubs; certain of the summits of the ridges are open, as is also a small tract on the south-west. These open patches are of interest since they afford an example of another plant-formation of the North, the heath, which, botanically at any rate, is almost of equal interest to the kauri forest, and which, as it now occupies so much of the Auckland Provincial District, is of importance likewise from the agricultural standpoint.

As for the geology of the district I can say little. On McKay's map (23) it is marked as Tertiary, but a sample of rock collected near the Taheke Road is, according to Mr. Speight, B.Sc., to whom I submitted a specimen, an olivine basalt.

The soil varies considerably in different parts of the area, that of the river-flats being, of course, the richest, as it posesses not only its own humus, but the surface soil washed from the steep slopes. This richer soil is marked by the presence of certain trees, especially the puriri (*Vitex lucens*), which is altogether absent elsewhere. Generally speaking, the subsoil is a stiff clay with a

thinner or thicker coating of loam and humus. In some parts the clay is more or less orange-coloured and in others chocolate-coloured, but frequently it is much paler and almost white. The accompanying table, very kindly supplied to me by Mr. B. Aston, F.C.S., Chief Chemist, Department of Agriculture, and to whom I am much indebted, shows the chemical and physical constitution of certain soil-samples collected by me. Samples 600 and 601 were taken in the rimu forest near the Opanake–Taheke Road, the former being the top layer of humus 3¼ in. in depth and the latter the soil beneath to a depth of 2 ft. Sample 602 is a river-valley soil of the tararii association taken from beneath the humus layer to a depth of 2 ft., and sample 603 was from the kauri association near the base of Pukehurehu Hill, also taken to a depth of 2 ft.

As for the analyses, that of 600 shows a very high percentage of available potash, so much so that it appears as if the sample had been contaminated, which is hardly likely. Otherwise it is a typical humus soil, not being much decomposed, while the nitrogen-content is high. Samples 601, 602, and 603 are deficient in phosphoric acid for ordinary crops, and the amount of potash is normal.

CHEMICAL ANALYSIS.

No.	Classification.	Loss on Air Drying.	Loss at 100°C.	Loss on Ignition.	Total Nitrogen.
		Per Cent.	Per Cent.	Per Cent.	Per Cent.
600	Humus soil	67	16·16	78·17	1·770
601	Clay soil	36	10·08	22·20	0·303
602	Clay soil	32	10·16	21·50	0·273
603	Clay soil	33	11·28	21·24	0·268

No.	Available by 1 per Cent. Citric Acid.		Colour of Extract on Ignition.	Reaction of Soil to Litmus.
	Potash.	Phosphoric Acid.		
	Per Cent.	Per Cent.		
600	0·090	0·020	Greyish-brown	Acid.
601	0·013	0·005	Yellowish-brown	Acid.
602	0·027	0·004	Light-chocolate	Acid.
603	0·016	0·003	Reddish-brown	Acid.

MECHANICAL ANALYSIS.

—	Sample No. 601.	Sample No. 602.	Sample No. 603.
Residue on washing	Very small residue of well-worn rock-particles	Small residue of worn quartz and ferruginous particles	Small residue consisting of small even-sized worn quartz-particles.
Stones	Nil	Nil	Nil.
Gravel	Nil	2 per cent.	Nil.
Fine gravel	Nil	Nil	Nil.
Analysis of fine soil—			
Coarse sand	1 per cent.	7 per cent.	6 per cent.
Fine sand	23·88 "	29·09 "	16·87 "
Silt	9·07 "	7·56 "	5·78 "
Fine silt	7·24 "	4·75 "	4·53 "
Clay	50·28 "	55·01 "	58·77 "
Moisture, &c.	8·53 "	5·59 "	8·05 "
	100·00	100·00	100·00
Capacity for holding water	Very good	Very good	Very good.

C. THE NORTHERN FLORISTIC PROVINCE.

As we proceed from north to south in New Zealand certain plants occur, at first in abundance, then become fewer, and finally are quite absent, others appearing and disappearing in their turn. By collating the facts *re* the general distribution of the species it is possible to divide the New Zealand biological region into provinces, each having certain distinguishing features, both floristic and ecological. Thus I have divided New Zealand into a Northern, Central, and Southern Floristic Province (6), the first-named being by far the best-defined, containing as it does 120 species or distinct varieties of spermaphytes and pteridophytes which either do not pass beyond latitude 38° S., or overstep it only for a short distance and in limited numbers. This Northern

Floristic Province is marked by such well-known trees as the kauri (*Agathis australis*), the towai or tawhero (*Weinmannia sylvicola*), the pohutukawa (*Metrosideros tomentosa*), the tawari (*Ixerba brexioides*), the mangrove (*Avicennia officinalis*), the karo (*Pittosporum crassifolium*), the toatoa (*Phyllocladus glaucus*), the tawapou (*Sideroxylon costatum*). Also, as might be expected, most of the plant formations are peculiar likewise, such as the kauri forest, the northern heath, the mangrove formation, and the pohutukawa formation of the coast.

D. EFFECT OF MAN AND INTRODUCED ANIMALS ON THE RESERVE.

Although the Waipoua Forest is to all intents and purposes a virgin formation, man in certain places has wrought considerable changes. This has been brought about through the digging for fossil kauri-gum within the forest, and through the climbing of the kauri-trees themselves for the raw material.

The digging was altogether carried on in the neighbourhood of the kauri-trees, and so round their bases much of the undergrowth has been destroyed. At the same time gum-diggers' camps were established at a few places in the forest, and there still greater changes have been brought about. Further, well-defined bridle-tracks for the taking-out of the gum and the bringing-in of stores wind here and there to the camps, while many narrower paths lead to the groves of kauri and even to isolated trees.

The tree-climbing was carried on in the first instance in order to procure that gum which frequently collects in large masses high in the tree-tops, exuding from cracks in the bark. More recently the practice of "bleeding," as it is called, has been resorted to. This consists in making larger or smaller incisions through the bark into the sapwood, the viscous fluid pouring out and congealing finally in whitish, opaque, tallow-like masses on the bark (Photo 1). At first the trees were "bled" to only a small extent, but as the practice increased so were the wounds made larger and more numerous, until now it is no uncommon sight to see a magnificent forest giant covered with dozens of most unsightly gaps, many several inches both in depth and breadth, and some feet in length at times. That this treatment is injurious to the tree goes without saying. Leaving the loss of the sap out of the question, the openings allow the incursions of fungi inimical to the tree, and rotting wood in abundance soon shows the damage that is being done, while dead trees, alive and healthy only a few years before, testify to the rapidity of their action. How far the "bleeding" affects the value of the wood for timber purposes I am not in a position at present to state, and further investigations are required on this head, though it is possible that the timber is uninjured.

The climbing itself is a daring-enough business. The climber throws a light cord with a weight attached over a branch of the tree, which may be 60 ft. or 80 ft. from the ground, and this done, by its means he hauls over the limb the thicker rope up which he is going to climb, bringing its ends to the ground. By means of this double rope he climbs on to the bough, and, thence using the rope as need be, can pass over the whole branch-system. Finally, passing the line over a stout limb, he seats himself upon a piece of wood fixed to one part of the rope, while the other part he holds in his hands, and so can lower or raise himself in order to secure whatever gum may be on the trunk itself, which has exuded from the cuts made through the bark. Coming opposite a piece of gum, he wraps one end of the rope round his leg, anchors himself to the tree by means of a cord furnished with a hook and attached to his belt, and then, his hands free, he chips with a tomahawk the gum from off the bark and collects it in a bag he carries for the purpose (Photo 2).

Both climbing and gum-digging are now illegal in the Waipoua Forest, and no one at the present time is allowed within its precincts without having obtained special leave.

There are a few cattle, both wild and belonging to the settlers and Maoris, within the forest, and these trample down the undergrowth and feed on certain of the shrubs and young trees. However, their effect is as yet hardly noticeable, and the same may be said as to that of the wild pigs, of which a few are present.

The following are the plants principally eaten by stock, and so much are many of them relished that, according to Mr. Maxwell, the caretaker, who kindly furnished the list, cattle will thrive and fatten on these alone:—

Corynocarpus lævigata.
Schefflera digitata.
Nothopanax arboreum.
Geniostoma ligustrifolium.
Coriaria ruscifolia.
Rapanea Urvillei.
Vitex lucens.
Melicytus ramiflorus.
Coprosma robusta.
Veronica salicifolia.
Hoheria populnea.
Freycinetia Banksii.
Cyathea medullaris.
Solanum aviculare.
Pittosporum tenuifolium.
Rhapalostylis sapida.
Olea lanceolata.

Fire, too, has here and there attacked the forest on the outskirts; but, thanks to the difficulty of burning any green standing forest in New Zealand, and the almost impossibility of damaging one in such a wet climate, very trifling harm has resulted—in fact, it was stated to me by residents in the district that it would be impossible to burn the forest.

E. CLIMATE.

There are no meteorological records dealing directly with the Waipoua Forest Reserve, but fortunately a station was established a year or two ago at an altitude of about 2,000 ft. on the Tutamoe table-land. So far as the rainfall is concerned, this district has long had the reputation of being the wettest in the Auckland Province, and my own experiences fully bear this out. The rainfall, as shown in the accompanying table, will probably represent the maximum which falls over the area, the amount decreasing towards the sea, but in all probability being there still very

(1.) Kauri tree which had been "bled," with Resin dripping from the Wounds. Trunk 4 ft. in diameter.

Photo., L. Cockayne.

(2.) Gum-climber at Work on Trunk of Kauri.

Photo., L. Cockayne.

considerable. The figures of 103 in. and 146 in. for the two full years during which the record has been kept are very high, and the number of rainy days—260 and 261—are also very considerable. The smallest monthly rainfall, 5·24 in., is in February, and the highest, 15·89 in., on twenty-nine days in July. Indeed, the figures show, so far as they go, that no month is at all dry. This state of affairs must lead to cloudy skies and comparatively little sunshine, while the air at the same time will be usually highly saturated with moisture—in fact, within the forest plant-life must be exposed to the most extreme hygrophytic conditions, and that these are not more reflected by the vegetation as a whole is dependent probably upon the contour of the ground and the nature of the soil.

It is unfortunate that so few details are at present available for 1908, a year of abnormal dryness for the whole of New Zealand. At any rate, the small rainfall of January and February shows that plants even of the moistest forests are occasionally subject to conditions other than those to which they are attuned.

Although so far to the north, frost is not unknown in the lowest portions of the forest, though probably it never reaches beyond 1° or 2°. On the higher land frosts of much greater severity are said to occur, but I should think that more than 5° or 6° Fahr. will be extremely rare.

High winds are frequent, as in nearly every part of New Zealand, and these, of course, have an immense effect in counteracting the intense hygrophytic conditions brought about by a great rainfall, a large number of rainy days, and a moist atmosphere.

All the above is most scanty and to some extent mere guesswork, and infinitely better data are required before we can have any true knowledge as to the relation between the climatic factor and the kauri-forest vegetation.

Month.	1905.	1906.	1907.	1908.	Average.
January—					
Inches	...	7·13	20·71	0·49	9·44
Days of rain ...	...	16	17	8	13
February—					
Inches	...	8·06	6·84	0·81*	5·24
Days of rain ...	...	20	21	...	20
March—					
Inches	...	8·55	6·72	...	7·63
Days of rain ...	...	21	18	...	19
April—					
Inches	8·77	6·24	11·64	...	8·88
Days of rain ...	26	19	21	...	22
May—					
Inches	9·43	11·38	10·02	...	10·27
Days of rain ...	25	26	25	...	25
June—					
Inches	14·13	8·18	11·14	...	11·15
Days of rain ...	24	20	22	...	22
July—					
Inches	11·80	18·77	17·10	...	15·89
Days of rain ...	27	30	30	...	29
August—					
Inches	10·56	10·27	18·98	...	13·27
Days of rain ...	27	25	27	...	25
September—					
Inches	12·44	8·75	12·55	...	11·24
Days of rain ...	29	25	24	...	26
October—					
Inches	15·29	3·55	12·80	...	10·54
Days of rain ...	28	20	24	...	24
November—					
Inches	7·96	8·85	5·64	...	7·48
Days of rain ...	19	23	16	...	19
December—					
Inches	4·59	4·18	12·55	...	7·10
Days of rain ...	19	15	16	...	16
Totals	94·97	103·91	146·69	...	...
	224	260	261	...	...
Monthly average	10·55	8·66	12·22	...	9·91†
	24	21	21	...	22†

* Record ceased. † Average per month over whole period.

Before concluding this introduction I must express my sincere thanks for much valuable assistance to Mr. A. Hamilton, Director of the Dominion Museum. My thanks are also due to Mr. B. C. Aston, F.C.S., Chief Chemist of the Agricultural Department, who analysed certain soil samples, and to Mr. J. Maxwell, caretaker of the Waipoua Kauri Forest, who gave me much information *re* Maori names and uses of the plants.

PART II.—THE PLANT FORMATIONS.

A. INTRODUCTION.

In what follows, the forest as a whole is considered as one formation, notwithstanding that it differs much in different parts and that no one tree or collection of trees is everywhere dominant. This treatment shows certainly a much broader conception of a plant-formation than that in any of my other phytogeographical writings, and it virtually means the inclusion of all the types of New Zealand rain-forest under one head. Such an arrangement has its advantages, since in any classification of the forests of the world the rain-forests of New Zealand could be most conveniently considered as one whole. Also they can be subdivided into their minor natural divisions, and these, according to their relative importance, be classified, as is here done with associations and sub-associations. A further delimitation would be *groups* such as the association of *Gahnia xanthocarpa* and *Astelia trinervia*, but it is to be feared a too minute classification would be more artificial than natural.

B. FOREST FORMATIONS.

1. General Remarks.

The great mass of trees forming the Waipoua Forest is by no means of uniform composition. The nature of the soil, the steepness or flatness of the ground, and the height above sea-level govern the arrangement of the plants. Thus, steep slopes, flat rich valley-bottoms, or fairly level ridges, vary considerably in their plant covering. As for altitude, certain plants—*e.g.*, *Macropiper excelsum*, *Hoheria populnea*, *Sophora tetraptera*, *Hypolepis distans*—are only to be found in the lowest parts of the forest. Other plants, notably the kauri itself, hardly occur at above 1,200 ft., while at this altitude *Ixerba brexioides* and *Quintinia serrata* become plentiful. At nearly 2,000 ft. the forest changes altogether, the tarairi being comparatively rare and the rimu (*Dacrydium cupressinum*) dominant, while there, too, occurs the broadleaf (*Griselina littoralis*), a plant quite absent from the lower levels. From the Toetoehatiko ridge right to the eastern boundary of the forest there is no kauri, and the tarairi becomes gradually less in evidence, it giving place to the tawa (*Beilschmiedia tawa*), the towai* (*Weinmannia sylvicola*), or, on the highest ground of all, to the rimu (*Dacrydium cupressinum*). Where the ground is badly drained and water can lie comes in the kahikatea (*Podocarpus dacrydioides*) and the maire-tawake (*Eugenia maire*). With the above exceptions and a few minor ones dealt with elsewhere, the forest consists of the tarairi (*Beilschmiedia tarairi*) and the kauri (*Agathis australis*) as the dominant trees. From the above it might seem easy enough to show that the forest is made up of different associations, and so doubtless it is, but these usually imperceptibly merge the one into another, while, excepting in the wettest ground, a very large percentage of the trees, shrubs, and ferns occur in all parts of the forest, also different portions of what might be considered a definite plant-association differ both in species and physiognomy. Notwithstanding the above, it seems reasonable to consider the forest a collection of associations, some of which, as the kauri-tarairi, are well marked. Also certain other plants grow associated together, especially *Gahnia xanthocarpa* and *Astelia trinervia*, which form those dense thickets that, although so characteristic of kauri forests in general, occur also where that tree is altogether absent.

Bearing in mind the limitations observed in the preceding paragraph, the Waipoua Forest may be considered as made up of the following associations:—

(*a.*) *The kauri-tarairi*, in which *Agathis australis* and *Beilschmiedia tarairi* are dominant each in a sub-association of its own, though there is an intermediate stage where the kauri is merely dotted here and there, the tarairi forming the main mass of trees.

(*b.*) *The tawa-towai-rimu association*, which is most ununiform, one or other of the trees giving it the name being dominant and not usually all three in equal proportions.

(*c.*) *The swamp association*, which also is not uniform everywhere, the kahikatea (*Podocarpus dacrydioides*) giving the character in some instances, while in others the arborescent growth is comparatively scanty.

2. Leading Physiognomic Plants and their Life-forms.

In order to save repetition when describing the formations, and so that readers unacquainted with the New Zealand flora may understand what follows, it seems well to give a brief account of those species on which the physiognomy of the forest depends, laying stress rather on their general appearance and ecological peculiarities than on such special marks as are used for purposes of botanical classification. The following comprise the most important:—

Filices: *Cyathea dealbata, Dicksonia lanata, Blechnum Fraseri, B. filiforme.*
Taxaceæ: *Podocarpus dacrydioides, Dacrydium cupressinum.*
Pinaceæ: *Agathis australis.*
Pandanaceæ: *Freycinetia Banksii.*
Cyperaceæ: *Gahnia xanthocarpa.*
Palmæ: *Rhopalostylis sapida.*
Liliaceæ: *Astelia trinervia, A. Solandri.*
Lauraceæ: *Beilschmiedia tarairi, B. tawa.*
Cunoniaceæ: *Weinmannia sylvicola.*
Rutaceæ: *Phebalium nudum.*
Myrtaceæ: *Metrosideros robusta, M. florida, M. scandens.*
Epacridaceæ: *Dracophyllum latifolium.*
Loganiaceæ: *Geniostoma ligustrifolium.*
Caprifoliaceæ: *Alseuosmia macrophylla.*
Compositæ: *Senecio Kirkii.*

* Towai is used rather than tawhero throughout this report, since it is the sole name for *Weinmannia sylvicola* in the Hokianga district.

Some of these are dealt with in other sections, and so are not described here.

The kauri (*Agathis australis*) is a very lofty and massive forest-tree (Photo 3), having a columnar trunk from 4 ft. to 12 ft. in diameter or more, 50 ft. to more than 80 ft. tall without a branch, covered with a shining grey bark, the outer part of which is more or less loose and in large scales, and with a head of enormous branches spreading upwards and outwards, which finally bear somewhat twisted, gnarled, terete branchlets marked with old leaf-scars, which at their ultimate 12 in. give off closely numerous branchlets almost at right angles, in opposite or subopposite threes. These branchlets are green in colour, stout but flexible, and arch upwards. They are generally furnished with similar but much shorter final leaf-bearing branchlets, and the arching of the ultimate branch-system is such that the leaves touch and a close head of olive-green foliage results. The leaves are closely and spirally arranged, imbricating, but do not touch one another. They are olive-green, thick, coriaceous, rather stiff, linear-oblong to obovate-oblong in shape, and about 1½ in. long by $\frac{7}{16}$ in. broad. On the bark are many wavy lines and close reddish warts. The young kauri is quite different in its form from the adult (Photo 4). The branches are slender, inserted at right angles to the main trunk, and arch upwards, especially at their extremities, where are given off numerous short, yellow-green branchlets at an acute angle and pointing upwards and outwards. These are closely covered with lanceolate leaves near their apices, the whole mass of yellow greenery rather compact and gradually tapering to a blunt apex. The rootlets of the kauri are closely covered with nodules. The flowers are monœcious, the female cones finally almost spherical and falling to pieces when the seed is mature.

The tarairi (*Beilschmiedia tarairi*) is a lofty evergreen tree, 50 ft. to 80 ft. tall, with a straight, erect, slender trunk 1½ ft. to 3 ft. in diameter, covered with brown or reddish-brown bark which frequently appears white owing to the presence of a crustaceous lichen. The branches are usually few and short, the lower ones are given off more or less at a right angle, and frequently droop or arch downwards somewhat. The upper branches pass off at a narrower angle. From all sides of the main branches others are given off more or less at right angles, and these again branch similarly, but usually with a curve. Finally there pass off at an acute angle short branches, quite stout, and furnished closely with leaves, the whole system making a dense but rather small head to the tree. The leaves are of oblong type, about 5 in. long by 3 in. broad, simple, entire, dark-green and slightly glossy, bluish-white on under surface through a waxy covering, coriaceous, stiff and elastic, the distinct pale yellowish-green raised veins giving a special firmness. The flowers are small and hermaphrodite, and are succeeded by large, dark-purple berries. The final branchlets, petioles, and veins of the leaves beneath, and the upper surface of young leaves, are closely covered with a reddish-brown velvety tomentum.

The northern rata (*Metrosideros robusta*) is a very lofty forest-tree, sometimes reaching 100 ft. or more in height, with a thick, frequently enormous trunk, most irregular in shape; a reddish-brown bark, furrowed longitudinally and transversely, which falls off in flakes; and with spreading, often crooked, branches, forming a rounded head, the final branchlets of each main branch being densely leafy, and making close, dark, but vivid-green masses, which are not intermingled with one another. The leaves are from 1 in. to 1½ in. long, of lanceolate type, coriaceous, thick, and dark shining green. The flowers are dark-scarlet and produced in great quantities. The seeds are minute, light, and very numerous.

The maireire (*Phebalium nudum*) is a bushy shrub 6 ft. to 12 ft. tall, made up of a close mass of erect and semi-erect slender leafy twigs, dark-purple below but reddish-purple above, the whole having a flecked reddish appearance. The leaves are small, linear-oblong, an inch or so long, rather glossy green, marked with red, especially on the under-surface, coriaceous, moderately thick, and strongly aromatic. The flowers are white, ⅓ in. in diameter, fragrant, and arranged in many-flowered corymbs.

The forest-groundsel (*Senecio Kirkii*) is, where there is room for its development, a symmetrical, slender-stemmed shrub about 12 ft. tall. The main stem is covered with slightly furrowed light-brown bark, naked and unbranched below, but above branching into stiff, straight branches, three or four together, which radiate outwards and upwards, and which, at the lower part of the plant, may be 2 ft. long, but get shorter towards the summit, finally branching into three or more short, stiff twigs, which bear rosettes or semi-rosettes of spreading leaves near their extremities. The whole shrub is loose and open, and of a candelabra-like form. The leaves are very variable in shape (this depending mainly on their width and degree of toothing), tender and soft, rather fleshy and thick, cold and clammy to the touch, moderately dark-green on the upper surface, quite pale beneath, and twenty, more or less, are crowded together near the extremity of the naked stem. The young stems are soft, purple, flexible, and of herbaceous character. The flower heads are very numerous, 2 in. in diameter, conspicuous, and beautiful through their pure-white ray-florets.

Alseuosmia macrophylla is a slender-branched shrub of irregular habit, with very brittle, dark-brown, stiff stems, greenish near their extremities, frequently bent, and branching most sparingly into distant, flexible, leafy twigs. The leaves are variable in shape, usually of ovate-lanceolate type, dark-green, much paler on under-surface, glossy, moderately thick, flexible, coriaceous, simple, and almost entire. The flowers are in fascicles of two to four, 1⅛ in. long by ¾ in. across, deliciously scented, the mouth of the tube creamy-yellow in colour, marked with pink lines on the exterior and flushed with pink within, or quite unstained in the interior of flower.

The rimu (*Dacrydium cupressinum*) is a very tall forest-tree with a straight, unbranched trunk, 2 ft. to 6 ft. in diameter, covered with dark-brown bark which scales off in large flakes. The head of foliage is small for the size of the tree, occupies about its upper sixth, and is made up of short branches given off at first at a wide angle, which branch three or four times and finally give off numerous drooping leafy twigs, which hang vertically and give a weeping appearance to the tree. The leaves imbricate, are linear, short, trigonous, and $\frac{1}{12}$ in. to ⅛ in. long.

The juvenile plant is distinct from the adult, being pyramidal-shaped, the lateral branches given off at right angles, pendulous, and covered with leaves larger than those of the adult.

The kahikatea (*Podocarpus dacrydioides*) is a lofty forest-tree with a rather slender, mast-like, quite unbranched trunk for about its lower seven-eighths, and having a most scanty and rather fastigiate-shaped head quite out of proportion to the size of the tree. The leaves are dimorphic, those of the adult being inserted in a spiral, imbricated and adpressed to the stem, subulate-lanceolate and $\frac{1}{12}$ in. to $\frac{1}{8}$ in. long, while the juvenile are distichous, flat, linear, $\frac{1}{6}$ in. to $\frac{1}{4}$ in. long, and dull-green, reddish, or at times almost bronze-coloured. The juvenile form is shrubby, with long, spreading, slender, more or less horizontal twiggy branches, much exceeding in length the height of the plant. From its main stem very short shoots are given off most closely.

The giant cutting-sedge (*Gahnia xanthocarpa*) is a very stout sedge, forming enormous tussocks 8 ft. to 12 ft. tall. The leaves are erect or semi-erect, $\frac{1}{2}$ in. broad or more, involute, scabrid on their margins, glossy but rather dark-green, coriaceous, and moderately stiff. The old leaves rot away and leave many persistent, decaying, and usually wet leaf-bases.

The kauri-grass (*Astelia trinervia*) forms very large tussocks made up of numerous leaves 5 ft. to 7 ft. long by $1\frac{3}{4}$ in. broad, tapering into a long-drawn-out point, and expanded below into a broad, fleshy, sheathing base clothed with long white hairs. They are pale-green, coriaceous, glabrous above, covered beneath with a silvery pellicle. The flowers are small and dicœcious, the berry $\frac{1}{3}$ in. in diameter and bright-red.

The towai (*Weinmannia sylvicola*) is a moderate-sized evergreen tree of the forest, but merely a shrub of the heath. The trunk, often irregular in form, is from 1 ft. to 3 ft. in diameter. The leaves are dimorphic; the adult are entire, ternate or pinnate, with two or more lateral leaflets, rather dark shining green, with at times a yellow tinge, moderately thick, pale on the under-surface. The juvenile plant is treated of in the section dealing with the ecology. The flowers are small, very numerous, white or pale-rose, and in terminal or axillary racemes.

The parataniwha (*Elatostemma rugosum*) is a prostrate, stout, herbaceous plant, with very long, branching, somewhat rigid, terete, juicy, pale yellowish-green stems, $\frac{3}{4}$ in. in diameter, which branch abundantly, and give off distant, rather stout, cord-like roots, 10 in. long or less. The stems ascend at their apical portion, and give off on their flanks large, thin, pale yellowish-green, lanceolate serrate leaves, 3 in. to 10 in. long. The flowers are very minute, on fleshy, monœcious receptacles of a pinkish colour, in the axis of the leaf.

The silver tree-fern (*Cyathea dealbata*) has a stout trunk 30 ft. tall at most, strongly thickened by vertically descending, dark chestnut-brown, aerial roots. It is much expanded at the base, where it may be 18 in. or more in diameter, clothed to its middle or below with leaf-bases each 3 in. or 4 in. long, and bears at its summit numerous very large, feathery, horizontal leaves, light-green above and covered beneath with a white powder, each 5 ft. to 12 ft. long or more and 2 ft. or 3 ft. broad, spreading out radially from the trunk and arching a little downwards, and with a distinct umbrella-like appearance.

The woolly tree-fern (*Dicksonia lanata*) is a small tree-fern with a trunk almost unnoticeable, or reaching a height of 6 ft. or more, dark-brown in colour near its base, and there covered with aerial roots. The sterile fronds, shining dark-green, are 5 ft. in length, more or less, coriaceous and moderately thick, and spread out semi-horizontally. The fertile fronds, on the contrary, are bright-green with a yellow tinge, and raised conspicuously above the unfertile.

Besides the above plants, others, such as *Polypodium Dictyopteris;* filmy ferns of various species; the epiphyte, *Astelia Solandri* (Photo 5); *Pittosporum tenuifolium*; *Coprosma grandifolia;* the kohekohe (*Dysoxylum spectabile*); the pukatea (*Laurelia novæ-zelandiæ*), play at times an important part in the physiognomy of the forest, but such and other plants of local physiognomic importance are dealt with further on in describing the various associations, or in the part relating to the ecology.

