Gen. 3. *Polyotus*.

Sp. 4. *P. palpebrifolius*, Hook.; Chain Hill ravines.

Fam. III. PLATYPHYLLÆ.

Gen. 4. *Madotheca*.

Sp. 5. *M. Stangeri*, Gottsche.; Greenisland Bush (Martin).

Fam. IV. JUBULÆ.

Gen. 5. *Frullania*.

Sp. 6. *F. falciloba*, Hook. fil. and Tayl. (Otago Crypt. 283).

Gen. 6. *Androcryphia*.

Sp. 7. *A. confluens*, Tayl. (Otago Crypt. 283).

Fam. V. DIPLOMITRIÆ.

Gen. 7. *Sarcomitrium*.

Sp. 8. *S. prehensile*, Tayl. (Otago Crypt. 283).

Gen. 8. *Symphyogyna*.

Sp. 9. *S. flabellata*, Hook.; Chain Hill ravines.

Fam. VI. JECORARIÆ.

Gen. 9. *Marchantia*.

Sp. 10. *M. tabularis*, Nees; swamps, East Taeri Bush; damp, shady places, Chain Hill ravines.

Fam. VII. ANTHOCEROTEÆ.

Gen. 10. *Anthoceros*.

Sp. 11. **A. lævis*, L.; East Taeri Bush.

IV. *List of Ferns, Lycopodiaceæ, and Marsileaceæ collected in Otago, New Zealand.* By W. LAUDER LINDSAY, M.D. F.R.S.E., F.L.S., &c.

The Ferns recorded in the following list were collected for the most part in the Greenisland district of Otago, between October 1861 and January 1862. A few were gathered in the Tuapeka and Inch Clutha districts, at a greater distance from Dunedin—the former locality being about thirty miles in the interior, the latter near the coast. The majority of species were sylvan, luxuriating in the damp, shady recesses of the Bush, generally in narrow glens or gullies by the banks of hill streams. The arborescent species especially generally grew from the midst of a deep accumulation of leaf-mould—the formation, doubtless, of countless years—a soft, spongy, brown, rotten compost.* The patches of primitive forest, or “bush,” in which my Otago ferns were mostly collected, were those covering portions of Saddlehill, Scroggs’

* *Vide* footnote (†), p. 31.

Hill, Stoneyhill, the Greenisland and Chain Hills, Anderson's Bay, the East Taeri Plain, and Inch Clutha. Several of the handsomest sylvan forms were also corticolous, climbing on or pendent from the bark of trees—mostly old, decayed, or dead, frequently in a condition of moist rot—one of the chief trees affected being the "Broad leaf" (*Coprosma lucida*, Forst., and *Griselinia lucida*, Forst.) Some were terricolous, though growing in the shade of the Bush; others were both sylvan and grew "in the open," to use an expressive colonial phrase; and these illustrated well the diversity of form produced by difference of habitat. Some terricolous Ferns grew only "in the open," in glens or gullies of the hills, or on the uplands of the Chain Hills, Saddlehill, Kai-korai Hill, or the Tuapeka ranges. Others were saxicolous, frequenting the crevices of exposed, often maritime, rocks (of basalt or mica slate) on the coast or cliffs between Ocean Beach, near Dunedin, and Greenisland Bluff or Peninsula; or of the Chain Hills; or they occurred in the damp shade of caves and cliffs of tertiary crag, limestone, sandstone, or conglomerate, on Saddlehill or the Greenisland Hills.

The localities or habitats in question will be found further described in my previously published lists of other groups of Otago cryptogams.*

The plants now recorded were examined and named in 1862-3 by Dr Hooker, while preparing his "Handbook of the New Zealand Flora" (Part I. 1864).