3. The Kauri-Tarairi Association.

(*a.*) *General Remarks.*

This consists of two sub-associations, the tarairi and the kauri, which, although forming one compact whole, are generally distinct from each other, the kauri being in most instances accompanied by certain definite species, and this even when a tree stands isolated and the tarairi is present in abundance on all sides. This association occupies all the country to the west of the Toetoehatiko ridge, excepting where the ground is too wet, though in some places other trees than the kauri—*e.g.*, *Beilschmiedia tawa*, *Weinmannia sylvicola*, *Dacrydium cupressinum*—enter in and become dominant over small areas. A most excellent view of this part of the reserve may be obtained from the high ground along the Merowharara–Katui Track, the forest lying extended over the ridges and valleys as a dark and somewhat gloomy mass fading into blue in the distance. The great area of the whole detracts considerably from the height of the constituent species. Dead trees stand out here and there near the outskirts. The kauris rise high (Photo 7) above the other members of the forest, isolated or in groups, each tree-crown distinct, or occasionally these are quite close. Seen from a short distance their colour is dull olive-green or brown, but from further away the distinguishing hues of the various members are lost. The adjacent forest lying in the hollow below is very beautiful. The roof is quite uneven owing to the different heights of the trees. Young upright-growing kauris are in plenty, fringing the margin, and their colour is not uniform. Some are green; others are of a darker shade with a bluish tinge, and these latter are especially handsome. The older kauris, distinguished by their branching—so different, as already pointed out, from that of the juvenile form—are very conspicuous. They rise up above the general mass just as does an ordinary forest from the under-scrub, which in this case is itself

mostly tall forest, the actual undergrowth being quite hidden. Thus there is the appearance of one forest super-imposed upon another. The ratas, of a rich and dark but vivid green, likewise raised above the remaining forest-trees, are extremely conspicuous. The tarairis are marked by their greyer colour and denser heads of foliage.

Outside the forest, as the leading constituent of the adjoining heath, is the bright yellow-green of the juvenile much-leafy *Weinmannia sylvicola*.

It is a truly magnificent spectacle, this great forest-mass of virgin vegetation.

(b.) *The Kauri Sub-association.* (Photo 17.)

(1.) *Its Distribution.*—A view from some point of vantage such as mentioned above shows that the chief kauri-mass extends in a broken belt from about south-east to west. On the central ridges or the hills between the two main tributaries of the Waipoua groves and clumps of kauri are scattered over the whole. The tree in question also ascends to the top of Pukehurehu, but is thickest on the lower ground. There is also a considerable amount of kauri on the Crown land, Block No. 7, lying to the south of the hill just mentioned, while across the Merowharara Stream there is still abundance of the tree. The most easterly occurrence in any quantity is up the valley, and the slopes leading thereto, of the Toronui, although a few isolated trees occur still further to the east, one example being present near the waterfall of the Waipoua River not far from the Opanake Road. By far the most important mass of kauri occurs on the high ground between Omaia and the Huaki. Here, over large areas the kauri is easily the dominant tree, and, according to Mr. Maxwell, the caretaker of the forest, this piece of forest quite equals any that he has been connected with during his experience of many years in the Hokianga district. Finally, the north-western portion in the neighbourhood of the River Wairau contains a good many trees, and it is these and the ones near the Huaki which have been especially damaged by the gum-climbers.

(2.) *Its Members.*—Few plant-associations are better defined than that of the kauri. No matter where found, the following species are almost certain to be present: The kauri (*Agathis australis*), the maireire (*Phebalium nudum*), the kauri-grass (*Astelia trinervia*), the giant cutting-sedge (*Gahnia xanthocarpa*), the white forest-groundsel (*Senecio Kirkii*), the hoihoi (*Alseuosmia macrophylla*), the neinei (*Dracophyllum latifolium*), the silver tree-fern (*Cyathea dealbata*), the miniature tree-fern (*Blechnum Frazeri*) (Photo 8), the climbing hard fern (*Blechnum filiforme*), the hangehange (*Geniostoma ligustrifolium*), the kiekie (*Freycinetia Banksii*), the large-leaved climbing rata (*Metrosideros florida*), the New Zealand sandalwood (*Fusanus Cunninghamii*), and juvenile plants of the following: the kohekohe (*Dysoxylum spectabile*), the tarairi (*Beilschmiedia tarairi*), the towai (*Weinmannia sylvicola*).

(3.) *Its Physiognomy* (Photos 9 and 10).—This association owes its striking physiognomy in part to the form of the kauri-tree itself and in part to the dense and tall thickets made by the tussocks of the kauri-grass (*Astelia trinervia*) and of *Gahnia xanthocarpa*, through or near which grow various rather straggling and usually but little-branched young trees and shrubs. These thickets are not always present to any marked degree, for where the kauri association spreads over a wide area they are absent in places, and the giant trees alone control the scene. Thus in the neighbourhood of the Huaki the great trunks, there usually of a reddish-brown colour, though elsewhere of a shining grey, rise up as bare and massive columns, 5 ft. or 6 ft. in diameter, for 50 ft., and frequently more, without a branch as far as the eye can pierce through the subdued light. Close at hand the bark, scaling off in large hard flakes, is plainly to be seen, and also the numerous ripple-like marks on the trunk (Photo 11). Round the base of each tree has collected a great mound of humus formed from the decaying bark, called *pukahukahu* by the Maoris, and which is frequently occupied by various plants, especially *Astelia trinervia*, the liane *Metrosideros florida*, and the forest-groundsel (*Senecio Kirkii*). Such mounds are 5 ft. or 6 ft. high, and of a pyramidal shape. Large roots from the kauri ramify through them. The whole is a rather moist, chocolate-coloured humus, containing much vegetable matter not altogether decayed. There is frequently here no close undergrowth to hide the view, but between the massive trunks are multitudes of straight, bare, slender stems of the tarairi, rising up parallel with one another for the most part, and thrusting their sparse heads of greenery to the branches of the kauris. Here, too, are the larger and more irregular trunks of the tawa (*Beilschmiedia tawa*), some 20 in. in diameter, these more richly covered with green and yellowish-green mosses and liverworts, or with sheets of the epiphytic fern *Polypodium Dictyopteris*, of a bright-green colour, its fronds in little tufts of five or six together, 7 in. long by ½ in. broad, and arching slightly at right angles to the tree-trunk.

A more extended view shows that the number of species is not so limited as at first appears. The feathery fronds of the silver tree-fern (*Cyathea dealbata*), pale but shining green above, and bright silvery beneath, on trunks only a few feet tall, are dotted here and there. Juvenile plants of the towai (*Weinmannia sylvicola*), 4 ft. or so in height, and conspicuous through their large, pale, yellow-green, pinnate leaves, are in abundance. Here, too, are the fern-like juvenile miro (*Podocarpus ferrugineus*); the slender trunks of the kohekohe (*Dysoxylum spectabile*), 12 ft. or so tall, unbranched, and furnished in their upper part with great glossy green leaves, borne horizontally on long stout stalks; *Alseuosmia macrophylla*, its fine yellow flowers filling the air with fragrance in their season; the horopito (*Drimys axillaris*), with its slender, erect, black stems, and head of glossy dark-green leaves; colonies of the miniature tree-fern *Blechnum Frazeri*, 2 ft. or 3 ft. tall, its dark-green leaves semi-erect; the small tree-fern *Dicksonia lanata*, its short trunk perhaps 15 in. tall and 4 in. in diameter, and the green fronds arching outwards from their blackish stems, which shine with a metallic lustre. On the ground itself trail naked, stout stems of the kiekie (*Freycinetia Banksii*), the large tufts of rich dark-green leaves frequently blotched with yellow and having pale nerves—rising to a height of some 22 in. Here, too, but prostrate, is the climbing fern *Lygodium articulatum*, or it may frequently wind its very slender, wiry,

tough stems round one or other of the slender young trees, covering them with its bright-green leaves. In some places young and graceful tawas give the chief character to the undergrowth. *Rapanea salicina*, *Nothopanax arboreum*, an occasional stemless young palm, young *Melicytus macrophyllus*, seedling *Coprosma grandifolia*, *Asplenium bulbiferum*, and the semi-tree-fern *Blechnum discolor* are also frequently present. High overhead are the great spreading limbs of the kauris, each equalling a fair-sized tree in bulk, and in the spaces between the supporting columns of the kauri, the pale-green, lace-like, open foliage of the tawa, and the darker and denser heads of the tarairi.

In this open forest lianes are few. Besides the *Lygodium* already mentioned, an occasional *Freycinetia* climbs the trees. But the kauri itself, owing to its bark-shedding habit, remains inviolate and quite without lianes, except for an occasional climbing rata of some species or another, which manages to ascend for a few feet on the basal portion of the tree, only in course of time to be ejected through the shedding of the bark. (Photo 12.)

The above description is quite inapplicable to the groves of kauris, large or small, or to the association of plants in the neighbourhood of individual kauri-trees, which form by far the most common examples of the kauri association as it occurs within a kauri-tarairi forest. The kauri-trees themselves are usually some chains apart, and the space between is occupied by the *Gahnia-Astelia* undergrowth. This consists of immense tussocks growing as closely as possible, so that it is extremely difficult to force one's way through them. Out of the mass emerge certain characteristic plants, especially the maireire (*Phebalium nudum*), its slender branches covered with dark-purple bark, and which, branching frequently, are clothed with small aromatic leaves, whose reddish under-surface imparts that hue to the plant as a whole. With the tussocks is mixed, and often to a considerable extent, the liane *Freycinetia*, thus adding to the density of the association; and the forest-groundsel, *Senecio Kirkii*, which branches in a somewhat candelabra-like fashion and has moderately dark-green leaves, which are pale beneath, borne only near the extremities. Seedlings also of this plant, with leaves most variable in shape, are extremely common on the open ground. The hangehange (*Geniostoma ligustrifolium*), with its soft, glossy, bright, shining, green leaves, pale beneath, grows mixed with the *Gahnia*. The liane *Metrosideros florida* is frequently abundant in a similar position, and where there is space *Blechnum Frazeri* is sure to be present. The branches of the kauri, rising high above the general forest-growth themselves approaching ordinary trees in size, form close heads of foliage, which are usually distant one from the other, so that much light enters the forest, which accounts for the luxuriance of the "grassy" growths.

Where the soil is wettest the *Gahnia* is most abundant, but where drier it becomes much less luxuriant, and the *Astelia* then is the dominant tussock. Sometimes the *Gahnia-Astelia* thickets are almost pure, with their erect or semi-erect leaves drooping at their apices, and, beneath, the straw-coloured dead leaves. Very frequently the neinei (*Dracophyllum latifolium*), with its peculiar and striking form, becomes a special feature of the kauri association, and the tall tree-fern *Cyathea dealbata*, the great fronds arranged after the manner of a huge umbrella, is nearly always present, as are young tarairi-trees, slender-stemmed and sparingly leafy, as before noted. Finally, *Coprosma grandifolia*, *Nothopanax arboreum*, and *Alseuosmia macrophylla* are common plants.

(*c.*) *The Tarairi Sub-association.* (Photo 13.)

With regard to this association, no account can be given which would be typical of the whole, its members varying in their relative proportion and changing according to topographical and soil conditions. Generally speaking, the tarairi itself is most abundant where the soil is richest, just as the pure kauri association occurs on the worst ground. The following, in inverted commas, are extracts from my note-books, and give a more truthful idea of the physiognomy of the tarairi association than would any attempt at a detailed general account. At the same time it must be clearly understood that many points were not noted, and that at best such notes give but a general idea of the forest and its composition, while invariably many species were overlooked or not recorded.

On the Eastern Watershed of the Waikohatu Stream.—"The trees are about 45 ft. tall, and have mostly moss-covered straight trunks. Palms 25 ft. tall are dotted about. The heads of the trees are very scanty. The tarairi (*Beilschmiedia tarairi*) is abundant, and there is some tawa (*B. tawa*). Here is an odd plant of the kawaka (*Libocedrus Doniana*), a rather rare tree in the Waipoua Forest, whose reddish-brown bark, hanging in long strips, renders it conspicuous.

"The undergrowth is rather close, and consists of young trees and shrubs 18 ft. or so tall—*e.g.*, the kohekohe (*Dysoxylum spectabile*), *Melicytus macrophyllus*, the kanono (*Coprosma grandifolia*), the forest-groundsel (*Senecio Kirkii*), the hangehange (*Geniostoma ligustrifolium*), and the ivy-tree (*Nothopanax arboreum*). Where the trees are slender the mangemange (*Lygodium articulatum*) covers them with a delicate mantle of glistening green. A few mosses are on the floor, and *Blechnum Frazeri*, its slender trunks a foot or two tall, also seedlings of *Geniostoma*, together with small stemless *Cyathea dealbata*, *Blechnum discolor*, tufts of *Freycinetia*, and some of the grass-like *Uncinia australis*. There is an occasional lancewood (*Pseudopanax crassifolium*), some moderate-sized shrubs of the horopito (*Drimys axillaris*) and the ramarama (*Myrtus bullata*).

"Further on, the undergrowth becomes thicker and its members more spindling in character, *Coprosma grandifolia*, some 15 ft. to 20 ft. tall, being dominant. There are also a few tree-ferns, a tall palm or two, some *Geniostoma* and *Dysoxylum*. On the ground is abundance of *Blechnum filiforme* (a common ground-plant of this forest, especially of the drier portions) and a little *Freycinetia*. Logs are here and there, covered completely with the kidney fern (*Trichomanes reniforme*). Occasionally colonies several square yards in area may be met with of the great moss, *Dawsonia superba*, the individual plants from one to one and a half feet in height (Photo 1A), but the plant is by no means common.

"The middle view is dependent on the green leaves of the young trees and tall shrubs which everywhere meet the eye and hide the trunks of the taller trees. The large leaves of the kanono (*Coprosma grandifolia*) are especially instrumental in this regard. . . . .

"So dense here are the slender branches as to make progress very difficult, while the black, rigid stems of the supplejack (*Rhipogonum scandens*) spread in all directions and bar the way. *Cyathea dealbata*, with its spreading fronds on short petioles, also adds to the entanglement.

"The tree-tops, however, are quite distant, and the sky shows plainly through everywhere. *Beilschmiedia tarairi* is plainly dominant, and its trunk is frequently covered with mosses or encircled by the drooping shining fronds of *Blechnum filiforme*. . . . .

"*We are on the top of a ridge.* Here is a large tree of the rata (*Metrosideros robusta*), also the neinei (*Dracophyllum latifolium*), *Alseuosmia*, and *Coprosma grandifolia*. . . . .

"Here *Beilschmiedia tarairi* is still the leading tree, and there is an occasional totara (*Podocarpus totara*) and miro (*P. ferrugineus*). More frequent are the kohekohe (*Dysoxylum spectabile*), the rewarewa (*Knightia excelsa*), and the rata (*Metrosideros robusta*). These are more or less clothed with various mosses and liverworts, but especially do *Metrosideros scandens*, *M. florida*, *Freycinetia Banksii*, and *Blechnum filiforme* appear as lianes, the large pinnate leaves of the latter drooping and quite hiding the stems which it embraces. These also have, as epiphytes, *Astelia Solandri* and at times *A. trinervia*, *Pittosporum cornifolium*, *Griselinia lucida*, *Asplenium adiantiforme*, *Dendrobium Cunninghamii*, *Asplenium flaccidum*, and *Lycopodium Billardieri* (Photo 6). The *Metrosideros scandens* gives a green colour to the trunks when in its early stage its dorsiventral shoots are attached closely to the bark and make a mosaic, but finally its thick stems are pressed against them as woody ropes. The broad translucent fronds of *Hymenophyllum dilatatum* (a foot or so in length), and the kidney fern (*Trichomanes reniforme*), dark-green when old but almost emerald-green when young, play likewise a most conspicuous part, both as lianes, or perhaps epiphytes, and as mantles for fallen trees.

"As for the second tier of vegetation, young trees with stems unbranched for at least their lower two-thirds and of considerable stature, together with palms and tree-ferns, especially *Cyathea dealbata*, everywhere play the principal part. *Cyathea medullaris* is also present, sometimes in abundance, its black leaf-stalks rendering it conspicuous. The greater number of these young trees consist of *Beilschmiedia tarairi*, but at times in equal abundance is *Dysoxylum spectabile*, while the juvenile form of *Knightia excelsa*, with its long and narrow leaves, so different from those of the adult, is also frequent. In some places the rather dull-green *Coprosma grandifolia* is dominant, or nearly so. The principal of the smaller shrubs are *Senecio Kirkii* and *Alseuosmia macrophylla*, which are everywhere, as are the seedlings of the former. *Freycinetia* grows in tufts, straggling, as it so frequently does, on the ground, or climbs the trees, quite hiding the trunks with its dark-green sword-like leaves. Even when its support is gone it still keeps its position as an erect plant, thanks to the rigidity of its thick stem. *Lygodium* also, climbing from the ground, where it is frequently prostrate, winds round itself and binds together the branches of the smaller trees and shrubs, while these are also encircled by *Rhipogonum scandens*.

"On the ground, where dry, is a close covering of the delicate fronds of *Hymenophyllum demissum*, extending over many square yards, or in some places *Trichomanes reniforme*, the latter especially on dead, fallen trees, and the former on the driest ground and on roots raised above the ground-surface, where it is mixed with mosses. Large colonies of *Blechnum Frazeri* are everywhere, but the juvenile form only, sometimes to the exclusion of other ground-vegetation. On the floor also are various mosses and liverworts, in addition to the above-named filmy ferns, and at times a good deal of *Metrosideros hypericifolia*, while here, as in most parts of the forest, lie the dead brown leaves of the tarairi. Seedlings, too, of all the forest-plants abound, especially *Knightia*, *Podocarpus ferrugineus*, *P. dacrydioides*, *Beilschmiedia tarairi*, and *Senecio Kirkii*. . . . .

"Further on, the tarairi forest becomes still more open. This particular part is quite remarkable for the multitudes of quite straight saplings of *Dysoxylum*, 15 ft. to 20 ft. tall. Hardly branched, and but little leafy, they form almost the entire undergrowth, and offer no obstacle to progress. I do not know what can be the ultimate fate of such young trees as these. Most will die by degrees, I suppose; some will probably be strangled by lianes; but at any rate a comparatively few years ought to show some great change in such a formation. At present there is here a distinct young forest growing beneath an older one of the same species. On the ground there is little but the brown dead leaves. Stone crops out everywhere, and on it is some *Blechnum filiforme* and *Metrosideros hypericifolia*. On the earth is some *Freycinetia*, a little *Asplenium bulbiferum*, and colonies of *Hymenophyllum demissum*. As for the general physiognomy, multitudes of slender grey stems chiefly meet the eye, while in the middle distance are the bright-green leaves of the saplings. . . . .

"At the north-west corner of the reserve, on the slope descending to the Wairau, a creek was crossed, almost dry and full of large stones, which were more or less moss and fern covered with *Polypodium Dictyopteris* and *Hymenophyllum dilatatum*. In the bed of the stream were noted *Macropiper excelsum*, *Carmichaelia australis* 6 ft. tall, *Rhopalostylis sapida*, and very large *Asplenium lucidum*. Probably there were other seed-plants and ferns and notably seedlings. The dominant tree is, as usual, *Beilschmiedia tarairi*, and palms are extremely numerous. Large rocks jut everywhere out of the ground, which there is for the most part bare but with tufts of *Freycinetia*, plenty of *Blechnum filiforme*, and many fallen tarairi leaves. *Coprosma arborea* is abundant, with slender stems, branching at a right angle, and abundant brownish leaves, also *Dysoxylum* with long stems, *Beilschmiedia tarairi*, and *Knightia*. Young *Weinmannia sylvicola* and *Brachyglottis repanda* are common, and the comparatively dry nature of the ground is testified to by the presence of *Adiantum fulvum*. Other plants of this portion are juvenile miro, *Fusanus Cunninghamii*, young *Olea montana*, plenty of *Uncinia australis*, some *Pteris comans*,

plenty of *Microlæna avenacea*, *Hedycarya arborea*, and the stems of *Rhipogonum* here and there. The smaller trees are embraced by *Lygodium*, as, *e.g.*, *Coprosma arborea*. *Dryopteris pennigera* is an abundant constituent. The vivid green of the climbing *Lygodium* contrasts strongly with the brownish-leaved *Coprosma arborea*.

"I descended towards the Wairau River down a very steep slope, where in shallow gullies it was extremely wet. The trees are quite close; trunks meet the eye everywhere. In some places there is no undergrowth of any moment except seedlings, tree-ferns, palms, and *Freycinetia*, but these on the drier slopes do not form a dense growth, and are dotted about rather. Fallen trees are to be occasionally met with, as, *e.g.*, a fallen *Metrosideros robusta* quite covered by *Polypodium diversifolium*. Where the ground is wetter *Freycinetia* forms a close entanglement with more or less *Rhipogonum*." . . . .

Looking from a Spur down a Gully on the Eastern Side of Waikohatu Stream.—"A rather indistinguishable mixture of grass-like *Gahnia;* tree-fern stems, and their pale, spreading, and umbrella-like heads of leaves; small and slender *Beilschmiedia tarairi;* together with an occasional grey and reddish columnar trunk of *Agathis australis;* while much of the sky shows through, and there are really no tall trees, the kauri excepted. Within the above are heads of *Freycinetia* rising from the floor and 25 in. to 40 in. tall, the leaves arching, and at the extremities of the stiff, bare stems; while above them are numerous semi-erect leaves of the silver tree-fern, small tarairi-plants, and clumps here and there of *Astelia trinervia* and sparsely branched *Senecio Kirkii*.

"Of the trees, *Beilschmiedia tarairi* is easily dominant. Also *Podocarpus ferrugineus* is present, and an occasional *Dracophyllum latifolium*, its trunk and stems quite naked, and pine-apple-like green clusters of leaves at their apices. On the ground are many dead fronds of ferns, juvenile *Blechnum Frazeri*, and a few seedlings of the usual kind—*e.g.*, *Senecio Kirkii*, *Geniostoma*. In an open space on the floor are *Geniostoma* (abundant), *Melicope simplex*, *Senecio Kirkii*, *Alseuosmia macrophylla*, *Rapanea Urvillei*, *Melicytus ramiflorus*, *Styphelia fasciculata*, a few mosses, and many dead and rotting leaves.

"The forest is distinctly open. The trees are seldom less than 10 ft. apart, and often more, their trunks 1 ft. to 2 ft. in thickness, or sometimes more, and quite straight.

"The grass-like plants growing as tussocks, either touching one another or some distance apart, give a special character, while man-high above them are the silver tree-fern fronds, and above these again, some yards apart, slender young trees of bright-green *Dysoxylum* and pale-green *Geniostoma*, small-leaved *Pittosporum tenuifolium*, and an occasional tall tree-fern, either *Cyathea dealbata* or *C. medullaris*, raising the green fronds high on slender stems towards the forest-roof, the leaves arching horizontally in an umbrella-like fashion.

"The trunks vary in colour, or they may be masked by mosses or lianes and so lose their character. There are kauris here and there, with groundwork of shining grey embellished with red and more or less circular patches and waving lines, or young kauris with much darker bark. As for the moss covering, there is frequently a most beautiful golden-greenish-coloured species, the shoots crowded but hanging downwards with the apices turning upwards, the vivid golden-green contrasting with the reddish-brown dead leaves of the interior of the mantle. This latter is 1½ in. in thickness. The lateral shoots are drawn out into filiform points, which possibly root and thus form new plants.

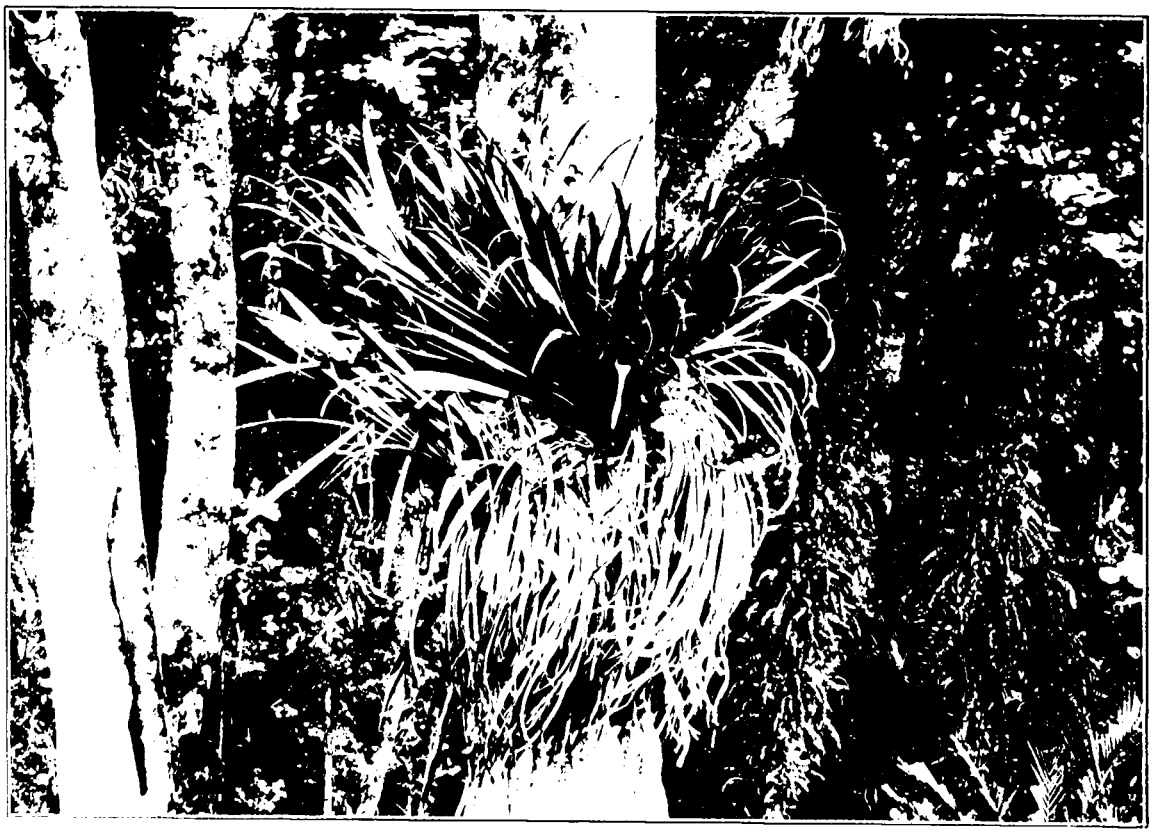
"Rising from the ground are the extremely slender and stiff dark-coloured stems of *Blechnum Frazeri*, terminating in a crown of dark-green shining leaves, eight to ten in number, which are held semi-erect or at times almost horizontally. Such stems may be 1 ft. or less to 3 ft. tall, and the whole form miniature forests of ferns." (Photo 8.)

Descending a Slope towards a Gully.—"Here, the conditions being slightly more moist, a good deal of a pale-yellow species of *Gottschea* occupies the ground, and shrubs or shrubby growth are more abundant—*i.e.*, the undergrowth becomes thicker, tree-ferns dominate, especially *Cyathea dealbata* and *C. medullaris*, and there is some *Dicksonia squarrosa*."

The tops of the ridges usually have a dense vegetation, while the slopes are of a more open character. For instance, my notes say,—

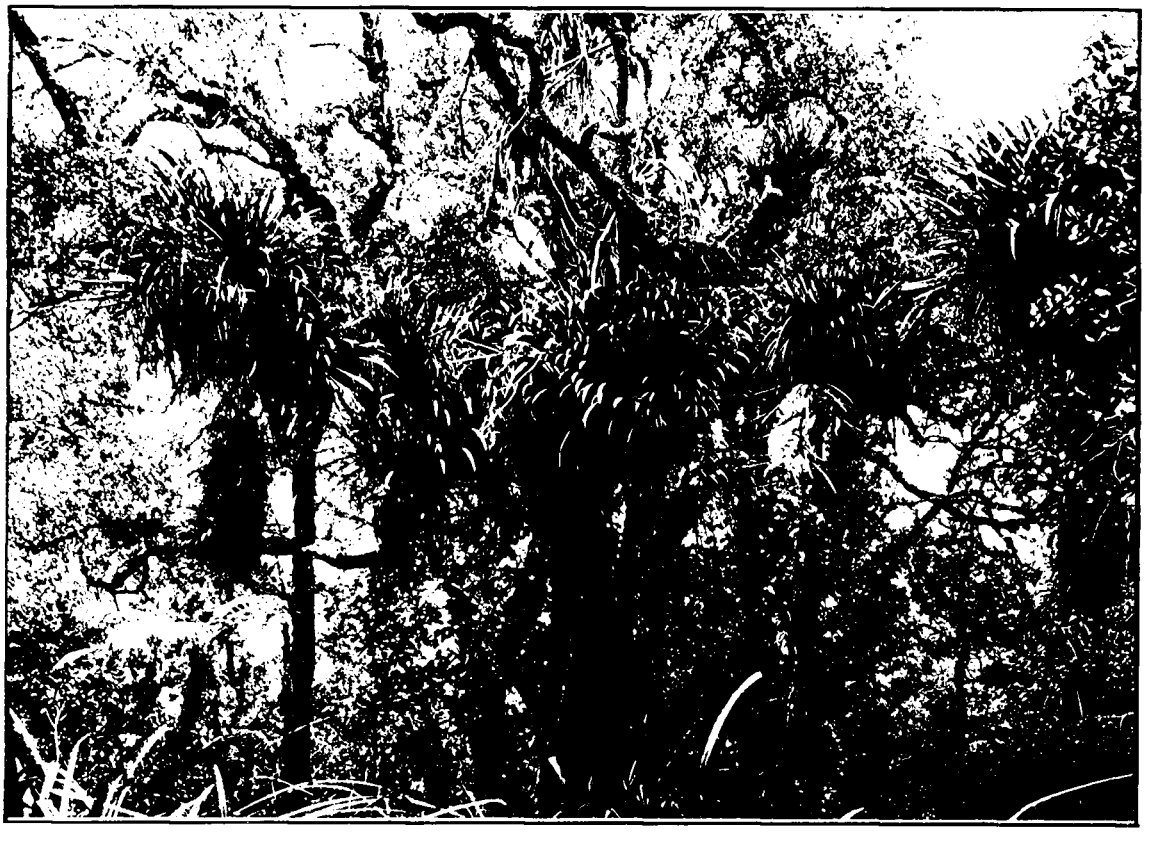
"We are on the summit of a ridge. Here, in addition to the dominant tarairi, are *Metrosideros robusta* and *Knightia excelsa* (rewarewa). The undergrowth is all entangled together, and consists of *Alseuosmia macrophylla*, young *Beilschmiedia tarairi*, *Geniostoma*, *Melicytus macrophyllus*, *Nothopanax arboreum*, *Dysoxylum spectabile*, silver tree-fern (*Cyathea dealbata*), and supplejack (*Rhipogonum scandens*). Nothing but a close entanglement or network of branches meets the eye, with green leaves scattered through. Near by, the dense undergrowth is formed of *Gahnia xanthocarpa* tussocks, with *Dracophyllum latifolium*, *Alseuosmia macrophylla* and *Coprosma grandifolia* growing out of them, and *Freycinetia* also in abundance."

Many tall palms grow out of the shrubby undergrowth, and they are indeed one of the most characteristic features of the forest. Near the track from the Omaia Hill, not far from the Waipoua River (see Map), where the soil is especially good, they form almost the sole undergrowth, many hundreds raising their feathery leaves from trunks 12 ft. or more tall and growing so near one another that the leaves form a close covering—a remarkable sight indeed in a forest in the temperate zone. Although abundant enough, lianes and epiphytes do not generally play a very conspicuous part in the forest physiognomy. It is on the irregular trunks of the ratas that they are most abundant. The base of these is frequently covered with great sheets of kidney fern, while on its giant limbs are huge masses of *Astelia Solandri* in surprising abundance. *Blechnum filiforme* completely surrounds the slender stems of young trees, its great pinnate leaves drooping downwards. The smooth stems of the palms are a favourite station for *Polypodium Dictyopteris*, whose roots form thick mats upon the bark. The mangemange (*Lygodium articulatum*) is found only on the more slender stems and trunks; it does not ascend the taller trees. Frequently its wiry stems,



(5.) The Epiphyte *Astelia Solandri* growing on a Slender Erect Trunk of the Tarairi (*Beilschmiedia tarairi*).

[*Photo., L. Cockayne.*



(6.) Epiphytes on Tawa (*Beilschmiedia tawa*) in Waipoua Forest. Large Masses of *Astelia Solandri*, 3 ft. tall. On left depends a Great Bunch of *Lycopodium Billardieri*, 4 ft. long.

[*Photo., L. Cockayne.*

twining round and round themselves, form masses several feet in depth. The cable-like woody stems of *Metrosideros florida* depend near the trunk which they have originally climbed, and the shrub-like growth of it and *M. scandens* on the trunk or amongst the branches is a distinct feature where it occurs.

4. The Rimu-Tawa-Towai Association.

(*a.*) *General.*

This association might also be denominated the upland forest, as it occupies the highest ground of the Waipoua Reserve, and is continuous with the general plant covering of the table-land. It varies considerably in its constitution in different parts: in some places the rimu is dominant, and a true forest of that tree results, but in other places the towai or tawa, one or both, are the leading trees, while the rimu may be absent or present in a smaller quantity. But so far as the associated plants go, the two sub-associations are almost identical, while the whole merges gradually on the west into the tarairi-kauri forest.

(*b.*) *The Rimu Sub-association.*

The following are my notes written after some days' examination of the eastern part of the Waipoua Reserve:—

"So far as the Waipoua Forest is concerned, the rimu is confined to a comparatively narrow belt between the Waipoua River and its north branch on the west and the Opanake–Kaihu Road on the east. From without the forest the rimu-trees are easily distinguished by the yellow-green colour of their small heads of foliage. The individual trees are sometimes dotted about rather distantly, and at other times in fair-sized groups. The towai (*Weinmannia sylvicola*) is also somewhat of the same colour as the rimu, but the pendant final shoots of this latter render the difference conspicuous, to say nothing of its more lofty stature. Here and there a dark-green rata (*Metrosideros robusta*) shows up conspicuously, while occasionally it may be seen perched high on some rimu, which will eventually be strangled.

"Within the forest the graceful willow-like foliage of the tawa (*Beilschmiedia tawa*) renders it distinct from any other tree. The forest-roof is quite uneven, though this is not noticeable at a distant view. As for the rimus, they stand up somewhat above the other trees, each also being distinguishable from its nearest neighbour, although their boughs may intermingle.

"Where the forest has been burnt it is easy to note the frequency of any special tree, and observations showed that the rimus varied from about twenty-five to forty-five to the acre. Besides the rimu, the tawa (*Beilschmiedia tawa*), the towai (*Weinmannia sylvicola*), the miro (*Podocarpus ferrugineus*), and an occasional totara (*P. totara*) are present, the first two in considerable numbers usually, and at times dominant. The larger trees vary from 50 ft. to even 100 ft. in height in the case of tall examples of the rimu. The undergrowth here, as in other parts of the forest, varies much in its density, but is frequently close, and consists of a mixture of small trees and shrubs, of which the most important are *Coprosma grandifolia, Senecio Kirkii, Ixerba brexioides, Griselinia littoralis, Weinmannia sylvicola, Nothopanax Edgerleyi, Schefflera digitata.* With these young trees and shrubs is an abundance of the tree-ferns *Dicksonia squarrosa* and *Hemitelia Smithii*, while *Dicksonia lanata*, growing in close colonies, is also common, and these various ferns give a characteristic stamp everywhere. In short, the undergrowth of young trees and ferns would be a forest in itself were the tall trees removed, as may be well seen where, in the burnt portion on the Marlborough Settlement, the undergrowth has escaped and progress now is extremely difficult. The small trees, &c., are usually of somewhat open growth, but not of the liane-like, long-stemmed, little-branched form so common in the kauri-tarairi association. In certain places the tree-ferns form colonies, and in such their closeness of growth does not permit a floor vegetation."

The floor of the forest was at the time of my visit excessively wet, and this, judging both from the rainfall of the district and the vegetation, must be a fairly normal condition. On it luxuriate mosses, hepaticas—of which a species of *Gottschea* dominates—and filmy ferns, while, as a striking testimony to the constant dampness of the ground, *Blechnum nigrum* is plentiful in the wettest places, associated with *Trichomanes elongatum*. The trees are covered completely with mosses and hepaticas on their lower parts, while every log and raised root has its mantle of filmy ferns, the kidney fern being especially abundant.

Here are a few notes taken within the forest:—

"The ground here is covered with filmy ferns, including *Trichomanes reniforme, Hymenophyllum demissum*, and *H. ferrugineum* in abundance, this latter very noticeable through its tawny-coloured fronds. The tall trees are *Weinmannia sylvicola, Dacrydium cupressinum*, and *Beilschmiedia tawa*. The ground is uneven owing to the great number of roots spreading over it. The shrubs are *Coprosma grandifolia* and *Schefflera digitata*. Near the creek are many square yards of ground covered with *Blechnum nigrum* and *Trichomanes elongatum*, the fronds of this latter covered abundantly with epiphytic mosses. The tree-fern stems are draped with *Hymenophyllum ferrugineum*."

On dryer ground my notes mention *Blechnum Frazeri* in abundance, *Blechnum discolor, Beilschmiedia tawa* as the leading tree, an abundance of *Senecio Kirkii*, an example of *Dicksonia squarrosa* green with mosses and liverworts, and growing on it various seedlings of *Nothopanax Edgerleyi, Weinmannia sylvicola*, and *Metrosideros scandens*.

Although lianes are common enough, they are not in such abundance as to greatly affect the physiognomy, though where *Freycinetia* drapes the trees here and there it is of course noticeable. Epiphytic asteliads, too, are present, but they are not much in evidence.

A number of other plants are present in the rimu forest, but of special interest are those which are not common. These, as far as noted, are ***Knightia excelsa, Fuchsia excorticata, Aristotelia racemosa, Rhapalostylis sapida, Cyathea dealbata, Olearia Cunninghamii, Geniostoma ligustrifolium, Myrtus bullata.***

(c.) *The Tawa-Towai Sub-association.*

In passing from west to east through the Waipoua Forest after crossing the Toronui Stream and getting on to the higher ground, the following gradual changes are noticed in the forest: (1.) The kauri association gives out at 1,000 ft. altitude or less. (2.) The tarairi association becomes gradually modified. (3.) The tawa enters in more abundantly, and at the same time *Weinmannia*, no longer in its juvenile form, merely a plant of the undergrowth, becomes more abundant as a tree. (4.) Finally taxads become, if not dominant, of major importance. (5.) As the altitude increases the tree-ferns change, *Hemitelia Smithii* and *Dicksonia squarrosa* replacing in great measure *Cyathea dealbata* and *Cyathea medullaris*.

Of course, this sub-association differs a good deal in various places, but an account of a few selected spots may give some idea of the whole.

The western slope of Toetoehatiko gives some notion of the composition of the class of forest under consideration. The following are some of my notes:—*

"*Beilschmiedia tawa* is an important constituent of the Toetoehatiko forest. The undergrowth varies according to whether a thicket of *Astelia-Gahnia* mixed with *Rhipogonum scandens* or merely arborescent vegetation plays a part. The tallest trees at the lower level of the mountain are *Beilschmiedia tawa*, *Podocarpus totara*, *Metrosideros robusta* occasionally, but both the two latter rarer than the first-named. Where open, the trees are straight-trunked, and there is undergrowth of the usual character consisting of *Senecio Kirkii*, *Weinmannia sylvicola*, *Alseuosmia macrophylla*, *Coprosma grandifolia*, *Melicytus micranthus*, *Rapanea Urvillei*, *Lygodium articulatum*, *Blechnum discolor*, *Blechnum Frazeri*, *Microlæna avenacea*, *Freycinetia Banskii*, *Astelia trinervia*, *Geniostoma ligustrifolium*, and the ordinary lianes of the forest. Generally speaking, the mountain vegetation is denser than on the lower slopes. Liverworts of the *Gottschea* type are plentiful, and *Hemitelia Smithii* is an important tree-fern. . . . . Further up, young *Beilschmiedia tawa* is important in the undergrowth, but not physiognomic as in some parts of New Zealand forests; also young *B. tarairi*, *Rapanea salicina* (occasionally), and *Knightia excelsa*. There are low roots all over the ground, moss- and fern-covered. *Blechnum Frazeri* and *Lygodium articulatum* are common. Here and there the trees are climbed by *Freycinetia*. Other plants noted: *Nothopanax arboreum*, *Dysoxylum spectabile*, *Olea montana*, *Cyathea medullaris*, *Schefflera digitata*, *Styphelia fasciculata*. The tree-trunks are frequently mossed. . . . . In other places the forest becomes more open. Here is, *e.g.*, a knee-deep open space of *Freycinetia*, with *Blechnum Frazeri* rising out of it for a height of one or two feet, while the ground beneath is covered with *Gottschea*. . . . . Higher up, *Ixerba brexioides* appears, the other plants continuing as before. All the way there has been abundance of *Trichomanes reniforme* and *Hymenophyllum scabrum*. . . . . Not far from the summit is a close tangle of *Rhipogonum*, some *Freycinetia*, and any amount of hygrophytic leafy liverworts. The trees are hardly more than 30 ft. tall. *Weinmannia* is dominant. Also present are *Metrosideros robusta*, *Dacrydium cupressinum*, and *Podocarpus dacrydioides*. There are large quantities of tall *Dicksonia squarrosa*. . . . . Further on, another close supplejack tangle is encountered, in which is also *Senecio Kirkii*. The floor beneath is crowded with liverworts, while filmy ferns, including *Hymenophyllum tunbridgense* and *H. flabellatum*, are on the trunks of the trees. . . . .

"The plants noted here are *Rapanea salicina*, *Schefflera digitata*, *Coprosma grandifolia*, *Metrosideros hypericifolia*, *Ixerba brexioides*, *Dysoxylum spectabile*, *Hedycarya arborea*, *Blechnum discolor*, *Polypodium diversifolium*, *Hymenophyllum tunbridgense*, *Polystichum adiantiforme*, *Lygodium articulatum*, *Asplenium bulbiferum*, *Hymenophyllum flabellatum*, *Myrtus bullata*, *Pittosporum tenuifolium*, *Griselinia lucida*, *Astelia trinervia*, *Beilschmiedia tarairi*, *Geniostoma ligustrifolium*, *Metrosideros albiflora*, *Dracophyllum latifolium*, *Melicope simplex*, *Cyathea dealbata*, *Podocarpus totara*, *Styphelia fasciculata*, *Hymenophyllum dilatatum*, *Melicytus ramiflorus*, *Asplenium lucidum*, *Beilschmiedia tawa*, *Microlæna avenacea*, *Gahnia xanthocarpa*, *Dacrydium cupressinum*, *Asplenium flaccidum*, *Nothopanax Edgerleyi*, *Histiopteris incisa*, *Rhopalostylis sapida*, *Olearia Cunninghamii*, *Pseudopanax crassifolium*, *Clematis indivisa*.† These are not all together, but at any rate they are not far distant. . . . . Much of the forest towards the River Waipoua, after crossing over the summit of Toetoehatiko, is quite open, the trees being few, while the dominant plants over large areas are the tree-ferns *Hemitelia Smithii* and *Dicksonia squarrosa*, nor are the shrubs which are present of any moment. Such trees as there are are merely dotted about here and there, and there is nothing in such a place approaching a continuous forest-roof. It looks—and the appearance of the trees justifies this idea—as if in such places as this the forest was naturally dying out—a thing which must happen in the course of events. The trees, when present, are *Dacrydium cupressinum* and *Beilschmiedia tawa*, but they are frequently in a state of decay."

Near the eastern boundary of the Waipoua Forest after leaving the rimu belt the following is an example:—

"*Dicksonia lanata* is very common, growing more than breast-high. It varies considerably as to the size of its trunk. With it is very tall *Blechnum Frazeri*. *Weinmannia sylvicola* is a very common tree, reaching a height of 60 ft. It is more slender and regular in its growth than *W. racemosa*. Its bark is pale-grey. The physiognomy is marked by tree-ferns and tree-trunks. Where the ground becomes more open is *Gottschea* on the ground, and colonies of *Blechnum Frazeri*. The shrubby undergrowth there is scanty and consists of young *Senecio Kirkii*, while young *Lygodium* may rise out of the *Gottschea* of the floor. The second tier is made up of drawn-up, slender *Weinmannia sylvicola*, with long, straight stems. Here there is no *Dacrydium cupressinum*, the tall trees being *Metrosideros robusta*, *Beilschmiedia tawa*, *Weinmannia sylvicola*,

*—These notes were taken while climbing the hill to its summit. †—These were growing associated together not far from the summit of Toetoehakito.

with *Freycinetia* as their liane, and the tops distant enough for the sky to be plainly visible. Such trees will be 40 ft. to 45 ft. tall. *Senecio Kirkii* is the chief under-scrub. The floor is uneven. . . . . Again, in another place the trees are one chain, half a chain, and a quarter of a chain apart, their trunks mossed and stout or slender. Thus *Beilschmiedia tawa* is 19 in. in diameter, but many trees are less. The sky shows through everywhere. *Trichomanes reniforme* is common on the trunks. The second tier is chiefly small *Weinmannia*, an occasional *Nothopanax Edgerleyi*, and *Senecio Kirkii*. *Rhipogonum* occurs here and there. *Blechnum discolor* is quite common, but here it does not occupy wide breadths as so frequently in many South Island forests."

Here are further extracts from my notes dealing with various situations in the eastern Waipoua Forest:—

Going down slope into North Branch of River Waipoua.—"The trees are distant and open, and in the undergrowth is an occasional plant of *Astelia trinervia*. The second tier consists of *Ixerba*, *Weinmannia sylvicola*, *Knightia excelsa*, moderate-sized *Cyathea dealbata*, *Alseuosmia macrophylla*, *Rapanea salicina*. There is plenty of small *Freycinetia* on the ground and small *Coprosma grandifolia*.

"From the physiognomic standpoint the first tier is of moderate-sixed trees of *Beilschmiedia tawa*, which is dominant, and the second tier of straggling shrubs and small trees, together with breast-high *Blechnum Frazeri* and *Freycinetia*, also some *Styphelia fasciculata*, and as the creek is approached tall *Blechnum capense* gets more and more abundant. On the ground is some *Blechnum filiforme*." . . . .

Steep bank in perfect shade.—"This is closely draped with the very dark-coloured fronds of *Blechnum nigrum* and *Trichomanes elongatum*, hanging downwards; also a few green liverworts and lichens between. Above them and out of the bank juts *Blechnum capense* and some *Freycinetia*. In front and still more shutting out the light is a tall *Hemitelia Smithii* or two. Near by is a small gully full of tree-ferns, for the most part *Hemitelia*. . . . . Further on, the undergrowth is dense with *Rhipogonum*, *Coprosma grandifolia*, and tree-ferns. There is abundance of *Blechnum capense* and *Dryopteris pennigera*. Tall trees are almost absent; ferns and *Rhipogonum* supply all the undergrowth. Here is a tall rata, there a moderate-sized *Weinmannia*, and here again a small *Laurelia*. The trees are covered with *Blechnum filiforme*, and seedlings on the floor are more abundant. The sky is quite open through the tree-tops. There is a large *Dacrydium cupressinum*, small *Beilschmiedia tarairi*, *Geniostoma*, and *Rubus schmidelioides* in plenty climbing over the low shrubs. From semi-horizontal boughs *Hymenophyllum dilatatum* hang downwards. There is some small *Olearia Cunninghamii*, and, where open, a little *Aristotelia racemosa*. *Beilschmiedia tawa* is in abundance, and *Polypodium grammitidis* on the leaning trunks. . . . . Here one looks through a close mass of irregular and entangled undergrowth in a small gully leading to the creek. There is, *e.g.*, *Melicytus ramiflorus*, a young *Beilschmiedia tarairi*, *Weinmannia sylvicola*, *Coprosma grandifolia*, &c. One can see no distance ahead for the close greenery and slender trunks and stems. There is *Weinmannia sylvicola*, *Beilschmiedia tawa*, *Geniostoma*, and *Rhipogonum*."

Slope, very steep and moist.—"Plenty of *Asplenium bulbiferum* on the ground. Here is *Coprosma grandifolia*, *Geniostoma*, *Beilschmiedia tarairi*, and *Schefflera digitata* The stems are slender and liane-like. The *Cyathea medullaris* may be 30 ft. tall. There is arching *Blechnum capense* with fronds 9 ft. long, one above the other, and forming the physiognomic mark. Their fronds are bright-green in colour, but are very frequently blotched or stained with dark-purple."

North Branch of River Waipoua.—"Here are the leafy (*Plagiochila*, &c.) liverworts in abundance. Also *Hymenophyllum ferrugineum* is common and some *H. australe*. These on tree-ferns and stones of bank. *Blechnum capense* of great length hangs down to the water's edge. *Blechnum lanceolatum* is common, and more or less pressed to the ground. The boulders are covered with liverworts. A tree across the creek glistens with kidney fern. *Microlæna* is on the ground. Slender trees of irregular shape meet and almost meet with their branches across the creek. The trees are *Ixerba*, *Weinmannia*, *Fuchsia*, *Schefflera* (*i.e.*, over creek). On the stones is *Nertera depressa*."

We now cross the creek and proceed up and along the steep bank.—"There is a dense tangle of the various trees, which are low-growing and bound with *Rhipogonum*. These and the tall ferns (*Blechnum capense* and *Dryopteris pennigera*) all touch. There are no tall trees, but only the close growth of *Blechnum capense*, *Weinmannia sylvicola*, small *Hemitelia Smithii*, *Coprosma grandifolia*, *Asplenium bulbiferum*, *Schefflera digitata*, and *Freycinetia Banksii*. The trees are merely two or three inches in diameter. The stems are long and bare, and have their tops touching. Beneath is *Blechnum capense*. The creek is rushing below and trickling in small streams amongst the ferns. The trees are here merely ten or twelve feet tall, and fairly close. All that strikes the eye is a close tangle of greyish stems and branches, and green arching ferns, and circinate paler green and reddish young leaves and buds. Here and there is some *Freycinetia*. The straight stems, always more or less moss-covered, are one, two, or even more feet distant, and may be parallel or the contrary. Out of the close mass a black tree-fern rises out occasionally, especially towards the upper margin of the gully."

On to the ground above the creek.—"Here, again, is normal forest. The trees are 50 ft. tall, and the forest is open and flat. It consists of *Podocarpus ferrugineus*, a large amount of *Weinmannia sylvicola*, *Beilschmiedia tawa*, *Melicytus ramiflorus*, groves of *Dicksonia squarrosa*, and a certain amount of *Dacrydium cupressinum*, with *Freycinetia* as the liane. As under-shrubs are *Myrtus bullata* and *Senecio Kirkii*. All over the ground is *Freycinetia*, the height of a man, together with *Blechnum Frazeri* and *Hymenophyllum demissum* in sheets, with many small, shrubby growths, and above these low-trunked *Dicksonia squarrosa*, while there is also an occasional

Cyathea dealbata. The surface of the ground is quite uneven owing in part to low, creeping roots, and in greater measure to stones and fallen logs, all of which being moss- and fern-covered affect the physiognomy of the forest. *Metrosideros hypericifolia* also, as so frequently elsewhere, creeps over the ground. As for the crowns of the trees, these do not touch, and the upper covering is thus quite open. The trees here, as listed, are *Dacrydium cupressinum* here and there, *Beilschmiedia tawa*, *Weinmannia sylvicola*, and also *Rhipogonum*, young *Laurelia*, and an occasional *Styphelia fasciculata*. *Hymenophyllum dilatatum* hangs from trees, &c., as usual, and there are plenty of mosses. A pale-green filiform liverwort is at times conspicuous, and there are plenty of the tall leafy forms. *Astelia Solandri* is plentiful in the trees, and it is also frequent on fallen logs. Where most open there is *Microlæna* in abundance, and then only young trees— *e.g.*, *Weinmannia*, *Suttonia salicina*, and *Blechnum Frazeri* and *Freycinetia*. In such open spaces the latter, man-high, may exclude all else. Also here and there is almost an open sky. . . . . Another natural opening has *Freycinetia* dominant in some places and *Microlæna* in others, and there are shrubs and small trees, &c.—*e.g.*, *Weinmannia*, *Beilschmiedia tawa*, *Dicksonia squarrosa*, *Podocarpus ferrugineus*, *Rapanea salicina*, *Dracophyllum latifolium*, *Freycinetia*, *Blechnum Frazeri*, *Lygodium*, *Metrosideros florida* on the ground, and *Styphelia*. The adjacent forest contains a good deal of *Dacrydium cupressinum* and *Metrosideros robusta*, but their boughs do not meet."

5. Associations of Wet Ground and Swamps. (Photo 15.)

(a.) General Remarks.

Wherever the drainage is defective the ground remains permanently wet, while in no few cases pools of water lie on the surface. Such places, it can be well understood, support a special plant population, the leading members of which, if not absolutely confined to such ground, exist there in greater luxuriance and numbers than elsewhere. Gullies and river-flats also are frequently much wetter than the average forest, and here, too, certain plants, rare or absent elsewhere, occur. The following are the principal swamp or wet-ground species, some of which, however, as may be seen from what has gone before, are quite common in the ordinary forest:—

Filices: *Blechnum capense, Dryopteris pennigera, Dicksonia squarrosa.*
Taxaceæ: *Podocarpus dacrydioides.*
Pandanaceæ: *Freycinetia Banksii.*
Urticacæ: *Elatostemma rugosum.*
Monimiaceæ: *Laurelia novæ-zelandiæ.*
Rosaceæ: *Rubus schmidelioides.*
Myrtaceæ: *Eugenia maire.*
Rubiaceæ: *Coprosma tenuicaulis.*

The only swamps of importance are the Ngaruku, north of the Kohuroa Heath, a smaller one south of Omaia, several wet flats along the River Waipoua, and certain small pieces on the high land of the east. The swamps naturally fall into two categories—(1) those in which the kahikatea (*Podocarpus dacrydioides*) is the dominant member, and which is in miniature identical with the similar formation so extensive along the Kaipara Harbour and elsewhere; and (2) those where *Gahnia* and *Freycinetia* are dominant, arborescent plants playing a very secondary part. Finally there are the moist river-flats and gullies, these rather a part of the tarairi or tawa-towai associations than of the swamp

(b.) The Kahikatea Association.

The ground is excessively wet, pools of water occurring everywhere, so deep in places as to take one up to the knee. Fallen trees lie on the ground, and along these is the only comfortable but slow method of progression. *Podocarpus dacrydioides*, with slender mast-like trunk 80 ft to 100 ft. tall, and slender fastigiate heads, rise up on all sides, but not close together as in a typical kahikatea forest. Rather than the trees is the undergrowth the main feature. This consists of a tangle of the kiekie (*Freycinetia*) on the ground and climbing the trees and shrubs. Everywhere, but not close, are slender-stemmed plants of the maire-tawake (*Eugenia maire*). The piu (*Blechnum capense*), its fronds four or five feet long and close together, forms thickets. Fair-sized plants of the slender tree-fern *Dicksonia squarrosa* are in groups or singly here and there. *Dryopteris pennigera*, here with a slender trunk 3 ft. or so tall and elegant green fronds, is common. The thin-leaved juvenile form of the rose-leaved bush-lawyer (*Rubus schmidelioides*) creeps over the wet ground or climbs up the tree-fern trunks, as also does the lobed-leaved form of *Muehlenbeckia complexa*. The black stems of the supplejack (*Rhipogonum scandens*) are much in evidence, rising out of the water and forming entanglements. Finally, there is abundance of juvenile *Weinmannia sylvicola*, distinguished here as elsewhere by its pale yellow-green leaves.