The most interesting section of the Otago Ferns is the group of arborescent species—the *Tree ferns* or "fern trees" of the colonist. Six out of eighty-eight species, or 6·81 per cent., of Otago Ferns are arboreous, and these tree-ferns rank, undoubtedly, as to beauty, and frequently also as to height,† girth, and usefulness, with the exogenous forest trees, with which they are generally more or less intermixed. In addition to the species observed by myself and recorded in the following list, *Cyathea Smithii*, Hook. fil., *Dicksonia squarrosa*, Swartz, and *D. antarctica*, Br., are common Otago tree-ferns—the *Cyathea Smithii* being indeed, according to Buchanan, the commonest species of that genus in Otago.

* List of *Lichens*, Trans. Bot. Soc. Edin., vol. viii. p. 349. *Marine Algæ*, do., p. 420. *Fungi*, do., vol. ix. p. 13. *Mosses and Hepaticæ*, do., vol. ix. p. 22.

† Sometimes 40 to 60 feet.

C. Smithii is green and smooth-fronded; sometimes forked into two stems; trunk 20 feet high; wood hard, close-grained, heavy (Buchanan).

D. squarrosa is a very dark Fern with blackish stipes and rachis; frequently gregarious; cultivated in the new Conservatory, Kew. The most southern tree-fern in the world; the "Wheki," or "Weki," "Pehiakūra," or its abbreviation "Tūakūra" (Waik. dial.) of the North Island Maoris; the "Pakue" of the Otago Natives (Hector).

D. antarctica is dark green, sometimes forking in the stem; the "handsomest of all tree-ferns" (Hooker); the "Katute" (Hector), or "Tukirunga" or "Wekipunga" (Colenso), of the Maoris. This seems to be the principal tree-fern formerly used in house-building by the Maoris; preferred to the wood of exogenous forest trees, probably from its being more easily cut by their rude stone adzes and knives. Specimens of Maori domestic architecture are now mainly to be met with in old pāhs in the North Island and in the Chatham Islands. The posts of the wharés or huts are of tree-fern trunks, which are frequently lashed together with various "bush ropes" or "supple-jacks,"* and thatched with "toi"† grass, while the interior is sometimes lined with tree-fern fronds interwoven with flax‡ leaves.

There are several points connected with the *climatological relations and geographical distribution* of tree-ferns in the South Island of New Zealand (provinces of Otago, Canterbury, and Nelson), which possess a special interest. Of these the most prominent is the *association of tree-ferns with glaciers, snow, and other evidences of an alpine and rigorous climate*. Writers on botany and geology, descanting on the beauties of tropical vegetation, or the peculiarities of southern or insular Floras, or on the characteristics of the carboniferous Flora and its nearest analogues of the present day, have hitherto been in the habit of associating the beautiful tree-fern vegetation of New Zealand with equability of climate, sub-tropical heat, and stagnant moisture. But it is no longer possible to hug this pic-

* Climbers or creepers on forest trees; species of *Rhipogonum*; *Parsonsia*; *Metrosideros*; *Plagiunthus*; *Rubus*; *Clematis*.

† *Arundo conspicua*, Forst.

‡ *Phormium tenax*, Forst.

torial delusion ; for there are abundant proofs that in the provinces just named tree-ferns flourish in a climate in some respects as fickle and as rigorous as that of Scotland or the Swiss Alps. Nor are tree-ferns the only hitherto supposed sub-tropical tree-forms which are there found bordering glaciers. *Fuchsia* trees and cabbage palms (*Cordylines*) are associated with Araliaceous, Myrtaceous, and other trees hitherto regarded as exclusively the denizens of comparatively warm climates, in the neighbourhood of glaciers, as the firs fringe those of the Swiss Alps. My friend Dr Haast states that the largest glacier of Mount Cook, which gives rise to the Wairau river, descends as low as 500 feet above the sea-level on the west coast of Canterbury, and to within only eight miles of the sea ; on both sides of which glacier "luxuriant forests of Fern-trees, Cordylines, Myrtaceæ, and other temperate and sub-tropical types are found."* The same distinguished explorer further refers to the occurrence on the west coast of Nelson, at no great distance from the glaciers in question of the Canterbury Alps, of "groves" of true palms (*Areca sapida*, Soland.), with other trees of an equally sub-tropical character. Comparable to the occurrence of tree-ferns beside New Zealand glaciers, is the fact recently recorded by Mr S. Clifford,† of "Tasmanian tree-ferns covered with snow" about Mount Wellington, near Hobart Town, at an elevation of 1500 to 2000 feet above the sea—the Ferns growing 18 to 20 feet high, close together in damp shady gullies, associated with the Sassafras tree (*Atherosperma moschata*, N. O. *Atherospermaceæ*).