The swamp forest of the uplands near the Opanake Road is somewhat different. Here *Laurelia novæ-zelandiæ* is abundant, and at times it forms considerable colonies to the exclusion of all other trees. There is abundance of the reddish and thin-leaved *Eugenia maire*. *Rhipogonum* and *Freycinetia* form the usual entanglements. *Podocarpus dacrydioides* is present in quantity in some places, while the small-leaved, slender-twigged *Coprosma tenuicaulis*, a shrub of graceful habit, and the shining green-leaved broadleaf (*Griselinia littoralis*) are plentiful, growing in the wettest ground.

Blechnum capense and *Dryopteris pennigera* are common in many places. *Weinmannia sylvicola*, *Coprosma grandifolia*, and *Fuchsia excortica* grow mixed with the other plants. Finally, the tree-ferns *Hemitelia Smithii* and *Dicksonia squarrosa*, this last the more abundant, are present.

7. A View of Bush of Kauri forest, Pukehiwera Hill.

Plate [illegible]

8. A Glade in *Bush* or *Forest*. In background Kauri grass (*Astelia trinervia*).

Plate [illegible]

(c.) Gahnia Swamp.

The chief example of this is the Ngaruku Swamp. Owing to the very wet season there was too much water for an examination of the most typical part of the swamp; my notes, which follow, refer only to the vicinity of its margin:—

"The swamp here should be called rather semi-swamp, and I doubt much if water lies in any considerable quantity during the summer, but now pools lie all over the track, and the amount of mud is indescribable.

"The tall trees are distantly scattered here and there. *Dacrydium cupressinum* is the most abundant, but the whole expanse of sky is everywhere visible, the tall trees offering no obstruction to the light. Besides the rimu are *Podocarpus dacrydioides*, *P. totara*, *Weinmannia sylvicola*, *Beilschmiedia tawa*.

"The chief physiognomic plant is *Gahnia xanthocarpa*, the tussocks, individually of great size, touching, and rising high above one's head. With this is plenty of immense *Blechnum capense*, *Freycinetia Banksii*, and *Dicksonia squarrosa*. *Rubus schmidelioides*, as a low bushy liane, scrambles over the young trees in many places, and there is at times a good deal of *Rhipogonum scandens*

"Out of the tussocks rise, dotted and not forming thickets, many saplings to a height of five or six feet above the tussock, especially the graceful yellow-leaved young *Quintinia serrata* and *Ixerba brexioides*, also *Nothopanax arboreum* and *Coprosma robusta*, all these having slender stems. The ground itself is most uneven. Everywhere are horizontal roots and fallen trunks. Other small trees which are abundant are *Pseudopanax crassifolium*, *Weinmannia sylvicola*, and near the edge of the semi-swamp, *Leptospermum scoparium*. Where not so wet numerous kauris are associated with the rimus, and then more of the ordinary kauri association appears. Even in wet places there is a quantity of *Blechnum Frazeri*, and at times the kauris themselves grow right in the wet ground. As for the general physiognomy, the eye meets tussock-tops and the distant slender young trees rising out of the lower density. Above the whole are kauris 100 ft. tall, but these are not in the swamp. Also here are *Dicksonia squarrosa*, *Coprosma robusta*, plenty of *Blechnum capense*, and abundance of *Rubus schmidelioides*."

The swamp to the south of Omaia Hill contains but few trees. It is one close mass of extremely tall *Gahnia* tussock, mixed with a very great quantity of *Blechnum capense*, the leaves of immense size, *Pittosporum tenuifolium*, *Styphelia fasciculata*, *Weinmannia sylvicola*, *Nothopanax arboreum*.

(d.) River-flats, &c.

These belong rather to the general forest than to the swamp, and their vegetation is connected therewith by intermediates according to the gradually decreasing wetness of the ground. Where the ground is wettest the trees are of low stature, or there may be a shrubby growth only. The pukatea (*Laurelia novæ-zelandiæ*), marked by its far-spreading roots, buttressed trunk, and shining green, simple, toothed leaves, is common. Palms, quite without trunks but with leaves 5 ft. long or more, held in a semi-erect position, may be numerous. *Dryopteris pennigera*, with its bright-green and rather thin fronds raised high on slender trunks, which may be 3 ft. tall and 2½ in. in diameter, will be abundant, and the pale *Schefflera digitata* is an extremely common shrub. Where specially damp the far-creeping *Elatostemma rugosum* will cover the ground for many square yards, the succulent stems, bearing the bronzy-coloured leaves, rising up to quite 3 ft. in some places, while the *Dryopteris* and *Dicksonia squarrosa* grow out from the mass. *Rubus schmidelioides* will creep in abundance over the floor, but in the juvenile form only, and present also may be *Asplenium bulbiferum*, with small plants on the leaves; *Melicytus ramiflorus; Coprosma grandifolia; Nothopanax arboreum; Myrtus bullata;* and *Dysoxylum spectabile*, most of which are not specially plants of wet ground. The supplejack (*Rhipogonum*) is also a very frequent plant of the wet gullies. Finally, large clumps of *Hymenophyllum demissum* may be on the wet ground.

The change of the vegetation from the wet to the dry ground in some places is most striking. Thus in a piece of forest south-west of Pukehurehu is a piece of flattish swampy ground where water lies, and *Rhipogonum* and *Freycinetia* make an impenetrable tangle, *Eugenia maire* growing through them. But, closely adjoining, where the ground is dry, the tarairi is dominant, and there are many young palms and much *Blechnum Frazeri*.

6. The Transition Forest.

In many parts of the Waipoua Forest where it adjoins the "heath," its character altogether changes, certain of the heath-plants entering in, other ordinary members of the forest being absent, and others, again, increasing in numbers and assuming a prominence unknown in the tarairi or other associations. This forest is important, not merely as another combination of species, but from it some evidence may be gathered as to the history of kauri forests in general. The most interesting piece of this association examined was some short distance without the reserve, but it seems well to describe it notwithstanding. The forest in question consists of closely growing slender trees, with small heads, of *Weinmannia sylvicola*, together with an equal quantity of similarly slender *Leptospermum scoparium* and an undergrowth of *Lycopodium densum*, *Blechnum Frazeri*, seedling totara and rimu, *Senecio Kirkii*, *Astelia trinervia*, some *Cyathea dealbata* and *Blechnum discolor*, *Rubus schmidelioides*, young *Podocarpus ferrugineus*, *Styphelia fasciculata*. *Lycopodium densum* is dominant as the floor-plant, but in some places is a close mass of *Blechnum Frazeri*. One plant was noted of *Metrosideros robusta*, 6 ft. tall and on its own roots.

A similar association had the trees 25 ft. to 30 ft. tall. Besides the *Weinmannia* and *Leptospermum*, was *Knightia excelsa*. The other plants were much the same as above, but there was

also *Astelia trinervia, Geniostoma, Fusanus Cunninghamii,* a little juvenile *Dacrydium Colensoi, Coprosma robusta, Podocarpus totara, Rapanea Urvillei, Gahnia xanthocarpa, Dracophyllum latifolium. Leptospermum scoparium* was the dominant tree.

On the southern side of the Waipoua Reserve the formation gives place to heath, but between the two there is evidently a connection or transition. This is shown by the mixture of forest and heath plants at the junction of both and by the presence in the forest itself of such heath-plants as *Lycopodium densum* (Photo 16), *Styphelia fasciculata,* and *Cordyline Banksii.*

The transitional forest consists of *Leptospermum ericoides, Knightia excelsa, Weinmannia sylvicola, Melicytus ramiflorus,* and *Olearia Cunninghamii* as trees or low trees, and young *Knightia, Geniostoma,* and *Brachyglottis* as undergrowth. Here, too, in some places, *Cyathea dealbata* is dominant, its trunk man-high or less, and its great fronds arching laterally. Then *Leptospermum scoparium* becomes dominant, and this gives place finally to the true heath.

The most interesting feature of this transitional forest is the presence of young kauri, totara, and even rimu, in much greater abundance than seedlings of these occur in the true-forest interior. Moreover, juvenile kauri occurs as a rule near the general forest outskirts, an important point to be noted and dealt with further on.

The following quotations from my notes give some idea of the transition forest in various parts of the Waipoua Reserve:—

"Passing out of the tarairi-kauri forest on to the open heath, *Lycopodium densum* is knee-deep and mixed with tall *Blechnum capense.* Growing through this dominant undergrowth is *Leptospermum ericoides* and *Senecio Kirkii, Styphelia fasciculata,* moderately tall *Knightia excelsa,* young *Podocarpus totara, Coprosma lucida, Persoonia toru,* and young *Weinmannia,* with an undergrowth of *Gahnia* sp., *Lycopodium volubile, Blechnum Frazeri, Dianella intermedia.* . . . . Here is a low, dense forest, in which manuka (*Leptospermum scoparium*) is dominant. The undergrowth consists of a dense growth of *Astelia trinervia,* 5 ft. tall, mixed with bracken of an equal height. . . . . The manuka is 12 ft. to 14 ft. tall, its erect stems quite close. On the ground are seedlings of *Quintinia serrata, Senecio Kirkii, Weinmannia,* and young *Dacrydium cupressinum.* There is also tall *Nothopanax arboreum,* equal to the manuka in height, and abundance of *Quintinia serrata,* man-high or less, quite slender and little-branched. . . . . Here is a low forest 30 ft. tall. The dominant tree is *Leptospermum scoparium,* with very small heads. Then there is *Persoonia toru* with round heads, *Quintinia serrata, Rapanea Urvillei, Nothopanax arboreum,* and moderate-sized *Weinmannia.* The undergrowth is 6 ft. or so tall, and quite dense, and consists of *Astelia trinervia, Blechnum capense, Alseuosmia macrophylla, Senecio Kirkii.* The straight, slender, greyish stems of the manuka growing closely together, and the green, dense mass of *Blechnum capense* and *Astelia,* give the character to the association. On the floor, where more or less open, is *Lycopodium densum* and *L. volubile.* There are a few tree-ferns (*Cyathea dealbata*) and some young totara, *Weinmannia,* and *Styphelia fasciculata.* Near the outskirts tall *Dracophyllum Urvilleanum,* manuka, the common bracken (*Pteridium esculentum*), and *Lycopodium densum* form the undergrowth." . . . .

"On the south side of the Omaia Heath is a low forest. The undergrowth consists of *Blechnum capense* (with very long fronds), *Gahnia xanthocarpa, Astelia trinervia, Blechnum Frazeri.* and a good deal of *Dicksonia lanata* forming close thickets. The trees are *Podocarpus totara, Leptospermum ericoides, Weinmannia sylvicola,* slender *Quintinia serrata, Ixerba brexioides,* and *Dacrydium Kirkii.* Other plants of the undergrowth are *Senecio Kirkii, Cyathea dealbata, Coprosma grandifolia,* small *Dacrydium cupressinum,* and through the undergrowth some *Lycopodium densum.*

"Further on, the forest undergrowth makes a dense tangle. There is *Styphelia* in plenty, young *Podocarpus ferrugineus, Alseuosmia macrophylla,* young kauris, occasional young *Libocedrus Doniana, Geniostoma,* and *Phebalium.* . . . . Here on about a square yard are *Alseuosmia, Senecio Kirkii, Weinmannia sylvicola, Melicope simplex* (this is not a common plant, though frequently occurring in isolated examples), young *Dracophyllum latifolium;* and, close to above, *Cyathea dealbata, Phebalium nudum, Geniostoma, Nothopanax arboreum, Styphelia fasciculata*—in fact, nearly all the undergrowth plants. *Beilschmiedia tarairi* is here almost wanting."

On a ridge above the Waipoua River, at the south end of the forest, is an interesting example of the association under consideration. It is distinct from the forest proper, and is noteworthy principally for three reasons: (1.) The association is a forest-heath transition, but with more of forest character than usual. (2.) There is an abundance of young kauri-trees at various stages of development, and it looks as if the final destiny of such an association would be kauri forest proper. (3.) It contains also large numbers of seedlings and young trees of *Dacrydium Kirkii* and *Phyllocladus trichomanoides.* Generally speaking, a large percentage of the ordinary forest-plants are present, and with these are certain of the heath-plants. Here are some details:—

"This is a piece of forest consisting chiefly of small *Weinmannia sylvicola.* The trunks are straight, but occasionally leaning, and may be 6 in. in diameter, 30 ft. to 35 ft. tall, and quite unbranched except at the upper fourth, the branches sometimes spreading or at other times forming a compact head, semi-erect, and the leaves close together. Other trees are 5 in. in diameter, and some are smaller. Mixed with these is *Leptospermum ericoides,* also with small or spreading crowns, but sometimes of considerable diameter of trunk. Through their small leaves the light can penetrate. The brown bark sheds off in long strips. Many of the trunks are very straight, but some are leaning. There is also some *Olearia Cunninghamii,* but this is usually of irregular form and frequently much out of the perpendicular; its bark, too, is deciduous. This part just described is below the actual slope, on which the trees become smaller, while on the other hand the species are much more numerous, small *Knightia excelsa* especially being abundant. On the ground, which is mostly rather bare, are small and large (*i.e.*, without trunks, with small trunks,

and with medium trunks) *Cyathea dealbata;* cushions of a small, dense-growing, green and brown plagiotropous moss, and many quite small seedlings of *Senecio Kirkii*. Other seedlings are *Melicytus ramiflorus, Coprosma grandifolia, Rapanea Urvillei*. Above these are a few straggling *Weinmannia sylvicola, Beilschmiedia tarairi*, and *Senecio Kirkii*, man-high, and some taller *Leptospermum ericoides*. Scattered more or less thickly in places is *Blechnum capense* of moderate size There is also tall *Senecio Kirkii* and straggling *Styphelia fasciculata*. The *Senecio* is very irregular in habit of growth, the stems bare and spreading, and with rosettes at the ends of the ultimate branchlets. On the *Leptospermum* is *Hymenophyllum sanguinolentum*. Mixed with the *Blechnum capense* is *Lycopodium densum*. There are a few small *Beilschmiedia tarairi* seedlings.

"As the ridge becomes steeper and drier all the members are much smaller. Trees of *Knightia excelsa* appear and become numerous, also many tussocks of *Astelia trinervia*. *Leptospermum ericoides* is dominant. Here also are numerous young plants of kauri, totara, *Dacrydium Kirkii*, and above all *Phyllocladus trichomanoides* from mere seedlings to young trees. One juvenile rimu was noted. *Pteridium esculentum* is present here and there, a few seedlings of *Beilschmiedia tawa*, some *Dianella intermedia*, and an odd plant or so of *Persoonia*. Above all, the silver tree-fern plays a conspicuous part."

To sum up, the association consisted chiefly of *Leptospermum ericoides, Knightia excelsa, Weinmannia sylvicola, Phyllocladus trichomanoides;* and, of lesser importance, *Astelia trinervia, Cyathea dealbata, Styphelia fasciculata*, young *Agathis australis, Lycopodium densum*, and *Blechnum capense*. As the kauri association proper is neared, *Blechnum Frazeri* enters in.

Near the southern end of the Kohuroa Heath is a small transition piece of forest consisting in part of *Leptospermum scoparium* and in part of low forest-trees of the ordinary type. It is essentially distinguished by the presence of small *Dacrydium cupressinum* and *Podocarpus totara*, and by *Persoonia toru* on its outskirts, this latter just coming into bloom, and noticeable through its brownish-green colour. Also close at hand is a different association, where *Leptospermum* is dominant. My notes say,—

"Small, symmetrical, yellow-green, drooping *Dacrydium cupressinum* and *Podocarpus totara* of similar size, this latter with *Polypodium grammitidis* and *Hymenophyllum sanguinolentum* on the bark. The plants noted are *Olea lanceolata*, with dark-green, coriaceous, moderately-thick leaves; *Beilschmiedia tawa; B. tarairi; Geniostoma; Senecio Kirkii; Knightia excelsa; Hedycarya arborea; Dysoxylum spectabile; Pseudopanax crassifolium; Olearia Cunninghamii; Weinmannia sylvicola;* the climbing species of *Metrosideros; Blechnum Frazeri; Alseuosmia macrophylla; Litsea calicaris; Blechnum capense*. In the *Leptospermum* forest we have *Leptospermum scoparium, Knightia excelsa, Weinmannia*, and seedlings of various kinds. On the floor is a close mass of *Lycopodium densum* and *L. volubile*. Also there is some *Olearia Cunninghamii, Blechnum capense*, and *Astelia trinervia*."

C. THE NORTHERN HEATH.

A very common plant formation in New Zealand is that in which the manuka (*Leptospermum scoparium*) is the dominant plant, and to which I have in previous writings given the name of "heath." The consitituents of this formation vary considerably in proceeding from north to south, the species gradually getting fewer in number. The formation as it occurs in the northern floristic province is certainly worthy of a special name, and for this I have proposed the title of "the northern heath."

This formation occupies large areas in the Auckland Provincial District at present of little use to the Dominion except as gumfields, and the turning of these into agricultural land is one of the most important problems confronting scientific agriculture in New Zealand.

The northern heath is fairly uniform as to its members, though certain species are confined to the far north, such as the curious parasite *Cassytha paniculata*.

So far as the Waipoua Forest area is concerned, the heath plays no prominent part, certain patches being included in the south and west, while the summits of some of the hills — notably Omaia, Kohuroa, Huaki, and Tarahoka—are open spaces occupied by northern heath, and locally called "fern."

The northern heath as a whole has never been described botanically, and requires a very detailed examination, both from the scientific and economic aspects. As, however, this report is intended to deal principally with the forest, the present account of the formation is purposely quite brief.

Besides the manuka, certain other plants are present in numbers, and assist in marking the physiognomy of the heath. The most important are—(Filices) *Pteridium esculentum, Gleichenia circinata;* (Lycopodiaceæ) *Lycopodium densum, L. laterale*, in wet places; (Cyperaceæ) *Schœnus brevifolius, S. tendo; Lepidosperma laterale;* (Iridaceæ) *Dianella intermedia;* (Cunoniaceæ) *Weinmannia sylvicola;* (Rhamnaceæ) *Pomaderris phylicœfolia;* (Myrtaceæ) *Leptospermum scoparium;* (Epacridaceæ) *Dracophyllum Urvilleanum, Epacris pauciflora, Styphelia fasciculata*. Here and elsewhere on the heath is *Cordyline Banksii* without trunks and of the tussock form.

Were the heath elsewhere being dealt with, *Pomaderris elliptica* and *P. Edgerleyi* would have been also included.

Generally speaking, this association within the forest-area has been burnt again and again by the gum-diggers in order to clear the ground for their operations, the whole of the gumfields of northern Auckland belonging to this association; so it is possible that at the present time but little of the heath within the forest area is in a virgin condition, though introduced plants have gained a foothold to so small an extent that it is probable that even after repeated burnings the heath reproduces itself much as it originally was, and the various stages of redevelopment give a valuable clue towards the evolution of the formation in general.

The Kohuroa Heath.

"This is a fern-clad hill surrounded by forest. Small, fastigiate manuka, 3 ft. or more tall, rises for about 20 in. above a dense undergrowth, the plants all touching one another and making a close mass, which has the following composition: *Gleichenia circinata* is abundant, its fronds horizontal and the segments arching upwards, yellow-green in colour and flecked with brown, the wiry fronds all entangled together. Above this arches the bracken, which is usually not so tall as the manuka. Standing up for more than 2 ft. above the *Gleichenia* at intervals of 6 ft. or more are the erect, sparsely or moderately branched plants of *Weinmannia sylvicola*, the leaves almost yellow, horizontal and semi-horizontal, pinnate, with four or five segments, and having dark, purplish-brown, brittle stems about ½ in. in diameter. These contrast most strikingly with the dull-green, or at times reddish, small-leaved *Leptospermum* and the dark-green bracken. About the height of the *Gleichenia*, or a little more, are large quantities of the erect, yellow-green, conifer-looking *Lycopodium densum*, with its much divided branches given off abundantly from the main axis. Forming part of the undergrowth is a good deal of the small form of *Blechnum capense*, it also of a yellowish-green hue. In some places, rising even 3 ft. or more above the manuka or rather taller than the *Weinmannia*, are fastigiate bushes of darkish-green *Dracophyllum Urvilleanum*, the almost black, and stiff, slender, main stems, and wiry, twiggy, semi-erect branches, contrasting with the nearly vertical green leaves and their dark-purple apices. Dark-green, smooth, terete stems of *Schœnus brevifolius* emerge from the general mass. In places, and covered with its pure-white blooms, is *Epacris pauciflora*, the dull-green and reddish small leaves, which at times are quite reddish-purple, and its white flowers, giving a special character to the scene. Here and there is an upright tussock of *Dianella intermedia*, or a spreading one of bright-green *Gahnia Gaudichaudii*, or a pale yellow-green shrub of *Styphelia fasciculata*, while at the margin of the forest *Cordyline Banksii*, raised on a slender trunk from 3 ft. to 6 ft. tall, is common."

The Heath on Summit of Omaia Hill.

"This was probably originally low forest, with manuka dominant, just as now exists on its borders and stretches for a considerable distance to the west. The heath itself shows various stages of burning, and, where water can lie, changes its character altogether and becomes a sphagnum bog. The original formation, or, at any rate, the first growth after one burning near the margin of the forest, consists of dull-green *Leptospermum scoparium* 10 ft. tall, the plants very slender and only a few inches apart, mixed with *Epacris pauciflora*, erect, 5 ft. tall, and of a shining bright-green or reddish colour; bracken (*Pteridium esculentum*) of equal height; young yellow-leaved *Quintinia serrata;* the yellow-green, slender umbrella fern, *Gleichenia dicarpa*, its fronds climbing up through the close undergrowth; dull-green *Lycopodium densum; Blechnum capense;* erect *Dracophyllum Urvilleanum;* a little *Weinmannia sylvicola*, conspicuous through its yellow leaves; and some long-stemmed *Nothopanax arboreum*. Here and there are tussocks of the pale-green *Astelia trinerve*.

"Where the heath has been burnt several times and is exposed to sun and wind, bracken, knee-deep, is dominant. The soil in places shows through this covering, and it is dotted about with young *Dracophyllum Urvilleanum*, young *Epacris pauciflora*, and young manuka. Through the whole fair-sized tussocks of *Astelia trinervia* are scattered about at rather irregular intervals of from 3 ft. to 9 ft. apart, forming tufts of pale green, 29 in. tall and 43 in., more or less, in diameter. The *Astelia* is frequently red or reddish-purple near the extremities of the leaves, or these may be bright reddish-purple over the whole surface. There is also an occasional pale yellow-green *Weinmannia sylvicola*, the height of the bracken; and there are some clumps of *Dianella intermedia*, with yellowish-green arching leaves; small plants, a few inches tall, of the brownish-leaved *Gaultheria antipoda* and the erect-growing *Dracophyllum Urvilleanum*, its long, narrow, pointed leaves held vertically and more or less stained with red.

"In another part of the heath the umbrella fern, here not climbing but forming a close mass, its horizontal leaves interlacing and pale-green in colour, replaces the bracken. Tussocks of the sedge *Schœnus tendo* are common. Where the ground becomes boggy the *Gleichenia* is still dominant; there are hummocks of sphagnum, and the small club moss *Lycopodium laterale* forms a mat."

On the east of Puketurahu and close to the forest is a possibly virgin piece of heath formation growing on a steep slope. The tall bushes of juvenile *Weinmannia*, their yellowish leaves giving them a striking appearance, are everywhere, and between them *Dracophyllum*, *Epacris*, bracken, *Dianella*, *Styphelia fasciculata*, *Lycopodium densum*, *Gaultheria antipoda*, *Pimelea lævigata*, *Pomaderris phylicæfolia*, the two rush-like species of *Schœnus*, and numerous green clumps of the flat-leaved and -stemmed *Lepidosperma laterale*.

"On the edge of the forest are *Persoonia toru*, *Coprosma robusta*, *Senecio Kirkii*, *Olea Cunninghamii*, *Rapanea Urvillei*, small totara, *Dysoxylum*, *Knightia*, *Litsea calicaris*, and *Cordyline Banksii*, here with a tall and slender trunk. (Photo 18.)

"Between the eastern boundary of the Forest Reserve and the sea the low hills, intersected with many gullies, large and small, are covered everywhere with a dull-coloured mantle of the northern heath, and, although beyond the limits of the forest, a few words as to the vegetation of this area seem necessary. The formation keeps a more or less uniform character, and is made up of all the heath-plants previously noted, together with others, some of which, such as *Epilobium junceum*, *Lycopodium volubile*, *L. cernuum*, *Danthonia semiannularis*, *Geranium microphyllum*, *Drosera auriculata*, *Hydrocotyle asiatica*, *Lindsaya linearis*, *Coriaria ruscifolia*, and *Pelargonium australe*, occur also within the forest-area. The presence or absence of certain plants also, to a greater or lesser degree, changes its physiognomy. For instance, *Pomaderris Edgerleyi* is not everywhere, but increases in quantity as the coast is neared, as also does the parasite *Cas-*

(95) Piece of Kauri Subassociation in the Waipoua Forest, with Kauri (*Agathis australis*) in centre, 5 ft. in diameter, and an Undergrowth of Kauri grass (*Astelia trinervia*).

Photo., L. Cockayne.

(96.) Interior of Open Kauri forest, showing the Slender Tawari Trunks and Kauris to right and left in background.

Photo., L. Cockayne.

sytha paniculata. This latter plant consists of cord-like, pale-yellow stems, which wind the one round the other and round the various shrubs which they attack, making veritable entanglements so that one can easily trip over these horizontal cords. The sign of the coast is twofold—namely, the prostrate habit of *Leptospermum scoparium*, *Styphelia fasciculata*, and other shurbs, owing to the increase of wind and sandiness of the substratum; and, secondly, the appearance of *Cassinia retorta*. All stages of burning and of reproduction of the heath are present, and it is clear that perhaps there is nothing left of the original vegetation. On flat ground and in gullies are swamps and bogs, distinguished at once by their greener colour, which is owing to the presence of the *Schœnus*. Where such swamps are of larger size, *Phormium tenax* and *Cordyline australis* enter in. The soil is very wet during the winter and spring months, but in the summer it becomes extremely dry and hard, and suitable only for xerophytes. It consists of a stiff yellow or whitish clay, with a more or less deep covering of peaty humus. So peaty is the ground indeed that the water filling the numerous holes made by the gum-diggers has the colour of strong tea. On the burnt ground *Drosera auriculata* is one of the first plants to commence recolonisation. *Gleichenia dicarpa* and *Lycopodium laterale* are the characteristic plants of the bogs, where also is more or less *Blechnum capense*."

The special ecology of the heath-plants must be passed over with but a few words. They are for the most part strongly xerophytic, a condition demanded by the extremely dry ground of summer and the peaty water of other seasons. Small leaves of the ericoid habit, isolateral stems and leaves, prostrate growth, and coriaceous, hard leaves, are among some of the principal adaptations.

An interesting fact is the occurrence occasionally of very stunted examples of the kauri on the heath itself.

PART III.—ECOLOGY OF THE FOREST AND ITS MEMBERS.

A. GENERAL ECOLOGY OF THE FOREST.

The Waipoua Forest, as has been clearly shown, varies much in the combination of its species in different parts, in their relative proportion, their density, and so on. In some places it is open, in others there is a close undergrowth; this tree is dominant here, and that one there; in fact there is no uniformity.

Although it is quite impossible to explain in any manner approaching definiteness this state of affairs, certain general principles seem to govern the matter. The heavy rainfall and large number of rainy days sufficiently account for the presence of the forest as a whole—in fact, it is rather hard to see why a shrub-formation such as the heath should be present. Leaving this matter aside for the time being, variation in altitude accounts for the zonal arrangement of the forest, certain of the northern plants, like those of New Zealand in general, being very close to their cold-enduring capacity, and with the absence of special members, others, originally or elsewhere kept in check, can increase in number. Thus, at a low level and with certain soil-conditions the tarairi can overcome the tawa or the rimu. These soil-conditions are inextricably bound up with the water-holding capacity of the soil, and in the forest as elsewhere change of water-content, and that but slight, means change of vegetation, the presence of *Schefflera digitata* or the special abundance of palms in the moist hollows being excellent examples. But in such places the greater richness of the soil comes in, and so on river-flats certain plants—*e.g.*, the puriri (*Vitex lucens*) and the titoki (*Alectryon excelsum*)—appear which are absent elsewhere.

The direct action of light is very plainly manifest in many parts of the forest. Where through death of the trees or damage to the forest-roof a more than average degree of light is present, a quite different floor-covering or undergrowth may enter in. Thus we have the acres of tree-ferns before mentioned in the upland forest, and there, too, on small, well-illuminated areas there is, for instance—instead of the usual undergrowth of trees, ferns, and shrubs—the grass *Microlæna avenacea* knee-deep, the wineberry (*Aristotelia racemosa*) and *Histiopteris incisa*, the two latter most rare plants of this forest, also a few distant tree-ferns (*Dicksonia squarrosa*), a nikau palm, and a straggling-branched example of *Beilschmiedia tawa*. In short, the density of the undergrowth is in large measure a reflection of the intensity of the illumination.

Leaving out of consideration its transpiration-effect, wind exerts a powerful influence on the forest by damaging the forest-roof through breaking of branches, thus not only letting in light, but exposing the trees to the attacks of fungi. This natural damage to the trees is astonishing. Apical branches just broken off are constantly met with on the forest-floor, and so are epiphytes of various kinds, especially the immense "bough-gardens" of *Astelia Solandri*. The weight of these on the branches must be very great, and add materially to their danger of breaking. The branches are simply adapted to bear their own weight, and addition thereto much increases their chance of damage by the wind.

Apart from the changes brought about by moisture, light, heat, wind, and soil, there are always the reactions of one plant upon another to be considered. The struggle for existence constantly going on favours the increase of one species and the decrease of another. Where ground-conditions lead to close groups of tree-ferns, the floor-covering reaches its minimum, or where the *Gahnia-Astelia* tussock gets a footing the shrubby undergrowth is doomed to partial extinction. The age of different parts of the forest evidently varies very considerably—that is, so far as the taller trees are concerned. These may be in a state of decay, while beneath, owing to the increase of light, is a vigorous host of saplings ready to take their place and whose presence depends on many years' struggle and change in the undergrowth. All these struggles and changes doubtless are to be seen in the forest, but they are most difficult of recognition and their import very hard to decipher. At the best, without exact information as to the ecological factors and much more knowledge of the physiology of the living plant than is at present available, the best observations can only pave the way for suggestive guesses.

B. SPECIAL ECOLOGY.

1. Trees and Shrubs.

Between these two categories no hard and fast line can be drawn. The adult form of a plant, which may appear at an abnormally early stage of development, as Diels has so ably shown (8), is marked by the appearing of the reproductive organs, and he cites various examples from the Australian and other floras. A considerable number of the Waipoua plants behave in a similar manner, and such in the following list are marked thus: *. One or two examples demand brief discussion. *Weinmannia sylvicola* is a lofty forest-tree, very common not only in the Waipoua Forest, but in northern New Zealand generally. It has distinct juvenile and adult forms, the former with large pinnate leaves, and the latter with smaller pinnate, or ternate, or even simple leaves. Within the forest are abundance both of juvenile and adult plants, but on the heath the former alone are to be found, and these in some instances, although so different not only in stature but in form from the adult, produce fully matured flowers and ripen seed. Here, then, is a species which, according to its environment, is either a moderate-sized shrub or a forest-tree of lofty stature with a stout trunk. Its close relative, *Weinmannia racemosa*, a still taller and more massive tree of more southern New Zealand, behaves in a similar manner. The small, erect tree, *Dodonæa viscosa* (akeake), is, on some parts of the New Zealand coast, a prostrate plant, as is also *Leptospermum ericoides* (a fairly large tree of the Waipoua Forest), both on mountain hillsides and near fumaroles. So, too, *L. scoparium*, though usually a shrub and sometimes blooming precociously when an inch or two tall (20, p. 235), is a tree of the transition forest, but on the wet mountain-meadows of Stewart Island, according to my observations, it is prostrate, and roots with adventitious roots from near the ends of the branches, resembling a turf-forming plant in general appearance. The hangehange (*Geniostoma ligustrifolium*) is another example of precocious blooming, seedlings on rotten logs near the Waipoua River blooming when only about one year old and two or three inches tall at most.

In certain instances edaphic conditions such as the above appear to have nothing to do with the life-form. Thus the horopito (*Drimys axillaris*) may remain as a shrub of the forest and bloom, &c., or it may be found under similar conditions as a slender-stemmed tree. The tupakihi (*Coriaria ruscifolia*) belongs to another category. This plant in certain places produces an annual woody stem, which dies to the ground yearly, while at other times it is found only as a tall shrub or even small tree with a stout main stem. In this case, however, there are probably several elementary species included under the botanical conception of *C. ruscifolia*.

The trees may be divided into tall, medium, and small, though here again true hard and fast lines cannot be drawn. The rewarewa (*Knightia excelsa*), for instance, exceptionally attains a height of 90 ft., but it is frequently much smaller, and blooming plants 20 ft. high are not rare in the transition forest. The following lists show the categories to which the trees belong:—

Tall trees, finally attaining a height of from 80 ft. to 100 ft., and in some species more: *Libocedrus Doniana, Podocarpus totara, P. ferrugineus, P. spicatus, P. dacrydioides, Dacrydium Kirkii, D. cupressinum, Agathis australis, Knightia excelsa, Laurelia novæ-zealandiæ, Beilschmiedia tawa, Metrosideros robusta.*

Medium trees, finally attaining a height of from 50 ft. to 60 ft.: *Phyllocladus trichomanoides, Beilschmiedia tarairi, *Weinmannia sylvicola, Dysoxylum spectabile, Alectryon excelsum, Elæocarpus dentatus, Olea lanceolata, O. montana, Vitex lucens.*

Small trees, 20 ft. to 40 ft. tall, and sometimes less: *Dacrydium Colensoi, Rhopalostylis sapida, Macropiper excelsum, Persoonia toru, Fusanus Cunninghamii, * Drimys axillaris, Hedycarya arborea, Litsea calicaris, Quintinia serrata, Ixerba brexioides, * Carpodetus serratus, Ackama rosæfolia, Sophora tetraptera, * Melicope ternata, * Coriaria ruscifolia, * Dodonæa viscosa, * Aristotelia racemosa, Hoheria populnea, * Melicytus ramiflorus, M. macrophyllus, * Leptospermum ericoides, Eugenia Maire, * Fuchsia excorticata, Nothopanax Edgerleyi, * N. arboreum, Pseudopanax crassifolium, * Griselinia littoralis, Dacrophyllum latifolium, Rapanea salicina, * R. Urvillei, Coprosma arborea, * Olearia Cunninghamii, * Brachyglottis repanda, * Myrtus bullata.*

The relative size of the trees has some bearing on their life-conditions. The tall trees have always their crowns exposed to the maximum force of the wind and heat of the sun—*i.e.*, to the greatest transpiration conditions—while the smaller may be quite within the moist atmosphere of the forest, or, where forming a part of the roof, still sheltered in a measure by the crowns of the taller trees even when they are some distance away. Still, it must not be forgotten that these smaller trees in many New Zealand forests are dominant, and there, too, under much severer conditions than in the formation under discussion.

With the exception of *Fuchsia excorticata* and to some extent of *Sophora tetraptera*, all the trees and shrubs are evergreen. The tall and medium-sized trees have usually erect trunks quite without branches until the forest-roof is gained. These naked trunks are partly the result of rapid growth towards the overhead illumination, the main axis chiefly developing, and partly the effect of closeness of growth and destruction of lateral branches when young. The bark may be comparatively smooth, furrowed, or frequently scaling or hanging in strips. Plank buttresses occur in some instances, especially in certain of the taxads at times, in the tawa (*Beilschmiedia tawa*), but above all in the pukatea (*Laurelia novæ-zelandiæ*), where they are always to be found. For instance, one rather small tree had a trunk 26 in. in diameter above the buttresses, which themselves averaged about 50 in. in height and 5 in. in thickness, becoming thinner very gradually from the base to the rounded margin. These buttresses were continued as roots spreading along the surface of the ground, still in plank-form, one extending in serpentine fashion from the base of the tree for a distance of 30 ft., and finally entering the ground on the opposite side of a gully. At 24 ft. from the tree the flat root was still 16 in. tall, rounded on its upper margin, and of an almost uniform thickness of 2½ in. At 24 ft. from the tree it gave off similar lateral

roots, which wound above the ground for 30 ft. or more. This same tree at 27 in. from the ground gave off a horizontal stem, which continued in a straight line, not touching the ground, erect leafy shoots being given off at intervals; its extremity then bent to the ground, rooted, and gave rise to another tree of fair size, 7 in. in diameter, and finally entered the ground and there gave rise to another tree with buttresses and far-spreading roots.

This extending of roots above the surface of the ground is a very common feature of New Zealand forest-trees, and, though perhaps not so strongly in evidence in the Waipoua Reserve as is frequently the case, is still sufficiently striking. Thus *Podocarpus totara* spreads out its roots laterally for many feet, their upper half quite unburied and near the tree raised to a height of 16 in. or more. Though by no means everywhere, certain examples of *Laurelia* put forth from their overground roots most curious arching branches (Photo 19), forming knees 2 ft. in height after the manner of the North American *Taxodium distichum*, and which certainly, whatever their function, outwardly resemble pneumatophores.

The palm *Rhopalostylis sapida* frequently gives off adventitious roots (stilt-roots), red in colour, and so numerous as to touch one another at a distance of a foot or more from the base of the trunk. *Aristotelia racemosa* also, when growing on a moist river-flat, was observed in one instance raised on stout stilt-roots.

Details regarding branching of the trees cannot be given here, sufficient space having been devoted when speaking of physiognomic plants; but, generally speaking, the taller trees have but short branches and small heads of foliage—often, indeed, quite out of proportion to the size of the tree, as in the case of the kahikatea (*Podocarpus dacrydioides*), whose short, slender heads, made up of but few branches, look quite insufficient for the wants of a lofty tree.

The branching of juvenile trees and saplings is an altogether different matter from that of the adult. A frequent form is that slender one noted above, due in part to overhead illumination and in part to a specific character of the plant. Thus the kohekohe (*Dysoxyllum spectabile*) may be 10 ft. tall, quite without branches, and bearing the fine, glossy, bright-green, pinnate leaves only on the final 2½ ft., the stout petioles passing off at a right angle and the leaflets being held horizontally. The rewarewa (*Knightia excelsa*) again has exactly the same habit, which is indeed that of the well-known juvenile form of the lancewood (*Pseudopanax crassifolium*) when this holds its leaves horizontally, as it sometimes does in the forest. A plant of *Knightia* 42 in. tall was bare for 26 in. and then leafy, the leaves ½ in. distant, held horizontally, and borne on short petioles given off at an acute angle. The tarairi (*Beilschmiedia tarairi*) has usually a quite straight, slender, and naked stem, marked with old leaf-scars, and branching only near its apex. Its seedling shows the same habit, an example 6¼ in. tall having leaves only on the apical 1¼ in. Other trees are also slender and upright, but they branch freely from near the base in a pyramidal fashion—as, *e.g.*, the tawa (*Beilschmiedia tawa*) and the celery-leaved pine (*Phyllocladus trichomanoides*). To a third category belong those trees which have a prolonged juvenile form with interlacing branches and probably a quite different form of leaf from that of the adult. This is a phenomenon varying in degree, being only slightly marked in some plants, such as *Carpodetus serratus* and *Nothofagus fusca* or *N. Solandri* (these two latter not plants of the Waipoua Reserve, though *N. fusca* occurs in some semi-kauri forests), while in others, as in *Podocarpus spicatus* and *P. dacrydioides*, the early form bears no resemblance whatever to the adult. But this opens up the question of dimorphism and heterophylly, which is briefly discussed further on, so far as the Waipoua Forest is concerned.

The leaves of the forest-trees are for the most part of no great size: an arbitrary division into large, medium, and small gives for the *tall trees* 1 large, 2 medium, 9 small: the *medium trees*, 4 large, 5 medium, 1 small; the *small trees*, 10 large, 17 medium, 7 small. With regard to texture of leaf, using the terms "thin" and "coriaceous" respectively, we have—*tall trees*, 1, 11; *medium trees*, 3, 7; *small trees*, 12, 22. Thus the texture bears some relation to the degree of exposure of the plants, the least exposed—the small trees—showing 35 per cent. of thin-leaved species, the medium trees 30 per cent., and the tall trees only 8 per cent.

There are far more simple leaves than compound, the figures being respectively, for the whole arborescent vegetation, 47 simple, 9 compound; and with regard to their margins, 37 are entire and 19 are more or less toothed or cut.

With regard to the prevalence of coriaceous leaves, it is evident that those which have to endure the seasonal changes might require a stouter texture than the ones of the summer-green forests of the Old World, and that the thick texture need not be looked upon necessarily as a xerophytic adaptation. In fact, such is not needed at all, the ordinary tropophytic trees of the Old World thriving admirably in New Zealand almost everywhere and under conditions which would at once kill most of the native forest-trees.

The shrubs are nineteen in number. Several are comparatively rare, and others are confined to special stations, consequently only about five—viz., *Phebalium nudum*, *Geniostoma ligustrifolium*, *Coprosma grandifolia*, *Alseuosmia macrophylla*, and *Senecio Kirkii*—can be called common, while the first named might be also omitted, as it is essentially a plant of the kauri sub-association. From this it is plain that young trees, tree-ferns, certain lianes, and *Gahnia-Astelia* tussock play more part in the general physiognomy of the undergrowth—*i.e.*, are better adapted to the conditions of this particular forest—than are the majority of its shrubs. Taking the shrubs as a whole, seven are of the divaricating form, which seems quite out of place and much more suited for xerophytic than hygrophytic conditions. *Carmichaelia australis*, with its leaves reduced to the vanishing point, and with flat, assimilating stems, is also certainly not a normal forest-plant. *Veronica diosmæfolia* belongs rather to the open river-banks than the forest, and is really a heath-plant; it has the close-growing, ball-like form of its subalpine relatives.

Geniostoma, *Coprosma grandifolia*, and *C. robusta* are much-branched shrubs, but of more open habit than those of divaricating form.

Senecio Kirkii, the commonest shrub of the forest, is, as described before, of a very open habit. Strange to say, although usually an epiphyte in the central floristic province, it is here, so far as I could judge, invariably a ground-shrub, and yet the rata, at any rate, would afford it a typical station. *Alseuosmia macrophylla* is an upright shrub with stiff, slender stems of irregular form, frequently branching sparingly into distant, flexible, leafy twigs. *A. Banksii* is a very small, little-branched shrub, and *A. linariifolia* is erect, with many slender branches. The *Corokia* is quite rare, and found only on the forest-margin at nearly 1,000 ft. altitude, while *Leptospermum scoparium* and even *Styphelia fasciculata* are rather plants of the heath than of the forest proper.

The leaves of the shrubs (leaving out *Carmichaelia australis*) are all simple, 10 are toothed or otherwise cut, 9 are entire, and 6 thin, while 13 are coriaceous.

The flowers of the forest-plants are for the most part very small and inconspicuous, some thirty only having a claim to showiness, and this frequently to a very limited extent. Nearly all of these are white, the following being exceptions: The puriri (*Vitex lucens*), dull-red; the kowhai (*Sophora tetraptera*), golden-yellow and 1½ in. long; the waiouatua (*Rabdothamnus Solandri*), orange, striped with purple in the throat and red round the margin of the lobes; the hoihoi (*Alseuosmia macrophylla*), creamy-yellow, marked with pink lines on the exterior and slightly flushed within; the northern rata (*Metrosideros robusta*), dark-scarlet; the rewarewa (*Knightia excelsa*), dull-crimson.

Comparatively little has been written on the fertilisation of New Zealand plants, the important paper of G. M. Thomson (26A), published as long ago as 1881, being still the main authority. The whole matter needs going into most carefully, and, above all, experiments can alone decide in most instances as to the capacity of a plant for self-fertilisation. But with regard to the kauri-forest trees and shrubs, thirty-seven species, at any rate, are unisexual or nearly so, and of the remaining forty several are more or less gynodiœcious at times. It is therefore obvious that in a majority of cases cross-fertilisation either by means of animals or wind takes place. Birds doubtless play some part in fertilisation, as suggested by Petrie (23) for *Rhabdothamnus Solandri* and *Vitex lucens* (24). Possibly *Metrosideros robusta* and *M. florida* are similarly fertilised. The large number of species with inconspicuous flowers suggests wind rather than insect fertilisation, but here speculation is of no moment; each case must be investigated and considered on its own merits.

No less than forty-three species of the forest-plants have more or less succulent fruits, many of which are very showy, while many others are likewise edible, winged, adhesive, or minute and light. Thus there is every facility for the distribution of nearly all species, especially by means of birds.

2. Lianes.

Lianes, as in most New Zealand forests, are an important ecological group, and probably affect the general physiognomy more than any other class of plants. Here no detailed account can be given. Schenck's (26) various divisions—scramblers, root climbers, twining plants, and tendril climbers—are all represented. Nearly all the spermaphytic lianes are ligneous, but there are a number of climbing ferns, of which many are at the same time epiphytes. The plants under consideration do not always climb; frequently they sprawl over the forest-floor, and occasionally, under certain conditions, from shrub-like bushes. The most important lianes to be found in the Waipoua Forest are the supplejack (*Rhipogonum scandens*), the various climbing species of *Metrosideros*, the kiekie (*Freycinetia Banksii*), the climbing hard fern (*Blechnum filiforme*), and the mangemange (*Lygodium articulatum*). In some places *Lycopodium volubile* is common, and in the transition forest and the taller heath *Gleichenia circinata*, its wiry leaf-stalks lengthening excessively, and the plagiotropous position of their segments enabling it to reach 8 ft. or more as a scrambler. So, too, does the delicate-looking fern *Hypolepis distans* raise itself for a number of feet (though when of that length quite unable to stand alone), thanks to its slender, black, brittle stems and their numerous minute excrescences.

The supplejack (*Rhipogonum scandens*) puts forth a soft, succulent stem from its stout root-stock, covered closely with short, brown hairs, and provided only with adpressed, subulate, slightly fleshy, dark-coloured, non-assimulating leaves, 2½ in. in length, at considerable distances and quite different from those of the final flowering-stems, which are 3 in. or 4 in. long, coriaceous, green, and of oblong type. The seedling has similar leaves to the adult, but they are smaller and quite thin. These primary leaves are almost fully developed before the lengthening of the internodes, and, pressed together, effectually protect the growing-point of the stem. The plant grows usually at some distance away from any support which it can use, and the stems straggle over the ground until a sapling is gained, up which it can wind, and, having reached the summit, still lengthening, manages to gain a taller trunk, by means of which it, winding from right to left, can reach sufficient light to produce its leafing stage.

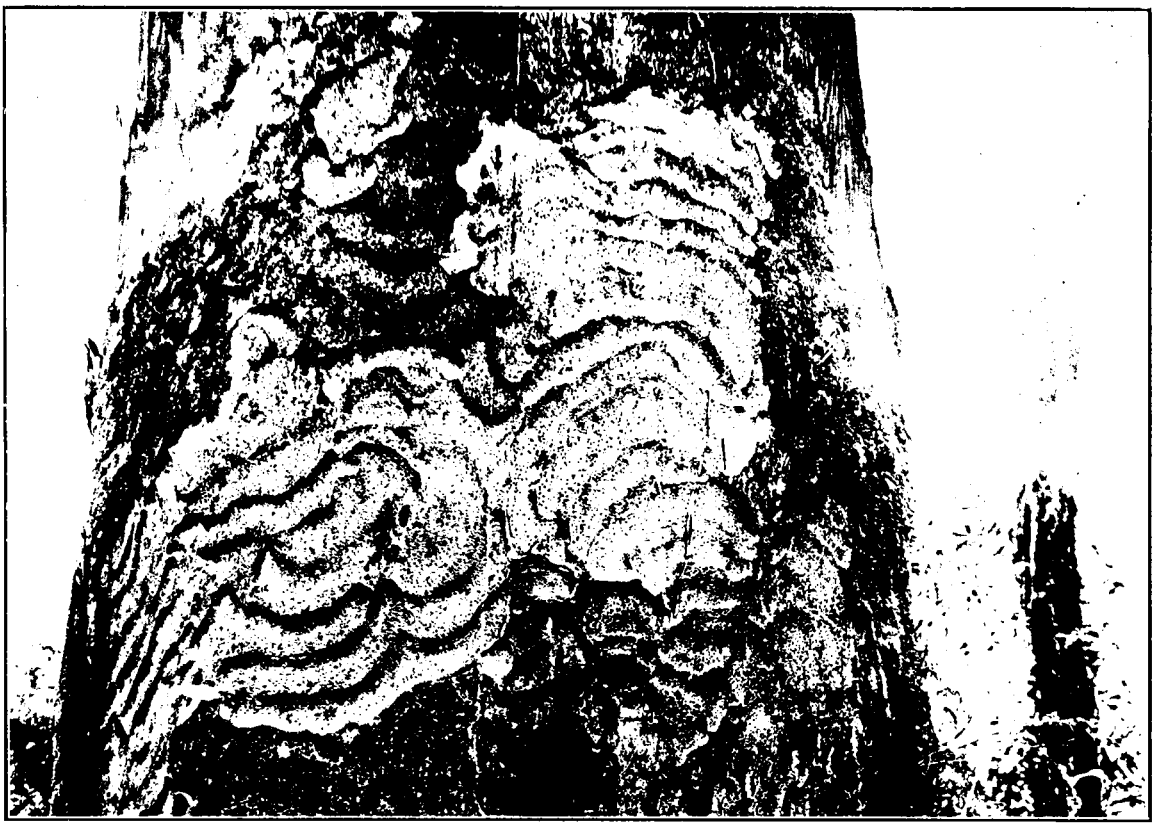
The methods by which the lianes gain their final supports have been little studied: a few notes taken *re Rhipogonum* may be of interest:—

"Here *Rhipogonum* winds round a small tree of *Beilschmiedia tarairi* 14 in. in diameter. The stem is 6 yards long and arches from the ground several times until the tree is gained.

"Here is another stem erect for 5 ft., then it bends, arching, and catches hold of a twig of a tarairi, 8 ft. tall from the ground, then bending laterally it catches into a tarairi sapling, 25 ft tall, ascending right into its slender head of foliage.

"Here a third makes a good-sized arch of 4 yards in length, then turns for 2 ft., ascends, making a half-turn round a *Weinmannia* at 4 ft. from the ground, passes up to a tarairi of 11 in in diameter, and catches it at 25 ft. from the ground.

"Here several quite slender stems of *Rhipogonum* are wound round one another, two are dead or semi-dead, one is broken, and one remains, which was wound round a dead sapling and thus on to a young tarairi.



(11.) Ripple-marks on Bark of Kauri where Outer Bark has been cast off.

[*Photo., L. Cockayne.*

(12.) Shedding of Kauri-bark. *Metrosideros scandens* has gained a hold, but it will be eventually cast off.

[*Photo., L. Cockayne.*

"Here one has climbed a sapling tarairi, left it at its summit, arched downwards and branched, putting a limb into another sapling.

"Quite a number of stems may wind round a sapling as a main axis and round one another.

"The main stem of a *Rhipogonum* creeps on the ground in circuitous fashion for 9 or 10 yards, bends on itself also on the ground, comes back nearly to where it started from, and then climbs a sapling 10 ft. tall of *Dysoxylum*—putting out all the way straight, non-climbing shoots, which have broad, coriaceous leaves on their flanks—and then continues from top of tree to forest-floor, leafy all the way, but its growing-point finally destroyed."

The number of juvenile trees destroyed by *Rhipogonum*, *Freycinetia*, and other lianes must be enormous, not merely their strangling action but also their extreme weight coming into play, and it is this removal of the original props which leads in part to the abundance of supplejack-stems forming close entanglements. In like manner liane cables hang from the forest-roof, especially of *Rubus australis*, and, in other forests but not in the Waipoua, strange to say, of *Muehlenbeckia australis*, these having in some cases lost their original support, and in other cases having broken away, through their strain and the action of wind, from that part of the forest-roof to which they really belong.

Freycinetia Banksii (the kiekie) is equally at home either on the ground or as a liane, completely hiding the trunk of a lofty tree with its green, coriaceous, sword-like leaves. Here the climbing habit is no special advantage, so far as its leaves are concerned, these receiving all the light they require when it is a ground-plant, and, indeed, getting more than when passing from the climbing stem. Whether the climbing is better for fruit-production I cannot say. The stems are terete, hard, woody, and rigid, 1 in. or more in diameter, marked with leaf-scars, and are fastened to the bark of the tree up which they climb by stout roots given off at about a right angle, which pass right round the supporting tree if it is slender, and even back to the liane-stem itself, finally branching into many slender branches, which are close together and parallel with the main root, or nearly so. These holding-roots cling most closely to the substratum, and can only be removed by a considerable degree of force.

The climbing species of rata are especially interesting, as no climbing Myrtaceæ exist out of New Zealand, the climbing habit having here arisen in this family owing to the presence of those special conditions—a moist atmosphere and equable climate—which have made the woody liane-form so common in tropical forests. They have all both climbing and non-climbing shoots, and coriaceous, thick, glossy, entire leaves. In *Metrosideros scandens* the slender main axis gives off numerous short, straight, lateral branches at an acute angle, and these may branch again several times, so that with the small, round, glossy, dark-green leaves a leaf-mosaic is formed on the tree-trunk. Short lateral roots are given off, binding the stems fast to the bark. The leaves are here situated on the flanks of the stems, and opposite, but on the non-climbing shoots they are arranged decussately, though almost invariably more or less bent to one side through heliotropism. After a time the roots cease to function, wither, and the climbing stem, no longer attached to the tree, may be at some distance away from it. This applies to all the climbing ratas, but their early climbing form is not so tightly pressed to the substratum as just described, and the lateral twigs may be held away from the tree. (See thick *M. florida* stem, Photo 1.)

The terminal portions of the climbing stems have frequently very few leaves for a considerable distance. The non-climbing stems may be produced very freely, and often come off from near the base of the plant. They differ in their density of branching in different species, and are frequently of considerable size.

The climbing hard fern (*Blechnum filiforme*) is chiefly remarkable for its surprising dimorphism, a brief account of which is given in my Kapiti report, together with a plate (4). The climbing stems are hard, brittle, brown in colour, and woody; they branch freely, and a perfect mantle of such branches may quite surround a trunk. This lateral branching assists in holding the plant to its support. The leaves of this climbing fern are a foot or more long, and are held out from the tree by the strong leaf-stalks, sometimes at right angles, sometimes drooping somewhat. No particular liane, unless it be *Freycinetia*, holds undisputed sway over a tree. Thus on a tarairi was noted the climbing form of *Metrosideros scandens*, the liane form of *Blechnum filiforme*, the bare stems of adult *M. scandens* 5 in. distant from the trunk but touching the tree at the base and again higher up, masses of *Hymenophyllum dilatatum* with semi-drooping fronds and close to the *Blechnum*, while on the same trunk were lichens, mosses, liverworts, and on the bough above at 30 ft. from the ground, immense plants of *Astelia Solandri*.

The only other liane* needing mention is the mangemange (*Lygodium articulatum*). This has a moderately slender, creeping rhizome about ⅛ in. in diameter, covered with a mat of chestnut-coloured linear scales. The stems are very slender, wiry, extremely tough and smooth, brown or purplish-brown in colour, often twisted on their axis, and bearing pinnæ in distant opposite pairs. The stems wind round themselves or a sapling, shrub, or small tree-fern from right to left, and finally form close, elastic masses some feet in depth. The leaves are bright-green, moderately thin, but rather stiff and waxy on the under-surface. The fertile pinnæ are pale greenish-yellow, and hang downwards, resembling little bunches of grapes. They show their relationship to the sterile by one of the lateral secondary pinnæ being frequently leafy and without sporangia. The young plant is erect and does not climb; it is only after several pinnæ are developed that the climbing stem is produced, at first quite pale green and with rudimentary pinnæ for a time. The climbing stem is slender, green, and soft in its apical portion, and its pinnæ in gradual course of development and of a pale, tender green.

* The remaining lianes are of no great importance in the Waipoua Forest; they are to be found in the list of species, where their life-forms are briefly noted.