The *altitudinal range* of tree-ferns in New Zealand is also, perhaps, somewhat greater than we have hitherto believed. Vincent Pyke, in his expedition to the west coast of Otago, *via* Lake Wanaka, in 1865, saw on the banks of the Burke River tree-ferns at an elevation of not less than 1200 feet above the sea. In the mountain forests and ravines of Nelson they ascend to the still greater height of 2000 feet (Haast).

The testimony of all explorers points to the fact, that tree-ferns are most abundant and luxuriant in the forests of

* "Report on the Mount Cook Glaciers of Canterbury," Nat. History Review, July 1864, p. 475.

† Seeman's Journal of Botany, May 1865, p. 158.

the *west* coast. This has been noticed especially by Hector, Haast, Symms, and others, in regard to the bush which fringes the deep sounds or fiords of that coast, *e.g.*, Thompson's Sound and Charles' Sound, where they frequently attain a height of 30 feet, while the umbrella-like top of fronds has a diameter of 14 or 15 feet. This maximum abundance and luxuriance of tree-ferns on the west coast is associated by travellers with its superior moisture* and temperature—the atmosphere of the dense, dark, jungly forests being saturated with damp, while the soil is a mass of the richest vegetable mould.† There exist as yet no sufficient data for the determination of the precise climatological conditions of the west coast; and very meagre, indeed, are the materials obtainable for even an approximate exhibition of the general meteorology of Otago.‡ But if Dr Hooker's remark is correct, that Ferns are “natural hygrometers, and their luxuriance a *certain proof* of the dampness of a climate,” the presence of Ferns in such beauty and plenty in the Otago bush must be held conclusive as to the humidity of the Otago climate. In connection with this, it must be noticed that in proportion as the forest is opened up to light and air by the woodman's axe, tree-ferns disappear, while the local climate becomes drier. Hence it happens that on the *east* coast, where the patches of bush are scant, and the bush itself has been thinned or “cleared” for the purposes of colonisation, tree-ferns, which were formerly abundant, are now rare, and of no great size or beauty (*e.g.*, in Willshire's Bay, mouth of the Clutha).

The *acclimatisation* of the New Zealand tree-ferns in the gardens and pleasure-grounds of Britain has lately been

* So markedly is this the case, that Haast punningly proposes changing the name of *west* coast to that of *wet* coast.

† Composed mainly of the dead and rotting leaves of phænogamous trees and shrubs, and of arborescent and other Ferns, with soft rotten tree-trunks and branches covered with Mosses and Hepaticæ—the whole mass soaked in moisture, and forming a deceitful tangled compost, into which I have frequently sunk up to my middle, and occasionally overhead.

‡ When I visited Otago there was only one series of regular meteorological records, *viz.*, that made in Dunedin by the Rev. Dr Burns. Assuming that these were scientifically accurate and complete, they only serve to indicate approximately the meteorology of the capital; while *numerous local meteorological observatories* would be required to exhibit all the *local climates* and their mean or average—that of the province as a whole.

attracting the attention of some of our most experienced horticulturists. My friend Mr Gorrie, the horticultural editor of "The Farmer," appears to regard them as sufficiently *hardy* to be suited for out-door growth throughout the year in this country, and he paints in glowing colours the possible effect on landscape gardening of their introduction. So different would a pseudo-tropical tree-fern vegetation be from that which at present characterises the gardens or policies of our noblemen's and gentlemen's seats, that "their addition would be hailed as a new and grand era in horticulture,"* forming—as he pictures, with more than the ordinary "ingenium perfervidum Scotorum"—"pleasure-ground *avenues*, which even the rich and exuberant verdure of the tropics could not surpass in beauty and elegance."† There are certain specious reasons for regarding the Otago tree and other ferns as hardy, and they constitute substantial grounds for experimenting on their acclimatisation in this country. But there are certain other conditions of their growth in their native country, which would not be imitated by the surroundings sketched in "The Farmer;" and this want of resemblance leads me to distrust the realisation of a consummation so desirable to all lovers of the novel and beautiful in landscape gardening.