3. Epiphytes. (Photos 5 and 6.)

It is the epiphytes, together with woody lianes, tree-ferns and Hymenophyllaceæ, which give to New Zealand mixed forests their tropical character. Perched high in the tree-tops, clinging to erect stems, or forming long lines of luxuriant growth upon a leaning trunk, the epiphytes mark the forest as distinct from those of the temperate Old World.

Strictly speaking, an epiphyte should be a plant which should be invariably found seated upon another. This in the kauri forest is true only for certain filmy ferns, mosses, liverworts, and a very few spermaphytes. These latter generally are also to be found on rocks, while some pass their existence quite well upon the forest-floor.* Thus *Senecio Kirkii*, invariably a ground-plant of the Waipoua Forest, is nearly always an epiphyte in the southern forests of the North Island. It is plain that epiphytes have been evolved from ground-plants, as so admirably demonstrated by Schimper in his pioneer work (26c). This process of evolution can be seen in its various stages in the forests of New Zealand. Tree-fern stems offer ideal conditions for the germination of seeds, and are usually occupied by seedlings of many ground-plants, especially *Weinmannia sylvicola*. Palm-stems, too, are favourite stations for seedlings, owing to their decaying leaf-sheaths. *Astelia trinervia*, essentially a plant of the undergrowth, ascends at times into the trees and there thrives. All that is needed in an epiphyte is a certain amount of xerophytic structure, not so much for the purpose of every-day use as for those quite special occasions in a moist forest when the soil in which it is growing becomes too dry. Thus most of the epiphytes have very thick or at least coriaceous leaves; *Astelia Solandri* holds considerable quantities of water in its leaf-bases, so that showers fall to the ground when the plant is shaken strongly; the epiphytic orchids have special water-absorbing roots in abundance. Some plants are of a drooping habit and are more shaded thus than when erect—*e.g.*, *Asplenium adiantiforme*, *Lycopodium Billardieri*. Furthermore, the epiphytes have either small seeds or spores suited for wind carriage, or succulent fruits which can be borne by birds.

Most essential of all for their welfare is a suitable water-retaining soil, and this is to be found in surprisingly large quantities where they are present. Such is produced quickly by the mosses and liverworts, the forerunners of the higher epiphytes. Trees, large and small, bear on their trunks and boughs, more or less abundantly, various species of muscineæ, which owe their epiphytic habit to the power of absorbing water directly through their leaves, and in many instances to special and peculiar adaptations, some being so constructed as to hold much water by capillary attraction, thus being veritable vegetable sponges, while others have certain of their leaves actually converted into small flasks or cups, which are usually full of water. Indeed, these very plants whose station is the wet forest—typical hygrophytes, in fact—need protection against sudden drought much more than desert plants. These mosses, &c., quickly form sufficient soil from their decay to support seedling epiphytes, and these more or less, each according to its specific capability, make much more soil from their decaying leaves, &c. Thus really enormous quantities of vegetable matter in varying state of decay collect on horizontal boughs and in the forks of trees and hollows, and veritable gardens exist high on the tree-trunks, numbers of epiphytes being joined together into a society, and being for the most part of mutual benefit the one to the other.

The following are the principal epiphytes of the Waipoua Forest: (Filices) *Asplenium flaccidum*, *A. adiantiforme*, *Polystichum adiantiforme*, various Hymenophyllaceæ, *Polypodium grammitidis*, *P. Dictyopteris*, *P. Billardieri;* (Lycopodiaceæ) *Lycopodium Billardieri*, *Tmesipteris tannensis;* (Orchidaceæ) *Dendrobium Cunninghamii*, *Earina mucronata*, *E. autumnale*, *Bulbophyllum pygmæum;* (Liliaceæ) *Astelia Solandri;* (Pittosporaceæ) *Pittosporum cornifolium*, *P. Kirkii;* (Myrtaceæ) *Metrosideros robusta;* (Cornaceæ) *Griselinia lucida*.

Some of these have special peculiarities of which brief mention must be made.

Polypodium Dictyopteris has a short, scaly rhizome, from which are given off the bright-green, entire, lanceolate, moderately thick, quite flexible fronds, which are provided with two parallel rows of sori on their under-surface on each side of the centre, these giving a very distinct appearance to the plant. From the rhizome many soft, slender, woolly roots, covered most densely with short brown hairs, are given off and spread out laterally, putting forth at intervals buds which develop into new plants. Thus by degrees a dense mat of roots is formed, several square feet in area, which may be stripped off in its entirety from a tree-trunk, especially that of a palm, where it is very common. It is about ¼ in. thick, and so interwoven are the roots that the mat can only be pulled in pieces by force. A young plant with two leaves 1½ in. long had a horizontal root 4 in. long which gave off a younger plant near its extremity with a leaf ¾ in. in length.

Tmesipteris tannensis in the northern forests of New Zealand is nearly always a plant of tree-fern stems, thrusting its long rhizome beneath their adventitious roots; but in the Southern Floristic Province it grows much more luxuriantly, and is a plant of decaying wood and humus on fallen logs, with all the appearance of a hemi-saprophyte.

Astelia Solandri forms enormous tufted masses high up on the tree-trunks,† its basal part and earlier leaves having decayed and formed a great quantity of loose vegetable matter, usually extremely wet. Here growing also will perhaps be large, scantily-branched, drooping or semi-drooping bushes of *Pittosporum cornifolium* or the very thick-leaved *P. Kirkii;* the shining-leaved *Asplenium adiantiforme*, its fronds, several feet in length, hanging down; as also long, pendent cords of *Lycopodium Billardieri;* while at its side may be a close-growing mass of the orchid *Dendrobium Cunninghamii*. The above-mentioned *Astelia* is a densely tufted plant with a great number of ensiform, coriaceous leaves, 3 ft. or 4 ft. long and 2 in. or 3 in. broad, provided with a black sheathing base, fleshy in its lower portion and there covered with a great quantity of long silky hairs. These sheaths hold large quantities of water, even in quite dry weather. (Photo 5.)

* I have even seen seedling plants of such a true epiphyte as *Pittosporum cornifolium* growing upon the ground in the forest on the Levin Experiment Farm.

† It is also quite common on upright and even quite slender tree trunks, in what looks at first sight a quite impossible position for such a heavy and massive plant.

Pittosporum cornifolium is a sparsely branched shrub made up of long, slender, flexible twigs, covered with blackish bark, giving off occasionally branches in whorls of three, and bearing brownish-purple flowers having a slight vanilla-like scent. The leaves are somewhat glossy, dark-green, thick, coriaceous, and rather stiff.

Pittosporum Kirkii is also a scantily branched shrub with long, naked, straggling main branches and final short, straight, fairly flexible, smooth, dark-purple twigs, which branch forking and diverging from one another. The leaves are opposite or in whorls of 3 or 4 near the extremities of the twigs. They are fleshy, thick, coriaceous, glossy, dark-green, with a much paler under-surface and a distinct, yellowish, raised midrib, and much reticulating venation.

The case of *Metrosideros robusta* is of special interest, since this lofty forest-tree begins life as an epiphyte high up on a rimu, for instance, and puts down roots to the ground, which give off lateral holding-roots, these quite encircling the tree (16). The roots gradually increase in thickness, and finally the host is killed, and, it decaying, the root-stems more or less coalesce and form a distinct though most irregular trunk. Other New Zealand trees do the same thing, especially *Nothopanax arboreum*, which makes a tree-fern its host, and on the Chatham Islands *Dracophyllum arboreum*. (See also Carse, 1A.)

4. Filmy Ferns and Tree-ferns.

The important ecological classes, the filmy ferns and the tree-ferns, can only receive brief mention. Besides the Hymenophyllaceæ, *Leptopteris hymenophylloides* and (were it present) *L. superba* would be included. With the exception of the kidney fern (*Trichomanes reniforme*), the fronds of the Hymenophyllaceæ consist of a tissue formed of only one layer of cells, which have the power of absorbing water from without. The condition of such organisms is then not unlike that of aquatic plants, and when the average monthly rainfall of the Waipoua Reserve—nearly 10 in.—and the number of rainy days—twenty-two—are considered, the leaves must be as frequently wetted as they require. Even after a shower the drip within the forest prolongs the rain-effect for many hours, while the almost constantly moisture-saturated atmosphere reduces transpiration to its minimum. The rhizomes are usually far-creeping and often form close mats. They are surrounded by muscineæ, fern-tree roots, and so on, and so have their short roots usually in a quite moist substratum. *Hymenophyllum ferrugineum* is covered with hairs, on which the moisture collects freely and falls from the drooping fronds in large drops. The forms of the fronds of these ferns are most varied, and they are frequently deeply cut, which guards them against damage. *Trichomanes reniforme* has, however, broad, entire* fronds, but their erect habit and extra thickness is a protection. In dry weather some of the species, especially *Hymenophyllum multifidum*, curl up their leaf-segments and reduce their transpiring surface, while the kidney fern also rolls up its margins for a similar purpose, sometimes looking withered and dead. *Trichomanes elongatum* grows only in the damper situations, such as on the sides of moist gullies, where intense hygrophytic conditions prevail. Its fronds are sometimes half a foot tall, raised on long stiff leaf-stalks, and are given off, four or so, from a short erect rhizome, which is clothed with the bases of old stipites and is analogous to the trunk of a tree-fern. This gives off numerous wiry, rather long, descending or spreading roots, furnished with lateral rootlets. The fronds are very dark-green and they are frequently covered with epiphytic mosses and liverworts, which, through their water-holding power, are a benefit to the fern; in fact, this appears to be a distinct case of symbiosis.†

The tree-ferns belong, strictly speaking, to the genera *Cyathea*, *Hemitelia*, and *Dicksonia*, but various other ferns, notably, so far as the Waipoua Forest is concerned, *Blechnum discolor* and *Dryopteris pennigera*, have frequently trunks of considerable size. On the other hand, *Dicksonia lanata* may have no apparent trunk, as is the case throughout the whole southern part of its range. The trunks in some of the species are closely covered with adventitious roots. In *Cyathea dealbata* these form more than one-half the bulk of the trunk. Such roots are positively geotropic, as on a leaning trunk masses may occasionally be seen pointing at right angles to the ground. They are formed in great quantities at the base of the trunk, which becomes in consequence much expanded, and this is of moment to the plant, since it is not deep-rooting. The leaves of the tree-ferns are usually more or less coriaceous. They are annual or nearly so in duration, but are not deciduous, and fall over as they wither, clothing the upper part of the trunk with a beneficial moisture-retaining covering. At the apex of the trunk are the thick buds coiled circinately, pressed together, and well protected by their firm, scaly hairs and position.

Blechnum Frazeri occurs in extensive colonies, usually on the drier ground, the slender, dark-chocolate-coloured stems, not thicker than a moderately stout walking-stick, and covered with persistent leaf-bases, rising up side by side and raising their dark-green, shining fronds at various heights into the air, some frequently much overtopping the others. These colonies may occupy many square yards, and there are few parts of the kauri or tarairi associations where they may not be met with. The leaves are on slender stalks, which are a little shorter than the blades. They are given off at a narrow angle, gradually diverging from the erect main stem through arching, and thus finally bringing the blade into a semi-horizontal position, the whole of the fronds thus forming a broad wine-glass-shaped structure. The texture is stiff but not thick, and the colour a shining dark-green. The most interesting point ecologically about this fern is that, notwithstanding its arborescent habit, from the bases of the erect trunks numerous runners pass off horizontally, spreading in all directions just beneath the surface of the ground. They are covered with scaly hairs and put forth roots. After spreading for four or five inches or more a

*Mr. A. Hamilton shows me at time of writing this a lobed form which he had just collected in the western Ruahine forests.

†*H. scabrum*, too, is frequently covered in a similar manner.

new plant is produced, which finally develops a trunk and runners. Thus large colonies are formed by vegetative increase alone.* One plant, for instance, may produce seven or more runners, and a whole colony yards in extent arise from one plant. The leaves not only come from near the apex, but from the sides of the trunk, and occasionally also from near its base. (Photo 8.)

5. Persistent Juvenile Forms.

No account of the ecology of any New Zealand tree or shrub formation can be complete without some reference to those plants which have a juvenile form distinct from the adult and persisting for a long period, or making its reappearance on the adult as a reversion-shoot. Here only those plants peculiar to the Northern Floristic Province are specially dealt with, or others of the kauri forest, though not confined to it, which have received no mention hitherto in botanical literature. The following are the chief of the Waipoua Forest plants which exhibit dimorphism of of the kind noted above: (Filices) *Blechnum filiforme;* (Taxaceæ) *Podocarpus dacridioides, P. spicatus, Dacrydium cupressinum, D. Colensoi, D. Kirkii;* (Pinaceæ) *Agathis australis, Libocedrus Doniana;* (Moraceæ) *Paratrophis heterophylla;* (Proteaceæ) *Knightia excelsa;* (Polygonaceæ) *Muehlenbeckia complexa;* (Cunoniaceæ) *Weinmannia sylvicola;* (Rosaceæ) *Rubus schmidelioides;* (Rutaceæ) *Melicope simplex;* (Elæocarpaceæ) *Elæocarpus Hookerianus, E. dentatus;* (Malvaceæ) *Hoheria populnea;* (Araliaceæ) *Pseudopanax crassifolium, Nothopanax Edgerleyi, Schefflera digitata;* (Epacridaceæ) *Styphelia fasciculata;* (Myrsinaceæ) *Rapanea salina;* (Oleaceæ) *Olea lanceolata, O. montana;* (Apocynaceæ) the two species of *Parsonsia.*

This list, which would be considerably larger were the whole New Zealand flora under review, shows how diverse are the families which show this peculiarity. Also, the whole are forest-plants and not those xerophytes which elsewhere in the biological area change their form according to environment. Still, here even something of that sort takes place. *Schefflera digitata* is an araliad whose adult form is provided with thin, digitate, finely toothed leaves. Its seedlings are usually merely reduced forms of the adult, the leaves being only toothed. But in moist gullies of the Waipoua Forest, and even when of a considerable size, seedlings are common with deeply cut leaflets, reminding one closely of the cut-leaved forms of *Nothopanax simplex and N. Edgerleyi.* This is, in the first place, another example of one species having two seedling forms,† and, secondly, from the station of the seedling it looks as if the increased humidity of the atmosphere were the stimulus which produces this form. The phenomenon is striking enough, but its interest is enhanced from the analogous case of the other two araliads. *Styphelia fasciculata* is a common shrub, extending in its distribution from the Northern Floristic Province to the northern part of the Southern Province. The plant of the North of Auckland seems to be identical with the southern form, and yet the former has seedlings and juvenile plants with broad leaves, which become still broader in the forest. The southern plant, even in the Central Province, so far as I have observed, never assumes the broad-leaved form. Here is a case different from the above, since we may be dealing with two separate races, but at the same time we cannot neglect the supposition that the environment may be at the bottom of the matter.

Rubus schmidelioides, common in both Islands of New Zealand and Stewart Island, and found in the Waipoua Forest only in the wetter parts, has a juvenile form distinct from the adult, its leaves being thin, small, and much marked by reticulating venation. This form remains unchanged for many years, and frequently it is the only one to be found. It apparently does not flower.‡ It forms creeping masses, far-spreading over the surface of the ground, and is provided with adventitious roots. On the other hand, the adult has larger, stiff, and coriaceous leaves, not resembling the juvenile to any marked degree. It is a climbing plant, and except under exceptional circumstances is not a ground-plant. Here again is a relation between form and environment, but at the same time heredity comes into play.

The case of *Weinmannia sylvicola,* a shrub (occasionally blooming) of the open and a tall tree of the forest, has been called attention to. The species is closely related to *W. racemosa,* and may be perhaps considered as a fixed juvenile form of that species.

The juvenile form of the kauri has been dealt with in the section regarding life-forms. Here attention need only be called to its strong resemblance to the early stages of other Araucariaceæ. *Phyllocladus trichomanoides* has true leaves at an early stage of development, but no experiments have been published regarding the persistency of these under definite cultural conditions.

The monoao (*Dacrydium Kirkii*) has a juvenile form so different from the adult that one seeing the two for the first time could hardly believe them to be related, much less to be forms of the same species (see Photo 20). The juvenile stage persists for many years, trees 30 ft. tall, or even taller, and without a trace of the adult foliage, being not uncommon. The seedling and later juvenile leaves are linear, subacute, flat, coriaceous but flexible, pale or bright green, and 1¼ in. or more in length by ⅛ in. broad, or thereabouts. They are close-set, spirally arranged, and pass off from the shoot-axis at about a right angle. The adult leaves, on the contrary, are of the cupressoid form, being thick and coriaceous, about $\frac{3}{16}$ in. long, quadrifariously imbricating, and pressed very closely to the branchlet. The final stage appears all on a sudden, juvenile and adult leaves frequently forming parts of the same shoot, while intermediate forms are quite wanting. The adult may ultimately reach a height of 80 ft. or more, and will have a stout

* Where a forest has been cut into and more light is available, this fern increases very considerably.

† The case of *N. simplex* is discussed in the report on the Tongariro National Park and in Trans. N.Z. Inst., Vol. xxxi, p. 355.

‡ A non-climbing species of Rubus collected in Westland some years ago by the late Mr. S. Barker, of Christchurch, which I and others have cultivated under various conditions, and which is allied to *R. parvus,* cannot be induced to flower, and probably is a flowerless species.

(13.) Scene in Waipoua Kauri-forest. On right *Beilschmiedia tarairi* (the Tarairi); in background Rata (*Metrosideros robusta*) to show Habit of Branching.

[*Photo., L. Cockayne.*

(14.) Interior of Tarairi Sub-association. In foreground Colony of the Large Moss *Dawsonia superba*, 1 ft. 9 in. in height.

[*Photo., L. Cockayne.*

trunk covered with flaking bark. The juvenile, on the contrary, is a graceful tree of a slender pyramidal habit, branching and leafy to the base, and of a bright and shining green. Between the two forms come transitions, described by Kirk, as "like a silver fir below and a cyprus above (21, p. 191). Evidently there is here no relation in these forms to the environment, both stages are hereditary, the juvenile persisting for a definite period just as in the case of other dimorphic plants, but with different leaf-characters—*e.g.*, *Pseudopanax crassifolium*, *Pennantia corymbosa*, &c. Possibly in the case of *D. Kirkii* a fixed juvenile race could be produced from cuttings, and an admirable garden-plant be so raised.

PART IV.—HISTORY OF THE VEGETATION.

A. FLORISTIC DETAILS.

The Waipoua Forest Reserve contains, so far as my observations went, 241 species of flowering-plants, ferns, and fern-allies, 178 belonging to the first-named, and 63 to the two latter categories taken together. Of these plants, 27 are found only in the Northern Floristic Province or just beyond its bounds, 213 belong to the Central Province also, while 159 extend to the Southern Province, and 62 are also to be found in the New Zealand subantarctic islands or the Chatham Islands.

As for the distribution of the plants beyond New Zealand, 60 are Australian, including in that term Tasmanian also, but of these 37 are filices or lycopodiaceæ, and only one a true forest-plant; 14 are South American, 10 Malayan, and 20 are Polynesian, while no fewer than 154—*i.e.*, 63 per cent.—are endemic. Of the non-endemic plants about 80 may be considered tropical or subtropical, and at the same time the genera of many of the endemic species also belong to the same category. The above figures deal with both the forest and heath plants, but if the former alone be considered, and the pteridophytes omitted, then out of a total of 127 forest plants, mostly trees and shrubs, no fewer than 120 are endemic. In other words, the kauri forest is strictly a production of New Zealand.

B. CAUSES FOR PRESENT DISTRIBUTION OF THE KAURI.

Before we can consider the origin of a kauri forest such as the Waipoua, it is necessary to examine into the reasons for the presence north of latitude 38° of such a large number of species, or, in other words, the question arises, Why do not the kauri, the pohutukawa, the mangrove, and certain other well-known plants extend much further to the south than is the case? The answer which would at once suggest itself is that they are prevented doing so by the colder climate of the south. This answer, doubtless, is quite correct so far as certain of the endemic plants are concerned, but it certainly does not meet the case with regard to the kauri, *Pittosporum crassifolium*, *Corokia buddleoides*, *Metrosideros tomentosa*, *Persoonia toru*, and other plants which are certainly quite hardy in the neighbourhood of Wellington and some of them even in Christchurch, one of the coldest places in winter at a low altitude in the whole biological area, not excluding the subantarctic islands. At the same time, in order to comprehend the matter more clearly, it is necessary to bear in mind the behaviour of certain southern plants which only reach a certain distance north, such as *Veronica elliptica*, a most abundant coastal shrub from the Campbell Islands to a little north of Dunedin on the east, and a native also of Fuegia. It forms also thickets at the West Coast Sounds and finally is more or less abundant in north-west Nelson, and crossing Cook Strait appears again at Titahi Bay, Wellington. So, too, with *Senecio rotundifolius*, which does not extend quite so far to the north, and with the small coastal herb *Crassula moschata*, which extends from Macquarie Island to the northern shores of Cook Strait. In these instances it is no case of cold, but excess of heat that might be urged were it not for the fact that *Veronica elliptica* and *Senecio rotundifolius* can both be cultivated with ease in the kauri region. Without going further into the matter here I may quote what I have already written on the subject in dealing with the distribution of New Zealand coastal plant (5, pp. 325, 326, 327):—

"It seems evident that extremes of climate is only one of the factors with regard to the distribution of coastal plants in New Zealand. Rather, perhaps, than heat or cold alone is the matter one of the ecological optimum of any special plant. Many plants would extend farther to the north or the south, but they encounter competitors better equipped for the struggle—*i.e.*, more in harmony with the surroundings than themselves. A plant which is slightly more suited than another for a particular station must evidently become the victor in the struggle for existence, although both outwardly may appear equally matched in every particular. The distribution of *Sophora chathamica* is an interesting case in point. Judging from the behaviour of the closely allied *S. microphylla* on the volcanic hills of Banks Peninsula, where this plant is abundant, one would conclude that similar hills on Chatham Island would be the habitat of *S. chathamica*. On the contrary, it is quite absent in such stations, being evidently not able to cope with the lowland forest-plants, and it is confined to a narrow strip of limestone country near the margin of the great lagoon. In this place the difference of soil evidently equalises the struggle, and it and the other lowland forest-trees there exist side by side. . . . Finally, to sum up the matter, all that can be said about the distribution of the New Zealand coastal plants is that it is the resultant of a large number of causes. The historical factor and evolution determine the species, climate and soil sort them out into groups, and the struggle for existence, which is governed by the life-forms and constitutions of the competitors, finally fixes the formation—that is, so far as a formation may be termed a fixed entity."

Now, the above explanation is not much of a one after all, and leaves the matter almost as at first. Rather perhaps does the history of the land-surface, and with this the history of the vegetation, come to our aid. Here I do not go into details; they are to be found in the geological writings of Hutton and others, and are for the most part in the Transactions of the New Zealand Institute.

Suffice it to say there is much evidence in favour of land-connection at one time with Australia and the Malay Archipelago, and that a considerable number of the ancestors of our species, and indeed some of the species themselves, came from thence—New Caledonia, the New Hebrides, and Norfolk Island being portions of the ancient land-bridge. Also, perhaps before the northern invasion, there was land-connection with an ancient antarctic or subantarctic continent, which at one time or another had been also connected with South America, and from this ancient land-area came the ancestors of our endemic or special genera, and perhaps some of our present species. *Nothofagus* may be taken as a type of the southern invaders and *Agathis* as one of the northerners. Between these two antagonistic classes of plants a struggle for the land would ensue, and the weakest would be driven to the most inhospitable places if their structure would allow them to occupy such. Thus we find remnants of the *Nothofagus* horde still remaining in the kauri region and even on Little Barrier Island. But the great army of these plants are to be found now in the colder southern parts and these principally in the poorer ground or at high elevations, the subtropical mixed forest occupying the better positions.

Nor is this all, for in all probability, as so ably shown by Speight in the report that is being published on the Tongariro National Park simultaneously with this one, the North Island was at one time an archipelago, a strait cutting off virtually what is now the Northern Floristic Province from the southern part of the Island. If this were the case, it is possible that a natural barrier existed, making difficult the spread of certain species to the south. In favour of this view is the distribution of the earthworms, for, according to Benham,* those belonging to an Australian genus, *Rhododrilus*, have not been found beyond latitude 38° south, whereas south of this earthworms of subantarctic origin are abundant. Bearing all these facts in mind, and also what has been said above as to the struggle for existence among the plants, the ecological optimum and so on, it seems to me that the above explanation is worthy at any rate of examination. Personally I can see various weak points. Many of the statements on which it is based can hardly be called facts, but if it assists in stimulating research it will fulfil the special and most important mission of any theory.

C. LIFE-HISTORY OF A KAURI FOREST.

From the forest itself, the distribution of its members, the difference noted in various parts, and especially from a comparison between forest proper, transition forest, and heath, something can be learned as to its evolution. First of all it must be borne in mind that the kauri forests have been very much more extensive than is now the case. I do not refer merely to the reduction of the area through sawmilling and fires, but go back much further, and to the time when not only the present northern heath, so full of kauri-resin, but the swamps also, equally full of the same, were kauri forests; otherwise whence came the resin? The heath, then, was certainly at one time a much less extensive formation than at present. Its presence now depends upon the nature of the ground, the absence of competition with other plants, wind, and other factors, which we cannot estimate. But the kauri grew there originally. Some probably was destroyed by fire in the Maori times, but that could not account for nearly all. Much more to do with the distribution have been the oscillations of the land: a sinking of surface would in many cases lead to swamp conditions and actual submersion by the sea, in which cases the new ground would be occupied by xerophytes in the first place. The great amount of kauri-gum in the swamps of the north points conclusively to this submersion. (See Cheeseman, 2.) If I am right, too, as to xerophytes being the first to occupy a barren and wind-swept area, where humus is absent, then the heath is not only the successor but also the forerunner of the forest, but this, as the heath becomes fitted for plant-life, may gradually encroach upon it, sending out first its more xerophytic plants, just as is happening at the present time in many places on the margins of the Waipoua Forest, where seedlings of nearly all the forest-plants exist within the transition forest and where those of the kauri are more abundant by far than under the kauri-groves or in such extensive colonies as that of the Huaki.†

If one thing more than another was impressed upon my mind it was the diverse character of the forest in different parts under very similar conditions. In other words, though it seems to be a most stable thing, it is really always in a state of change, and various parts represent various phases or climaxes. Thus it has been shown that one part may have little undergrowth and many large trees, while, on the contrary, another may have the undergrowth dominant. This latter will in time, through survival of the fittest and non-blooming of juvenile plants, result in a close forest with little undergrowth. These are two climaxes, and are expressions of the light-factor, the dense undergrowth meaning the maximum, and the final open forest with a close roof the minimum, of light. Between these two climaxes there are all kinds of transitions. Bring in more light still, and more xerophytic conditions will prevail, the hygrophytic forest-plants going to the wall, until with excess of light a transition forest and a heath may result.

But on the heath usually are abundance of juvenile members of the lofty forest-tree *Weinmannia sylvicola*, most of which acquire no great size but do not bloom. All the same, *they show the heath to be a potential forest*, and this is still more the case where young *Knightia* and even the kauri itself enter in. In fact, it seems to me that if heath were let alone and the climate was favourable, *Weinmannia-Leptospermum* forest would result, this followed in due course by kauri forest proper. In like manner we have the reversal to the heath. In other words, we have here Nature juggling with the same material as in the primeval New Zealand days, and much the same must be going on now as formerly—that is, where cattle, &c., and introduced plants are absent.

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* Trans. N.Z. Inst., Vol. xxxviii, p. 239, 1906.

† Greater light at once leads to increase in seedling kauris, as may be seen in most forests where the kauri has been cut out. (See also Matthews 22A.).