The circumstances favourable to the success of such experimental acclimatisation are the following:—Mr Gorrie mentions that some of these tree-ferns have in this country successfully withstood a temperature of 20° Fahr. without fire heat, but under glass.‡ Certain other Ferns, and certain lowland phænogams of New Zealand, have *proved* hardy in Britain (in the open). Tree ferns occur in New Zealand and Tasmania associated with ice and snow; they ascend as high as 2000 feet—altitude being regarded as so far equal-

* Hardy Plants of the Antipodes, "The Farmer," June 27, 1866, p. 822.

† Hardy Plants of New Zealand, "The Farmer, Edin. Feb. 28, 1866, p. 280.

‡ *Cyathea dealbata*, *Dicksonia antarctica* and *squarrosa* have been "unharmd by a temperature of 20° in a cool glass-house, with a northerly exposure, further than by having the fronds slightly discoloured on their upper surface." The same may be said of *Lomaria fluviatilis*, which has also "stood for last two winters at the base of a wall with a westerly exposure." Again, *Aspidium Richardi*, which he describes as "an interesting acquisition to our *hardy* Ferns . . . has stood this and the last three winters unharmd." (Letter of 28th January 1867.)

ising the difference in latitude between Otago and Scotland ; the Otago and Canterbury Alps are more than twice as high as those of Scotland—Mount Cook, the culminating point of the range (lat. $43^{\circ} 30' S.$), attaining 13,000 feet, the presence of mountains of such elevation, capped with perennial snows, and flanked by gigantic glaciers, tending to modify the insular climate, and, as in the last case, assisting in the equalisation of latitudinal differences. Though the winters in the lowlands and on the coasts appear to be milder than those of Britain, in the interior they are more rigorous, resembling those of the Swiss Alps ; while, except in so far as there is a less marked contrast between summer and winter, the climate of Otago does not greatly differ from that of Scotland. The experiment of acclimatisation would be assisted in its chances of success by imitating, so far as possible in this country, the conditions of growth of the Ferns in New Zealand, *e.g.*, by selecting as the localities of trial the milder districts of the south of England, or of the west coasts of Scotland and Ireland, which latter are at the same time moister, and, like the west coast of Otago, are distinguished by the variety, abundance, and luxuriance of their native Fern vegetation.

The unfavourable circumstances are, apparently—1. The difference in latitude between Otago and Scotland, amounting to about 10° (Otago lies between 44° and $47^{\circ} S.$; Scotland between 55° and $58^{\circ} N.$; Dunedin, $45^{\circ} 53' S.$; Edinburgh, $55^{\circ} 57' N.$) ; 2. The difference in temperature (that of Dunedin, summer, 59° ; winter, 42° ; mean annual, 51° ; Edinburgh, summer, 58° ; winter, 37° ; mean annual, 47° ; the isothermal of 50° in the northern hemisphere passes through Central Ireland and the south of England, but in the southern it passes southward of Otago) ; 3. The preponderance of *sea* in the southern, and of *land* in the northern, hemisphere, with its corresponding effects on the climate of the same parallels of latitude in the north as compared with the south ; 4. The growth of Otago tree-ferns in the dark shade of the dank, dense jungle.