The primitive forest-plants seem to be manuka (*Leptospermum scoparium*), towai (*Weinmannia sylvicola*), rewarewa (*Knightia excelsa*), toru (*Persoonia toru*), horoeka or lancewood (*Pseudopanax crassifolium*). Then follow totara (*Podocarpus totara*), rimu (*Dacrydium cupressinum*), and kauri (*Agathis australis*), while silver tree-fern (*Cyathea dealbata*) will form the larger undergrowth, together with *Senecio Kirkii* and *Blechnum Frazeri*. *In fact, we must have in many forest formations a gradual progression from the xerophyte to the hygrophyte, and in northern New Zealand this progression is clearly shown in the floristic relationship between the forest and the heath, which relationship may be traced (1) in the primeval formations, and (2) by means of unpremeditated human experiments.*

The above theory is supported to no inconsiderable extent by a comparative study of the Waipoua Forest near its junction with the heath, and it seems to illustrate what may be a fundamental general principle in plant-geography.

As for the details, much also is to be learnt both from the decay and revivication. There are, as may be remembered, for instance, the open kauri association, the pure tarairi forest, the tall tarairi saplings, the almost pure associations of tree-ferns and small groups of the same, the close shrubby undergrowth where the early struggle is in progress and where the gradual weeding-out is taking place. There are in the present forest the processes of its evolution in full play, and these are partly topographical and partly biological. No part, even without topographical changes, can remain permanent, while such changes bring about a new cycle of events. The following is perhaps the procession of events: (1) The heath; (2) the heath-forest; (3) the mixed forest, with many species and much undergrowth; (4) the increasing of the dominant plant and the gradual extinction of the others; (5) the death of the dominant plant and a gradual reconstruction of the forest; finally, a change of climate or topographical conditions, bringing about a more xerophytic state of affairs, and forest may be succeeded by heath. The study of these processes has a distinct economic bearing. They have not as yet been followed with certainty, but they suggest the line for further inquiry, and, on such, forestry operations, even in artificial forests, should probably be based. It is not enough to look for a certain supply from a forest—the forest should be self-supporting, and so constituted that one tree will gradually suppress and replace another.

The whole matter is most complex, and yet it does not seem impossible of solution. My own investigations were made during a comparatively short time, and do not profess to thoroughness in any marked degree.

D. SOME GENERAL CONSIDERATIONS REGARDING THE WAIPOUA FOREST.

The Waipoua Forest and one or two other smaller reserves are the only virgin kauri forests now belonging to the State. The kauri forest, as I have already stated, is the only plant-association of the kind to be found in the world. I have also attempted to show that it is one of great beauty and of extreme scientific interest. The forest reserve contains examples of 241 species of flowering-plants and ferns. It is therefore at present an important forest museum. Before very long, at the rate at which the kauri is being converted, there will be no forests of that kind, and very few examples of the trees either—in twenty years' time, or even less. Thus will pass away for ever from the face of the earth one of the noblest of forests and one of the unique attractions of New Zealand. Our fiords, glaciers, and hot springs have their like elsewhere; our kauri forests are no where else to be seen. What the future of the Waipoua Forest will be I cannot pretend to predict. If it is felled it will give employment for a few years to a certain number of men, who in any case at the end of that time will have to look for other employment, and in its place will be much waste land and a few farms, isolated from other settlement. If it is preserved there will be a magnificent heritage for future generations, and an attraction, constantly increasing in its interest, for the visitors to our shores.

Now, as to the forest itself. It certainly, as has been shown, contains a great deal of milling-timber, both kauri and rimu, together with some kahikatea, totara, miro, and matai. The kauri is found in quantity only to the west of the Toronui Stream, excepting some in the watershed of the Merowharara. Of this kauri belt, which extends from east to west, much of the kauri in the southern part of the forest is scattered, the milling-timber *par excellence* being that on the higher land near Kohuroa and the Huaki. But it must be borne in mind that a large part of the forest contains no milling-timber at all. On the high table-land and in a few other parts is much rimu. The land on which this grows is here of little value for agriculture, and the same remark applies to the continuation of the forest on the table-land. In other words, the present crop is the best the soil will ever yield, and it should surely not be felled merely for purposes of settlement while so much better land elsewhere is at present unoccupied.

The slopes of the Waipoua Forest on the south to the Waipoua River in many parts contain no milling-timber at all beyond some scattered kauris, and yet, though they give not a perfect example by any means of what a kauri forest is, their covering would suffice were no better available, and would make a very fair national kauri park. That such a park should be created seems to me incontrovertible. The only difference of opinion that can arise is as to its size. The Waipoua Forest as a whole would make, of course, the ideal park. It would be one of the great sights of the world, and as the years crept on it would be more and more prized by our descendants. To preserve the forest in its entirety would mean hastening the end of the kauri industry by a very few years; to cut it down would extend that industry for the same number.

PART V. LIST OF INDIGENOUS PTERIDOPHYTES AND SPERMAPHYTES.

EXPLANATION OF ABBREVIATIONS USED.

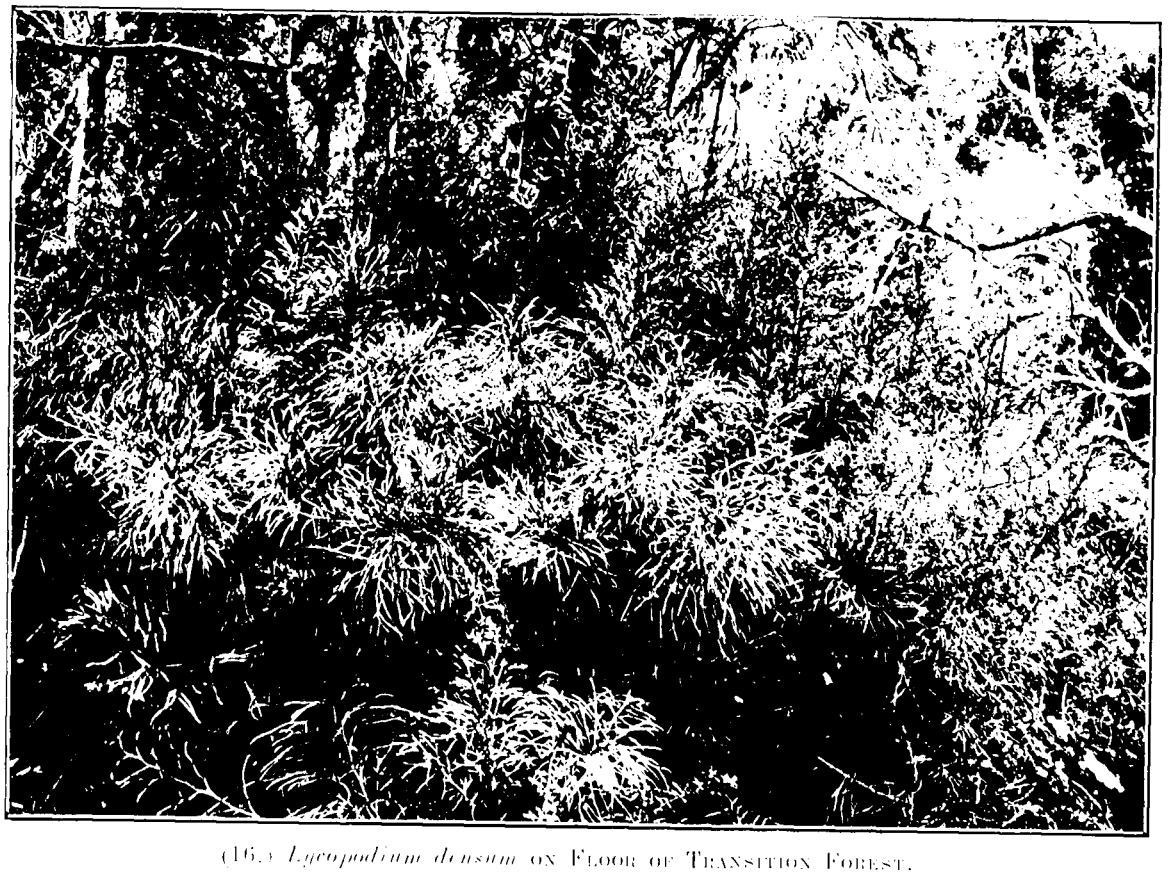
N. = Northern botanical province of New Zealand. C. = Central botanical province of New Zealand. S. = Southern botanical province of New Zealand. Sub. = Subantarctic botanical province of New Zealand. Ch. = Chatham Islands botanical province of New Zealand. Ker. = Kermadec Islands botanical province of New Zealand. End. = Endemic. Aus. = Australian and Tasmanian (one or both). S.A. = South American and subantarctic (one or both). Pol. = Polynesian. Mal. = Malayan and South Asian (one or both). Cos. = Generally distributed in temp. (= temperate) or trop. (= tropical) lands.

LIST OF INDIGENOUS PTERIDOPHYTES AND SPERMAPHYTES.

Species and Natural Order.	Maori Name.	English Name.	Distribution.			Life-form.
			Beyond New Zealand, or Endemic.	Within New Zealand.	In Forest, Heath, &c.	
PTERIDOPHYTA.						
HYMENOPHYLLACEÆ.						
Trichomanes reniforme Forst. f.	Kakakopamotu, konehu	Kidney fern	End.	N. C. S. Ch.	Forest	Filmy fern, with broad reniforme fronds.
—— *Lyallii* (Hook. f.) Hook.	..	Lyall's bristle fern	New Cal.	N. C. S.	„	Small pendulous filmy fern.
—— *humile* Forst. f.	..	Drooping bristle fern	Mal. Pol.	N. C.	„	„
—— *venosum* R. Br.	..	Veined bristle fern	Aus.	N. C. S. Ch.	„	„
—— *elongatum* A. Cunn.	..	Black bristle fern	New Cal., Fiji	N. C.	„	Very dark-green filmy fern, with deltoid fronds.
Hymenophyllum rarum R. Br.	..	Thin-leaved filmy fern	Aus.	N. C. S. Ch. Sub.	„	Small, shining, green, filmy fern, forming close patches on trees and rocks.
—— *sanguinolentum* (Forst. f.) Sw.	..	Scented filmy fern	End.	N. C. S. Sub.	„	Epiphytic, olive-green, entire-leaved, filmy fern.
—— *australe* Willd.	..	Crisped filmy fern	Aus. Mal. India	„	„	Moderate-sized filmy fern, with crisped, winged leaf-stalk.
—— *dilatatum* (Forst. f.) Sw.	Irirangi	Broad-leaved filmy fern	Aus. Mal. Pol.	N. C. S. Ch. Sub.	„	Large, epiphytic, bright-green, broad-leaved, filmy fern.
—— *demissum* (Forst. f.) Sw.	„	Drooping filmy fern	Mal. Pol.	„	„	Moderate-sized filmy fern, forming large patches.
—— *scabrum* A. Rich.	..	Rough-stalked filmy fern	End.	N. C. S. Ch.	„	Rather large epiphytic filmy fern, with reddish hairs on leaf-stalks.
—— *flabellatum* Lab.	..	Fan-leaved filmy fern	Aus. Pol.	N. C. S. Ch. Sub.	„	Small, far-creeping, epiphytic, filmy fern, with woolly, reddish hairs on rhizome.
—— *ferrugineum* Colla (syn. *H. subtilissimum* Kunze.)	..	Rusty filmy fern	S.A.	N. C. S.	„	Epiphytic filmy fern, covered with rust-coloured hairs.
—— *tunbridgense* (L.) Sm.	..	Tunbridge fern	Aus. S.A. Eur. S.Af. Jamaica	N. C. S. Sub.	„	Small filmy fern, forming dense patches.
—— *multifidum* (Forst. f.) Sw.	..	Sharp-toothed filmy fern	Aus. Mal. Pol.	N. C. S. Ch. Sub.	„	Rather large filmy fern, forming large matted patches.
Loxsoma Cunninghamii R. Br.	..	Loxsoma fern	End.	N.	Heath near forest	Tall fern, with long, stout rhizome.
CYTHACEÆ.						
Dicksonia squarrosa (Forst. f.) Sw.	Wheki, weki	Slender tree-fern	„	N. C. S. Ch.	Wet and upland forest	Slender tree-fern, with coriaceous fronds and persistent leaf-stalks on trunk.
—— *lanata* Col.	..	Woolly tree-fern	„	N. C.	Forest	Small tree-fern, with short trunk and yellow-green coriaceous leaves.

(15.) View of a Portion of Swampy Forest near Waipoua River. Abundance of Kiekie (*Freycinetia Banksii*) on ground, Pic (*Blechnum capense*).

Photo., L. Cockayne.



(16.) *Lycopodium dunsum* on Floor of Transition Forest.

Photo., L. Cockayne.

Cyathea dealbata (Forst. f.) Sw.	Ponga	Silver tree-fern	Lord Howe Isld.	N. C. S. Ch.	Forest	Tall tree-fern, with leaves silvery beneath with coating of white powder.
——— *medullaris* (Forst. f.) Sw.	Mamaku, korau	Black tree-fern	Aus...	„	„	Tall tree-fern, with rather slender trunk and black leaf-stalks.
Hemitelia Smithii R. Br.	Neineikura	Pale-leaved tree-fern	End.	N. C. S. Sub.	Upland forest	Medium-sized tree-fern, with rather thin green leaves.
POLYPODIACEÆ.						
Dryopteris pennigera (Forst. f.) C. Chr. (syn. *Polypodium pennigerum* Forst. f.)	Pakauroharoha	Feather fern	Pol.	N. C. S. Ch.	Wet forest	Semi-tree-fern, with rather long, thin, pinnate leaves.
——— *punctata* (Thnb.) C. Chr. (syn. *Polypodium punctatum* Thnb.)			Aus. Pol. S.A. Asia, African Islds.	N. C. S.	Forest	Tall fern, with much-divided, glandular-pubescent fronds and far-creeping rhizome.
Polystichum hispidum (Sw.) J. Sm. (syn. *Nephrodium hispidum* Hook.)		Hairy-stemmed fern	Aus...	„	„	Moderate-sized fern, with hairy leaf-stalk and long, stout, creeping rhizome.
——— *adiantiforme* (Forst. f.) J. Sm. (syn. *Aspidium capense* Willd.)		Thick-leaved shield fern	Aus. Pol. S.A. S.Af., Tristan da Cunha, Cuba	N. C. S. Ch.	„	Epiphytic fern, with thick hard leaves and long stout rhizome.
Lindsaya cuneata (Forst. f.) Ch. Chr. (syn. L. *trichomanoides* Dry.)		Broad-leaved lindsaya	Aus. Fiji	N. C. S.	„	Small fern, with dark-green, rather stiff leaves and slender, creeping rhizome.
Lindsaya linèaris Sw.		Narrow-leaved lindsaya	Aus., New Cal.	N. C. S. Ch.	Heath	Small fern, with narrow pinnate leaves and slender, creeping rhizome.
Asplenium adiantoides (L.) C. Chr. (syn. *A. falcatum* Lam.)	Petako	Drooping spleenwort	Aus. Pol. E.Af. Asia	„	Forest	Epiphytic fern, with large, often pendulous, shining, pinnate leaves.
——— *lucidum* Forst. f.		Shining spleenwort	Aus...	N. C. S.	„	Tall fern, with tufted, thick, glossy leaves.
——— *bulbiferum* Forst. f.	Maku	Common spleenwort	Aus. N.India, Penang	N. C. S. Ch. Sub.	„	Tall fern, with short rhizome and much-divided, bright-green leaves, sometimes proliferous.
——— *flaccidum* Forst. f.	Raukatauri	Pendent spleenwort	Aus. S.Af.	„	„	Erect or frequently pendulous, usually epiphytic, fern, with much-cut coriaceous leaves.
Blechnum discolor (Forst. f.) Keys (syn. *Lomaria discolor* Willd.)	Piupiu	Common hard fern	Aus., Norfolk Isld.	„	„	Tall fern, sometimes with short trunk and semi-erect crown of coriaceous pinnatifid leaves.
——— *lanceolatum* (R. Br.) Sturm. (syn. *Lomaria lanceolata* Spr.)		Lance-leaved hard fern	Aus. Pol.	N. C. S. Ch.	„	Moderate-sized fern, with tufted, spreading fronds, sometimes on short, raised trunk.
——— *capen e* (L.) Schlecht. (syn. *Lomaria capensis* Willd.)	Piu, piupiu	Long hard fern	Aus. Pol. Mal. S.A. S.Af.	N. C. S. Ch. Sub.	„	Tall fern, with long pinnate leaves.
——— *filiforme* (A. Cunn.) Ellingh. (syn. *Lomaria filiformis* A. Cunn.)		Climbing hard fern	Fiji	N. C.	„	Liane, with woody stem and dimorphic leaves.
——— *nigrum* (Col.) Mett. (syn. *Lomaria nigra* Col.)		Black hard fern	End.	N. C. S.	„	Moderate-sized fern, with very dark-coloured, spreading, rather thin, pinnatifid leaves.
——— *fluviatilie* (R. Br.) Lowe (syn. *Lomaria fluviatilis* Spr.)		Creek fern	Aus...	N. C. S. Ch. Sub.	„	Large fern, with spreading crown of pinnate leaves on short or slightly raised stem.
——— *membranaceum* (Col.) Mett. (syn. *Lomaria membranacea* Col.)		Membrane-leaved fern	End.	N. C. S.	„	Like a small form of *B. lanceolatum*.
——— *Fraseri* (A. Cunn.) Luerss. (syn. *Lomaria Fraseri* A. Cunn.)		Miniature tree-fern	Philippines	N. C.	„	Small tree-fern, with very slender trunk and crown of dark-green leaves.

LIST OF INDIGENOUS PTERIDOPHYTES AND SPERMAPHYTES—*continued.*

Species and Natural Order.	Maori Name.	English Name.	Distribution.			Life-form.
			Beyond New Zealand, or Endemic.	Within New Zealand.	In Forest, Heath, &c.	
POLYPODIACEÆ—*continued.*						
Hypolepis distans (Col.) Hk.	..	Brown hypolepis	End. ..	N. C. S. ..	Forest ..	Tall, slender fern, with 2-pinnate fronds and long, branched rhizome.
Adiantum affine Willd.	..	Common maidenhair ..	„ ..	N. C. S. Ch. ..	Bank of creek in open	Moderate-sized fern, with 2- or 3-pinnate fronds and much creeping rhizome.
——— *fulvum* Raoul	..	Brown-stemmed maidenhair	Pol. Aus. ..	N. C. ..	Forest ..	Similar to above but with smaller pinules.
Pteris tremula R. Br.	Tarawera	Trembling bracken ..	Aus., Norfolk Isld.	N. C. ..	„ ..	Tall fern, with bright-green 2–4-pinnate, tufted, herbaceous leaves.
Histiopteris incisa (Thunb.) J. Sm. (syn. *Pteris incisa* Thunb.)	..	Cut-leaved bracken ..	Aus. Cos. trop.	N. C. S. Ch. Sub.	„ ..	Tall fern, with 2–3-pinnate, soft, pale-green leaves and long creeping rhizome.
Pteridium esculentum (Forst. f.) (syn. *Pteris esculenta* Forst. f.)	Rau-aruhe, rauhurahu	Common bracken	Aus. S.A. ..	„	Heath ..	Tall fern, with stout, matted rhizome and 3–4-pinnate coriaceous leaves.
Pæsia scaberula (A. Rich.) Kuhn. (syn. *Pteris scaberula* A. Rich.)	..	Rough bracken	End. ..	N. C. S. Ch. ..	Forest ..	Moderate-sized fern, with far-creeping wiry rhizome and coriaceous, finely cut leaves.
Polypodium Billardieri (Willd.) C. Chr. (syn. *P. australe* Mett.)	..	Narrow-leaved polypody ..	Aus. S.Af., New Guinea, S.A.	N. C. S. Sub...	„ ..	Tufted, small, epiphytic fern, with entire, linear-lanceolate leaves.
——— *grammitidis* R. Br.	..	Saw-edged polypody ..	Aus... ..	N. C. S. Ch. Sub.	„ ..	Small, tufted, epiphytic fern, with pinnatifid leaves.
——— *Dictyopteris* Mett. (syn. *P. Cunninghamii* Hook.)	..	Cunningham's polypody ..	New Hebrides	N. C. ..	„ ..	Epiphytic fern, forming close and thick mats of roots which bear buds, and having lanceolate, entire leaves.
——— *pustulatum* Forst. f.	..	Scented polypody	Aus., New Cal., Norfolk Isld.	N. C. S. ..	„ ..	Climbing fern, with thin, irregular, pinnatifid leaves.
——— *diversifolium* Willd. (syn. *P. Billardieri* R. Br.)	Paraharaha	Climbing polypody ..	Aus., Norfolk Isld., New Cal.	N. C. S. Sub. Ch.	„ ..	Climbing or ground fern, with wide, polymorphous, coriaceous leaves.
Cyclophorus serpens (Forst. f.) C. Chr. (syn. *Polypodium serpens* Forst. f.)	..	Thick-leaved polypody ..	Aus., New Cal., Norfolk Isld.	N. C. S. Ch. ..	„ ..	Climbing fern, with round or oblong, small, entire, very thick leaves.
GLEICHENIACEÆ.						
Gleichenia circinata Sw.	Waewaekaka	Scrambling umbrella fern ..	Aus. Mal., New Cal.	N. C. S. ..	Heath ..	Tall, erect, or scrambling fern, with long, wiry rhizome and leaves dichotomously forked.
——— *Cunninghamii* Hew.	Tapuwaekotuku ..	Umbrella fern	End. ..	„ ..	Forest ..	Tall fern, dichotomously branched and pinnæ plagiotropous.
——— *flabellata* R. Br.	..	Fan-like umbrella fern ..	Aus., New Cal.	N.	Bank of River Waipoua	Moderately tall fern, with leaves dichotomously branched and fan-shaped.
SCHIZÆACEÆ.						
Lygodium articulatum A. Rich.	Mangemange	Twining fern	End. ..	„	Forest ..	Twining climbing fern, with wiry stems and glossy green leaves.

OSMUNDACEÆ.							
Leptopteris hymenophylloides (A. Rich.) Pr.	Heruheru	Single crape fern	„	N. C. S.	„	Tall fern, with dark-green *Hymenophyllum*-like tufted fronds.
LYCOPODIACEÆ.							
Lycopodium Billardieri Spring.	Whiri-o-Raukatauri	Hanging club-moss	Pol.(?)	N. C. S. Ker.	„	Tufted, pendulous epiphyte, much-branching dichotomously.
—— *densum* Labill	Waewaekoukou	Tree club-moss	Aus., Norfolk Isld., New Cal.	N.	Heath	Dense-growing, tree-like, with rigid, erect stems and short creeping rhizome.
—— *cernuum* L.		Creeping club-moss	Trop. Cos.	„	„	Prostrate. with much-creeping leafy stems.
—— *laterale* R. Br.		Bog club-moss	Aus., New Cal.	N. C. S.	Boggy heath	Small, much-creeping, with short. erect stems.
—— *volubile* Forst. f.	Waewaekoukou	Climbing club-moss	Aus. Pol. Mal., New Cal.	N. C. S. Ch.	Forest, heath	Scrambling liane, with long. wiry, much-branching stems.
Tmesipteris tannensis Bernh.			Aus. Pol.	N. C. S. Ch. Sub.	Forest	Epiphyte, with usually pendulous stem and closely placed, small, coriaceous leaves
SPERMAPHYTA.							
TAXACEÆ.							
Podocarpus totara A. Cunn.	Totara		End.	N. C. S.	„	Tall tree, with thick bark, and pungent, small, coriaceous leaves.
—— *Hallii* T. Kirk	„		„	„	„	Ditto, but bark thin.
—— *ferrugineus* Don.	Miro		„	„	„	Tall tree, with distichous, linear leaves.
—— *spicatus* R. Br.	Mai, matai	Black-pine	„	„	Forest (rare)	„ „ „
—— *dacrydioides* A. Rich.	Kahikatea, koroi	White-pine	„	„	Swamp, forest	Tall tree, with small head and scale-like imbricating leaves.
Dacrydium Kirkii F. Muell.	Monoao	Kirk's pine	„	N. S.(?)	Forest	Tall tree, with dimorphic foliage.
—— *cupressinum* Sol.	Rimu	Red-pine	„	N. C. S.	„	Tall tree, with drooping branchlets and small, imbricating leaves.
—— *Colensoi* Hook.	Monoao, Manoao	Silver-pine, Westland silver-pine	„	„	„	Small tree, with dimorphic foliage.
Phyllocladus trichomanoides Don.	Tanekaha	Celery-leaved pine	„	N. C.	„	Tall tree, with coriaceous, leaf-like cladodes.
PINACEÆ.							
Agathis australis Salisb.	Kauri		„	N.	„	Very tall, massive tree, with large, spreading head and thick, coriaceous leaves.
Libocedrus Doniana Endl.	Kawaka	New Zealand cedar, New Zealand arbor vitae	„	N. C.	„	Tall tree, with deciduous bark.
TYPHACEÆ.							
Typha angustifolia (L.) var. *Brownii* (Kunth)	Raupo	Bulrush	Aus. Pol.	N. C. S.	Sluggish stream	Tall, reed-like herb.
PANDANACEÆ.							
Freycinetia Banksii A. Cunn.	Kiekie	New Zealand screw-pine	End.	„	Forest	Root-climbing, woody liane.
GRAMINEÆ.							
Oplismenus undulatifolius Beauv.		Slender panic-grass	Cos. sub. trop.	N. C.	„	Small, semi-prostrate, thin-leaved grass.
Microlæna stipoides R. Br.	Patiti	Meadow rice-grass	Aus., Norfolk Isld	N. C. S.	Heath	Moderate-sized grass, with thin, flat leaves and creeping rhizome.
—— *avenacea* (Raoul) Hook. f.		Bush rice-grass	End.	„	Forest	Tall grass, with broad, flat leaves.
Danthonia pilosa R. Br.		Purple-awned oat-grass	Aus.	„	Heath	Tufted grass, with slender, involute leaves.

List of Indigenous Pteridophytes and Spermaphytes—*continued.*

Species and Natural Order.	Maori Name.	English Name.	Distribution.			Life-form.
			Beyond New Zealand, or Endemic.	Within New Zealand.	In Forest, Heath, &c.	
GRAMINEÆ—*continued.*						
Danthonia semiannularis R. Br.	..	Common oat-grass ..	Aus. ..	N. C. S. Ch. ..	Heath ..	Moderate-sized tufted grass, with slender leaves.
Arundo conspicua Forst. f.	Toetoekakaho ..	New Zealand reed	End. ...	N. C. S. ..	„ ..	Huge tussock-grass, with long, narrow, coriaceous leaves.
CYPERACEÆ.						
Elæocharis acuta R. Br.	...	Australian spike-rush ..	Aus., Norfolk Isld.	N. C. S. Ch. ..	Boggy heath ..	Small, tufted, terete-stemmed sedge.
Scirpus inundatus Poir.	...	...	Aus. Mal. S.A.	„ ..	Swampy ground	Rusk-like, prostrate plant, with slender stems, and often proliferous.
Schœnus brevifolius R. Br.	...	...	Aus... ..	N. C. ..	Heath ..	Moderate-sized rush-like plant, with smooth, terete, rigid stems
—— *tendo* Banks and Sol.	...	..	End. ..	„ ..	„ ..	Rush-like plant, forming close tufts of slender, grooved stems 2 ft. to 3 ft. tall
Cladium teretifolium R. Br.	..	..	Aus.	„ ..	Swampy ground	Rush-like plant, with densely tufted, stiff, striate stems 2 ft or 3 ft. tall.
Lepidosperma laterale R. Br.	..	..	Aus. ..	N.	Heath, ..	Flat, coriaceous-stemmed plant, forming tussocks.
Gahnia setifolia (A. Rich.) Hook. f. ..	Toetoekiwi	..	End. ..	N. C. ..	Forest ..	Tall sedge, forming large tussocks.
—— *pauciflora* T. Kirk	..	..	„ ..	„ ..	„ ..	Sedge, forming rather large tussocks.
—— *xanthocarpa* Hook. f.	..	Giant cutting-sedge ..	Lord Howe Isld.	N. C. S. ..	„ ..	Very tall sedge, forming huge tussocks.
—— *Gaudichaudii* Steud.	..	..	Sandwich Islds.	N. C. ..	Heath ..	Small, tufted sedge, with coriaceous, spreading leaves.
Uncinia australis Pers.	Matau-a-Maui ..	Broad-leaved uncinia ..	End. ..	N. C. S. Ch. ..	Forest ..	Tufted grass-like herb.
—— *Banksii* Boott	Matau	Narrow-leaved uncinia ..	„ ..	„ ..	„ ..	„
—— *leptostachya* Raoul	Matauririki ..	Tall uncinia	„ ..	„ ..	„ ..	„
Carex subdola Boott	..	..	„ ..	„ ..	Swampy ground	Slender, rather grass-like sedge.
PALMÆ.						
Rhopalostylis sapida (Sol.) Wendl. and Drude	Nikau	Nikau palm	„ ..	N. C. ..	Forest ..	Slender, moderately tall palm.
LEMNACEÆ.						
Lemna minor L.	..	Duckweed	Cos.	N. C. S. ..	Pools of water	Very small floating herb.
JUNCACEÆ.						
Juncus effusus L.	Wiwi	Common rush	„	„ ..	Wet ground in open	Pale-green, close-growing tall rush.
LILIACEÆ.						
Rhipogonum scandens Forst.	Kareao, pirita ..	Supplejack	End. ..	„ ..	Forest ..	Tall, woody, winding liane.
Cordyline Banksii Hook. f.	Ti-ngahere, hauora ..	Slender cabbage-tree ..	„ ..	N. C. ..	Forest, heath	Small tree with slender stem, and long leaves crowded on its summit.