On the whole, though I heartily concur in the desirability of making all due experiment, I am disposed to doubt whether the tree-ferns and most other ferns of New Zealand

will be found hardy enough to "stand the severest British winters," unprotected from the unnatural influences of excessive light, cold, and dryness; though I have none as to their suitability for growth in conservatories, where their natural conditions of existence can be closely imitated. Mr Buchanan, whose long experience as an Otago settler, and whose position as Botanist attached to the Geological Survey of Otago, entitle his opinions to great weight, takes, apparently, an intermediate position between my less favourable anticipations and the more sanguine expectations of "The Farmer"—stating as his belief, that the five arborescent Ferns of Otago (*Cyathea*, three species; *Dicksonia*, two species) would grow in Britain in the open air, "if planted in dark woods." Experience alone can decide: and meanwhile, let us hope that some of our leading horticulturists, who possess the necessary opportunities, will initiate the experiment!

Of the smaller New Zealand Ferns, species more or less hardy in Britain under glass, if not in the open, may at least be looked for in the genera *Leptopteris*, *Nephrodium*, *Aspidium*, *Polypodium*, *Asplenium*, *Trichomanes*, *Hymenophyllum*, and *Lomaria*, as well as in the genus *Lycopodium*. Some of these are alpine or sub-alpine, ascending to considerable elevations, forming a group which is more likely to prove suitable for outdoor growth in Britain than the more tender shade and moisture-loving species of the coasts and lowlands. Haast remarks on the considerable altitudinal range of species of *Lomaria*, *Asplenium*, and *Aspidium* on the western alps of Nelson. Some of the *Lycopodia* are, in Otago, common on the higher ranges of the south-eastern districts, at or above 4000 feet, where snow frequently falls or lies (Buchanan); while several were found, intermixed with grasses, on the *plains* to the west of the western alps of Nelson (Haast).

The "Bush" in Otago is confined mainly to the east and west coasts, and the central lake basins; which latter, from the circumstances of their physical features, possess a local and peculiar climate of their own. To these parts of the province Ferns are mainly confined. The interior consists mostly of undulating hilly country, partly covered with grass, partly with "Fern" (the ubiquitous *Pteris aquil-*

lina in its New Zealand variety). This fern occasionally grows much higher than a man, with corresponding strength, sometimes densely covering considerable tracts of country. I had occasionally to wade in its fields, and found it as difficult and exhausting to push my way through its tangled masses as through the flax swamps (of *Phormium tenax*). When dry, after summer droughts, it fires readily, burning with a rapidity and over an extent of ground somewhat resembling the prairie fires of North America.

The *classification* and *nomenclature* of New Zealand Ferns furnish us, I think, with some notable instances of the proneness to error of systematists in reference, *e.g.*, to the following points:—

1. Defining and limiting where nature, by a *continuity of variation*, draws no decided lines of demarcation.
2. Confusion of varieties, species, and genera.
3. Supposition that the plants of new botanical fields are necessarily or presumably *new species*.
4. Excessive and mischievous multiplication of *names*, and consequent confusion of *synonymy*.
5. Distinction between *book-species* and the species (or groups) of nature.
6. Artificialness and arbitrariness of botanical systematology.
7. Fallaciousness of botanical “characters.”*
8. Indefinite or infinite variability, even in the same individual and in limited areas.
9. Imperfect knowledge of the geographical distribution of plants; of the extent of their variation with differences in their conditions of growth; of botanical bibliography; and of the researches and publications of their predecessors.
10. Insufficient allowance for variation produced by differences in latitude, climate, elevation, exposure, character of the habitat, and other external conditions.
11. Cosmopolite character or wide geographical range of many plants, with limited variation.

Young states (*e.g.*, *Gleichenia speluncæ*, Br.), or *seedling*

* The presence of germinating bulbs on the pinnules of *Asplenium bulbiferum* is the supposed essential or distinctive characteristic of the fern; but they appear to be as frequently absent as present, so that the supposed “character,” not being constant, cannot be depended on.

fronds (e.g., *Polypodium tenellum*, Forst.), have been erected into separate species.