(17.) Interior of Kauri Forest near Kohuroa. In centre Kauri with Human Figure as Scale.

(18.) Interior of Waiboca Forest near Pukehuruhu. *Cordyline Banksii* in centre.
[*Photo., L. Cockayne.*

Cordyline australis (Forst. f.) Hook. f. ..	Ti, tikauka	Cabbage-tree, palm-lily ..	„ ..	N. C. S. ..	Heath ..	Small tree, with slender trunk, much-branching near summit and round, close heads of ensiform leaves.
Astelia trinervia T. Kirk	Kahakaha	Kauri-grass	„ ..	N. C. ..	Forest, heath	Tall plant forming dense tussocks of long, arching, pale-green, coriaceous, thick leaves.
—— *Solandri* A. Cunn.	Kahakaha	Perching lily	„ ..	„ ..	Forest ..	Epiphyte forming dense clumps of long ensiform leaves.
—— *nervosa* Banks and Sol.	Kakaha	Bush-flax	„ ..	N. C. S. ..	„ ..	Tall plant forming large tussocks of coriaceous, linear-lanceolate leaves.
Dianella intermedia Endl.	Turutu	Blue berry	Pol., Norf. Isld.	„ ..	Heath ..	Iris-like herb with creeping rhizome.
IRIDACEÆ.						
Libertia grandifolia (R. Br.) Sw.	Turutu	Large-flowered libertia ..	End. ..	„ ..	Forest ..	Rather tall iris-like herb, forming close tuffs of linear, coriaceous, stiff leaves.
—— *pulchella* Spreng.	..	Forest libertia	Aus... ..	„ ..	„ ..	Small tufted herb, with grass-like leaves.
ORCHIDACEÆ.						
Dendrobium Cunninghamii Lindl.	...	..	End. ..	„ ..	„ ..	Epiphyte, with wiry, long, branching stems and grass-like leaves.
Bulbophyllum pygmæum Lindl.	..	..	„ ..	„ ..	„ ..	Very small epiphyte, with matted rhizome and minute pseudobulbs.
Earina mucronata Lindl.	..	Pointed-leaved earina ..	„ ..	N. C. S. Ch. ..	„ ..	Epiphyte with close mat of rhizomes and grass-like leaves.
—— *autumnalis* (Forst. f.) Lindl. ..	Raupeka	Fragrant earina	„ ..	„ ..	„ ..	As for above.
Thelymitra longifolia Forst.	Makaika	Common thelymitra ..	Aus... ..	N. C. S. Ch. Sub.	Heath ..	Tuberous-rooted, terrestial orchid with one thick linear leaf.
Microtis unifolia (Forst. f.) Reichen. ..	Maikaika	Onion-leaved orchid ..	Aus... ..	N. C. S. Ch. ..	„ ..	Tuberous-rooted orchid with solitary terete leaf.
Pterostylis Banksii R. Br...	..	Common hooded orchid ..	End. ..	N. C. S. Ch. ..	Forest ..	Rather tall tuberous-rooted orchid with soft grassy leaves.
—— *graminea* Hook. f.	...	Narrow-leaved hooded orchid.	„ ..	„ ..	„ ..	As for above.
Acianthus Sinclairii Hook. f.	...	..	„ ..	N. C. Ch. Ker.	„ ..	Small terrestial orchid with solitary cordate leaf.
Corysanthes oblonga Hook. f.	...	..	„ ..	N. C. S. ..	„ ..	Small terrestial orchid with solitary ovate leaf.
—— *triloba* Hook. f.	...	..	„ ..	„ ..	„ ..	Small terrestial orchid with solitary reniform leaf.
PIPERACEÆ.						
Macropiper excelsum (Forst. f.) Miq. ..	Kawakawa	Tall pepper-tree	Pol., Norf., L. Howe	N. C. S. Ch. ..	Forest on lowest ground	Small tree with slender stems and thin, cordate, rather large leaves.
MORACEÆ.						
Paratrophis heterophylla Bl.	Turepo	Milk-tree	End. ..	N. C. S. ..	Forest ..	Small, dimorphic tree, with finally small, coriaceous leaves of oblong type.
PROTEACEÆ.						
Persoonia toru A. Cunn.	Toru	..	„ ..	N.	Forest, heath	Small tree, with long, narrow, thick, and coriaceous leaves, purplish on under-surface.
Knightia excelsa R. Br.	Rewarewa	Honeysuckle	„ ..	N. C. ..	Forest ..	Tall fastigiate forest-tree, with hard, coriaceous, rather large leaves.
SANTALACEÆ.						
Fusanus Cunninghamii Benth. and Hook. ..	Maire	New Zealand sandalwood ..	„ ..	„ ..	„ ..	Small tree, with slender trunk and alternate leaves of lanceolate type.

List of Indigenous Pteridophytes and Spermaphytes—*continued.*

Species and Natural Order.	Maori Name.	English Name.	Distribution.			Life-form.
			Beyond New Zealand, or Endemic.	Within New Zealand.	In Forest, Heath, &c.	
POLYGONACEÆ.						
Muehlenbeckia complexa (A. Cunn.) Meisn.	Pohuehue	Slender Muehlenbeckia	End.	N. C. S.	Forest	Winding liane, with most variable, rather small leaves.
RANUNCULACEÆ.						
Clematis indivisa Willd.	Pikiarero (puawhananga =the flower)	Native clematis	„	„	„	Tendril climber, with coriaceous leaves and showy white flowers.
——— *hexasepala* D. C.	Pikiarero	Smaller white clematis	„	„	„	Similar to above.
——— *parviflora* A. Cunn.		Small-flowered clematis	„	N.	„	Tendril climber, with thin leaves.
Ranunculus hirtus Banks and Sol.	Maruru	Common New Zealand buttercup	Aus...	N. C. S. Ch.	Heath, open forest	Small herb, with 3-foliate leaves and small yellow flowers.
MAGNOLIACEÆ.						
Drimys axillaris Forst.	Horopito	Pepper-tree	End.	N. C. S.	Forest	Small tree or shrub with black bark, and coriaceous leaves, glaucous beneath.
MONIMIACEÆ.						
Hedycarya arborea Forst.	Porokaiwhiri	Pigeonwood	„	„	„	Small tree, with opposite, oblong, coriaceous, dark-green leaves.
Laurelia novæ-zelandiæ A. Cunn.	Pukatea		„	N. C.	„	Tall tree, with shining leaves and trunk with plank buttresses.
LAURACEÆ.						
Beilschmiedia tarairi (A. Cunn.) Benth. and Hook.	Tarairi, Taraire		„	N.	„	Medium-sized tree, with moderately slender trunk and rather large, rounded, coriaceous leaves.
——— *tawa* (A. Cunn.) Benth. and Hook.	Tawa		„	N. C.	„	Tall tree, with thin willow-like leaves.
Litsea calicaris (Sol.) Benth. and Hook.	Mangeao		„	N.	„	Small tree, with reddish, ovate, parchment-like leaves.
DROSERACEÆ.						
Drosera auriculata Backh.		Climbing sundew	Aus...	N. C.	Heath	Small, slender, twining herb.
SAXIFRAGACEÆ.						
Quintinia serrata A. Cunn.	Tawheowheo		End.	N. C.	Upper forest	Small tree, with yellowish coriaceous leaves with crimped margins.
Ixerba brexioides A. Cunn.	Tawari		„	N.	„	Small tree, with rather laurel-like, thick leaves and showy white flowers.
Carpodetus serratus Forst.	Putaputawheta	New Zealand hawthorn	„	N. C. S.	Forest	Small tree, with small toothed leaves and abundance of white flowers.
PITTOSPORACEÆ.						
Pittosporum tenuifolium Banks and Sol.	Kohukohu	Thin-leaved pittosporum	„	„	„	Small tree, with small, entire, membraneous, oblong-ovate leaves.
——— *Kirkii* Hook. f.		Kirk's pittosporum	„	N.	„	Epiphyte, with slender stems and thick linear-obovate leaves.
——— *cornifolium* A. Cunn.		Straggling pittosporum	„	N. C.	„	Epiphyte, with slender stems and coriaceous leaves.
——— *eugenioides* A. Cunn.	Tarata	Lemonwood	„	N. C. S.	„	Small tree, with shiny, coriaceous, elliptic, whorled leaves.

CUNONIACEÆ.						
Ackama rosæfolia A. Cunn.	Makamaka	..	„	N.	Forest margin	Small tree, with large, thin, pinnate leaves.
Weinmannia sylvicola Sol.	Towai, tawhero	..	„	„	Forest, heath	Dimorphic tree or shrub, with coriaceous, ternate, entire, or pinnate leaves.
ROSACEÆ.						
Rubus australis Forst.	Tataramoa	Bush-lawyer	„	N. C. S.	Forest	Scrambling liane, with curved prickles and finally stout cable-like stem.
—— *schmidelioides* A. Cunn.	..	Rose-leaved lawyer	„	„	„	Dimorphic scrambling liane, with rose-like coriaceous adult leaves.
Acæna Sanguisorbæ Vahl.	Piriwhetau (pirikahu = the flower), piripiri	Biddybiddy (a corruption of the Maori name)	Aus., Tristan da Cunha	N. C. S. Ch. Sub.	Forest, heath	Creeping herb, with thin pinnate leaves and barbed fruits.
LEGUMINOSÆ.						
Carmichaelia australis	Makaka	Tall native broom	End.	N. C.	Forest	Almost leafless shrub, with flattened assimilating stems.
Sophora tetraptera J. Mill.	Kowhai	New Zealand laburnum, yellow kowhai	S.A.	N. C. Chat.	„	Small tree, with semi-deciduous pinnate leaves and showy yellow flowers.
GERANIACEÆ.						
Geranium microphyllum Hook. f.	..	Slender geranium	End.	N. C. S. Sub.	Heath	Small herb, with prostrate stems and small leaves.
Pelargonium australe Jacq.	Kopata	..	Aus., Tristan da Cunha	N. C. S. Ch.	„	Small herb, with ovate-cordate leaves.
OXALIDACEÆ.						
Oxalis corniculata L.	..	Yellow oxalis	Temp. and Trop. Cos.	N. C. S. Ker.	„	Small prostrate herb, with matted stems and 3-foliate leaves.
RUTACEÆ.						
Phebalium nudum Hook.	Maireire	..	End.	N.	Forest	Closely branched slender shrub, with small aromatic reddish leaves.
Melicope ternata Fors.	Wharangi	..	„	N. C. Ker.	„	Tall shrub, with glossy ternate leaves
—— *simplex* A. Cunn	..	..	„	N. C. S.	„	Moderately tall shrub with dimorphic foliage and small simple adult leaves.
MELIACEÆ.						
Dysoxylum spectabile (Forst. f.) Hook. f.	Kohekohe	Cedar	„	N. C.	„	Medium-sized tree, with large, glossy, pinnate leaves and inflorescence given off from trunk.
CORIARIACEÆ.						
Coriaria ruscifolia L.	Tupakihi (tutu = the fruit)	..	S. A.	N. C. S. Ch.	Bank of creek	Dimorphic shrub, with coriaceous, glossy-green, entire leaves.
CORYNOCARPACEÆ.						
Corynocarpus lævigata Forst.	Karaka	New Zealand laurel	End.	N. C. Ch.	Forest	Laurel-like, round-headed, small tree.
SAPINDACEÆ.						
Dodonæa viscosa Jacq.	Akeake	..	Trop. Cos.	N. C. S. Ch.	„	Small tree, with parchment-like entire narrow leaves.
Alectryon excelsum Gaertn.	Titoki	New Zealand ash	End.	N. C. S.	„	Moderate-sized tree, with rather thin pinnate leaves and showy scarlet fruit.
RHAMNACEÆ.						
Pomaderris phylicæfolia Lodd.	Tauhinu	..	Aus.	N. C.	Heath	Small heath-like shrub, with small revolute leaves.
ELÆOCARPACEÆ.						
Aristotelia racemosa (A. Cunn.) Hook. f.	Makomako	Wineberry	End.	N. C. S.	Forest	Small tree or shrub, with moderate-sized, thin, ovate, toothed leaves.

List of Indigenous Pteridophytes and Spermaphytes—*continued.*

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ELÆOCARPACEÆ—*continued.*						
Elæocarpus dentatus (Forst.) Vahl.	Hinau	..	End.	N. C. S.	Forest	Moderate-sized tree, with coriaceous leaves of oblong type.
—— *Hookerianus* Raoul.	Pokaka	..	„	„	„	Moderate-sized tree, with persistent juvenile form, and linear-oblong, coriaceous adult leaves.
MALVACEÆ.						
Hoheria populnea A. Cunn.	Houhere	Lacebark	„	N.	„	Small tree, with late-blooming, showy white flowers, and ovate, toothed, moderately coriaceous leaves.
VIOLACEÆ.						
Viola filicaulis Hook. f.		Slender violet	„	N. C. S.	Bed of Waipoua	Small prostrate herb, with numerous filiform stems and small leaves.
Melicytus ramiflorus Forst.	Mahoe	Whitewood	Pol., Norf. Isld.	„	Forest	Small tree or large shrub, with oblong-lanceolate, moderately coriaceous leaves.
—— *macrophyllus* A. Cunn.		Large-leaved whitewood	End.	N.	„	Similar to above.
—— *micranthus* Hook. f.		Twiggy whitewood	„	N. C. S.	„	Tall shrub, with small coriaceous leaves.
PASSIFLORACEÆ.						
Tetrapathæa australis Raoul.	Kohia, aka	New Zealand passion-flower	„	N C.	„	Tendril climber.
THYMELIACEÆ.						
Pimelea lævigata Gaertn., var.		Creeping pimelea	„	N. C. S.	Heath	Low-growing, suberect, small-leaved shrub.
MYRTACEÆ.						
Leptospermum scoparium Forst.	Kahikatoa, manuka	Red tea-tree	Aus.	„	Heath, forest	Small-leaved low tree or shrub.
—— *ericoides* A. Rich.	Manuka, kanuka, maru	White tea-tree	End.	„	„ „	
Metrosideros florida (Forst. f.) Sm.	Kahikahika, aka, akakura	Large-leaved climbing rata	„	„	Forest	Tall, woody root climber.
—— *albiflora* Sol.		White climbing rata	„	N.	„	Woody root climber.
—— *hypericifolia* A. Cunn.		Slender climbing white rata	„	N. C. S.	„	Slender-stemmed root climber.
—— *robusta* A. Cunn.	Ratawhero, rata	Northern rata	„	N. C.	„	Tall tree, usually epiphytic at first.
—— *scandens* Sol.	Akatorotoro, aka	Round-leaved climbing rata	„	„	„	Tall, woody root climber.
Myrtus bullata Sol.	Ramarama	Blistered-leaved myrtle	„	„	„	Moderately tall shrub with blistered leaves.
Eugenia maire A. Cunn.	Mairetawake	Red-fruited maire	„	„	Swampy forest	Small tree, with moderate-sized rather thin leaves.
ONAGRACEÆ.						
Epilobium junceum Sol.		Narrow-leaved willow-herb	Aus.	N. C. S.	Heath	Moderately tall, erect herb, with stem decumbent at base, and purplish flowers.
—— *rotundifolium* Forst. f.		Round-leaved willow-herb	End.	N. C. S. Ch.	Forest	Moderately tall, erect, sparsely branching herb.
—— *linnæoides* Hook. f.		Forest willow-herb	„	N. C. S. Sub.	„	Creeping herb.

(19.) "Knees" formed by Roots of *Laurelia novæ-zelandiæ*. [*Photo., A. Hamilton.*

(20.) Juvenile on left, Adult on right, with Seedling below, of *Dacrydium Kirkii*. [*Photo., A. Hamilton.*

Epilobium nummulariifolium R. Cunn. ..	..	Creeping willow-herb ..	„ ..	N. C. S. ..	„ ..	Creeping herb, with small leaves.
——— *pedunculare* A. Cunn.	..	Long-stemmed willow-herb ..	„ ..	„ ..	„ ..	„ „
HALORRHAGIDACEÆ.						
Halorrhagis erecta (Murr.) Schindl. ..	Toatoa	Tall haloragis	Aus., Juan Fernandez	N. C. S. Ker. ..	Heath ..	Erect suffruticose plant.
——— *incana* (A. Cunn.) (= *H. aggregata* Schindler non Buch.)	Piripiri ..	Heath haloragis	End. ..	N. C. S. ..	„ ..	Much-branched, wiry herb, with small coriaceous leaves.
Gunnera strigosa Col.	..	..	„ ..	„ ..	River-bank ..	Creeping herb, forming patches.
ARALIACEÆ.						
Nothopanax Edgerleyi (Hook. f.) Harms. ..	Raukawa	Edgerley's panax	„ ..	„ ..	Forest ..	Small tree, with dimorphic leaves finally 1-foliate.
Nothopanax arboreum (Forst. f.) Seem. ..	Whauwhaupaku ..	Ivy-tree	„ ..	„ ..	„ ..	Small tree, with coriaceous, digitate leaves.
Schefflera digitata Forst.	Pate, patete	Native fig	„ ..	„ ..	Moist forest ..	Small tree, with digitate, thin leaves.
Pseudopanax crassifolium (Sol.) C. Koch. ..	Horoheka, hohoeka ..	Lancewood	„ ..	„ ..	Forest ..	Small dimorpic tree, with straight naked trunk and round head of foliage.
UMBELLIFERÆ.						
Hydrocotyle dissecta Hook. f.	..	Cut-leaved marsh pennywort	„ ..	„ ..	„ ..	Slender, matted, small-leaved, creeping herb.
——— *novæ-zelandiæ* D. C.	..	New Zealand marsh pennywort	„ ..	„ ..	„ ..	Slender, far-creeping herb.
——— *moschata* Forst. f...	..	..	„ ..	„ ..	„ ..	„ „
——— *asiatica* L.	..	Asiatic marsh pennywort ..	Cos. trop. and sub.	N. C. S. Ch. ..	Wet heath ..	Creeping herb, with much-branched, rather stout stem.
Azorella Hookeri Drude	..	..	End. ..	N. C. S. ..	Stony bed of Waipoua	Slender creeping herb.
CORNACEÆ.						
Corokia buddleioides A. Cunn.	Korokia-taranga ..	..	„ ..	N.	Junction of forest and heath	Much-branched tomentose-leaved shrub.
Griselinia lucida Forst. f.	Puka	..	„ ..	N. C. ..	Forest ..	Woody epiphytic shrub.
——— *littoralis* Raoul	Kapuka, papaumu ..	Broadleaf	„ ..	N. C. S. ..	Upland forest..	Small tree or shrub, with shining coriaceous leaves.
ERICACEÆ.						
Gaultheria antipoda Forst. f. var. *erecta* Cheesem.	..	Erect snowberry	„ ..	„ ..	Heath ..	Small, much-branched, erect shrub, with roundish coriaceous leaves.
EPACRIDACEÆ.						
Styphelia fasciculata Forst. f.	Mingimingi, mingi ..	Tall bearded heath ..	„ ..	„ ..	Heath, forest ..	Much-branched tall shrub, with narrow pointed leaves.
——— *Frazeri* (A. Cunn.) F. Muell. ..	Totara	Dwarf bearded heath ..	Aus. ..	„ ..	Heath ..	Very low-growing shrub, with small pungent leaves and creeping subterranean stem.
Epacris pauciflora A. Rich.	Koputotara	Common New Zealand epacris	End. ..	N. C. ..	„ ..	Small, erect shrub, with small imbricating leaves.
Dracophyllum latifolium A. Cunn.	Neinei	Spiderwood	„ ..	„ ..	Forest ..	Small tree finally branching candelabra-like and with coriaceous, recurved, leaves in terminal rosettes.
——— *Urvilleanum* A. Rich.	..	Common needle-leaved heath	„ ..	„ ..	Heath ..	Erect shrub, with slender branches and almost vertical grass-like leaves.
MYRSINACEÆ.						
Rapanea salicina (Heward) Mez.	Toro.	Long-leaved matipo ..	„ ..	N. C. S. ..	Forest ..	Small tree, with long, linear, glabrous leaves.

LIST OF INDIGENOUS PTERIDOPHYTES AND SPERMAPHYTES—*continued*.

Species and Natural Order.	Maori Name.	English Name.	Distribution.			Life-form.
			Beyond New Zealand, or Endemic.	Within New Zealand.	In Forest, Heath, &c.	
MYRSINACEÆ—*continued.*						
Rapanea Urvillei (A. D. C.) Mez.	Tipau, mapau ..	Red matipo	End. ..	N. C. S. ..	Forest ..	Small, much-branched tree, with red twigs and small sub-coriaceous leaves with wavy margins.
OLEACEÆ.						
Olea lanceolata Hook. f.	Maire	White maire	Aus. ..	N. C. ..	„ ..	Much-branched small tree, with lanceolate coriaceous leaves.
—— *montana* Hook. f...	..	Narrow-leaved maire ..	„ ..	„ ..	„ ..	Similar to preceding.
LOGANIACEÆ.						
Geniostoma ligustrifolium A. Cunn.	Hangehange	New Zealand privet ..	„ ..	„ ..	„ ..	Much-branched shrub, with glabrous, soft leaves.
APOCYNACEÆ.						
Parsonsia heterophylla A. Cunn.	Kaiku, kaiwhiria ..	New Zealand jasmine ..	„ ..	N. C. S. ..	„ ..	Slender, much-branching, twining, woody liane, with dimorphic leaves.
—— *capsularis* (Forst. f.) R. Br. ..	Akakiore	Rosy New Zealand jasmine..	„ ..	„ ..	„ ..	As for above, but with narrow adult leaves.
VERBENACEÆ.						
Vitex lucens T. Kirk	Puriri, kauere ..	..	„ ..	N. C. ..	„ ..	Moderately tall massive tree, with large, dark-green, glossy leaves.
SOLANACEÆ.						
Solanum nigrum L.	..	..	Cos.	N. C. S. ..	Outskirts of forest	Moderate-sized herb, with spreading branches; woody near base.
—— *aviculare* Forst. f.	Poroporo, kohoho, poporo	Common solanum ..	Aus. ..	„ ..	Forest ..	Soft-wooded, moderately tall shrub, with thin leaves.
SCROPHULARINACEÆ.						
Veronica salicifolia Forst. f.	Koromiko	Common veronica ..	End. ..	„ ..	Heath ..	Moderate-sized much-branched shrub, with willow-like leaves.
—— *diosmæfolia* R. Cunn.	Aute	Heath-veronica	„ ..	N.	Bank of river..	Small, much-branched shrub, with small leaves and showy flowers in corymbs.
—— *plebeia* R. Br.	..	..	„ ..	„	Open ground near forest-margin	Slender prostrate herb.
GESNERIACEÆ.						
Rhabdothamnus Solandri A. Cunn.	Waiuatua, matata ..	..	„ ..	N. C. ..	Bank of River Waipoua	Slender moderate-sized shrub, with divaricating habit and conspicuous flowers.
RUBIACEÆ.						
Coprosma grandifolia Hook. f.	Kanono, manono ..	Large-leaved coprosma ..	„ ..	„ ..	Forest ..	Tall shrub, with large thin leaves and succulent orange drupes.
Coprosma robusta Raoul	Karamu	Glossy coprosma	„ ..	N. C. S. Ch. ..	„ ..	Tall shrub, with moderate-sized glossy leaves and succulent reddish-orange drupes.
—— *arborea* T. Kirk	..	Tree coprosma	„ ..	N.	„ ..	Small, closely-branched round-headed tree, with moderate-sized thin leaves and translucent fleshy drupes.

—— *spathulata* A. Cunn.	Mamangi	Spoon-leaved coprosma	„	„	„	Small, slender-branched shrub, with coriaceous spathulate leaves and fleshy black drupes.
—— *tenuicaulis* Hook. f.		Slender coprosma	„	N. C.	Swampy forest	Small shrub, with interlaced branches, very thin leaves, and small fleshy black drupes.
Nertera depressa Banks and Sol.		Fruiting duckweed	Aus. S.A., Tristan da Cunha	N. C. S. Sub.	River-bank	Creeping small-leaved herb, forming matted patches.
—— *dichondræfolia* (A. Cunn.) Hook. f.			End.	N. C. S.	Forest	Ditto.
CAPRIFOLIACEÆ.						
Alseuosmia macrophylla A. Cunn.	Hoihoi, horopito		„	N. C.	„	Moderate-sized shrub of irregular form, moderate-sized coriaceous leaves and showy yellow flowers.
—— *Banksii* A. Cunn.			„	N.	„	Small, slender, sparingly branched shrub, with small leaves variable in shape.
—— *linariifolia* A. Cunn. var. *ligustrifolia* (A. Cunn.) var. nov. = *A. ligustrifolia* A. Cunn.			„	„	„	Small, erect shrub, with moderately thin lanceolate leaves.
CAMPANULACEÆ.						
Pratia angulata (Forst. f.) Hook. f.		Common pratia	„	N. C. S.	„	Prostrate, much-branching herb, with small leaves and purple berry.
Lobelia anceps L. f.		Common New Zealand lobelia	Norf. Isld.	N. C. S. Ch.	Heath	Erect or decumbent, moderate-sized, sparingly branched herb.
COMPOSITÆ.						
Lagenophora Forsteri D. C.	Papataniwhaniwha	Native daisy	End.	N. C. S. Ch. Sub.	„	Small creeping herb, with tufted leaves.
—— *lanata* A. Cunn.		Hairy native daisy	„	N.	„	Small tufted herb, with hairy leaves.
Olearia Cunninghamii Hook. f.	Heketara	Forest daisy-tree	„	N. C.	Forest	Small tree, with moderate-sized, tomentose, thin leaves.
Gnaphalium luteo-album L.		White cudweed	Cos.	N. C. S. Ch. Sub.	Heath	Erect or suberect moderately tall annual or biennial herb, clothed with white tomentum.
—— *japonicum* Thunb.		Japanese cudweed	Aus. Mal. E. Asia	N. C. S. Ch.	„	Moderate-sized annual herb, covered with cottony tomentum.
—— *keriense* A. Cunn.	Puatea		End.	N. C. S.	Bank of River Waipoua	Prostrate, almost suffruticose plant, forming large patches.
Brachyglottis repanda Forst.	Pukapuka, wharangi	Wavy-leaved rangiora	„	N. C.	Forest	Small tree, with large, thin, tomentose leaves.
Senecio Kirkii Hook. f.		Forest-groundsel	„	„	„	Erect, moderate-sized, sparingly branched shrub, with glabrous leaves and fine white flower-heads.

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Crown Land

Gum Land

Fern & Teatree

Northern Heath

Kauri & Tairairi

Tairairi Bush

Large amount of scattered Kauri

Fair Soil Palms

Kauri Bush

Kaikatea Swamp

Mixed Kauri & Tairairi

23,000 Ac Approx

Tairairi Tawa & Rimu Fair Land

Rimu Tawa and Towai

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