The same species has received as many as ten to thirty different names, according as it was found in different parts of the world. Dr Hooker, whose experience on such a subject is inferior to that of no living botanist, and whose testimony on questions relating to the geographical distribution and variation of species possesses a correspondingly high value, gives several characteristic illustrations in his admirable "*Flora Novæ Zelandiæ*." Of *Ophioglossum vulgatum*, L., he says no less than thirty species have been made; and he adds, "I confidently affirm that, were I to show the authors of many of the so-called species of *Ophioglossum*, preserved in the Hookerian Herbarium, their own specimens named by themselves, and substitute 'Britain' on their tickets for the distant countries from which they were brought, these authors would unhesitatingly pronounce their plants to be *O. vulgatum*!"* *Pteris aquilina*, again, has received at least twenty different names in systematic works—or, in other words, a different designation in every part of the world in which it occurs; while of another cosmopolite, *Lycopodium clavatum*, about a dozen book-species have been manufactured by name-mongers.

Confusions of species, or of varieties and species, abound more or less in the genera *Asplenium* (*caudatum* and *falcatum*, *obtusatum*, *scleroprium*, *lucidum*, *Hookerianum*, *bulbiferum*, *Richardi*, and *flaccidum*); *Lycopodium* (*varium*, *Bilardieri* and *clavatum*); *Doodia* (all its three species pass into each other); *Lomaria* (*membranacea* and *fluviatilis*); *Aspidium* (*aculeatum*); *Pteris* (*Endlicheriana*); *Pellaea* and *Leptopteris* (their only two species appear to pass into each other); and *Hymenophyllum* (*unilaterale* and *Tunbridgense*). Of the New Zealand species of *Asplenium*, Dr Hooker remarks, "they have defied all attempts to be limited by words;" while Mr Berkeley speaks of their limits as "absolutely incapable of definition." Of *A. flaccidum*, which is, perhaps, the most variable Fern in the world, Dr Hooker says, "It would take many pages to enumerate half its protean forms;" and that "the most opposite charac-

* Moreover, one of its species has been made the basis of a separate genus—*Cheiroglossum*.

ters are sometimes presented by *different parts of the same frond*.* Of *Lomaria procera*, he writes, "There are no limits to the variations of this protean plant, . . . whose *varieties* (to an inexperienced eye) are more dissimilar than are other *species* of the same genus." The variability of *Aspidium aculeatum*, var. *vestitum*, he regards as "likely to give rise to as many discussions as its equally and similarly variable and very near ally *Polystichum aculeatum*, Sw., has done in England;" while he makes a like remark in regard to *Hymenophyllum unilaterale*, Willd., which often grows associated with *H. Tunbridgense*—"its real or supposed differences from which have given rise to endless discussions."

But such is the *continuity of variation* in New Zealand Ferns, that not only is it frequently impossible to define *varieties* and *species*, but the limits of *genera* are sometimes equally vague and unsatisfactory; whence a confusion of nomenclature and description occurs in systematic works, sometimes quite as marked in the major as in the minor divisions. Confusion of genera is to be found between *Polypodium*, *Nephrodium*, *Polystichum*, and *Aspidium* (*N. hispidum*, *Polypodium pennigerum*, *Polypodium sylvaticum*); *Polypodium* and *Hypolepis* (*H. tenuifolia* passes into *P. rugulosum*); † *Hymenophyllum* and *Trichomanes*; or *Darea* and *Asplenium*. The genus *Pteris* "has been divided," says Dr Hooker, "into so many *genera* . . . that . . . one might perhaps be found for each New Zealand species."

It were out of place here to enter into any special consideration of the infinite variability of New Zealand Ferns, or of its bearings on classification and nomenclature. It must suffice—as I trust elsewhere to discuss at length the subject of *continuity of variation* in plants, and its bearings on botanical systematology—meanwhile to record the general conclusions on this head, to which my study of New Zealand Ferns has led me, viz.:—

1. That in plants so variable, it is not only unnecessary but mischievous to give a name to every variety, unless this

* *Equally in the wild and cultivated state*, different parts of the same frond *A. bulliferum* frequently exhibit extreme differences of development.

† Berkeley regards the latter as a mere variety or state of the former.

is very constant, and its distinctive characters such as are capable of being rendered very evident to the student.*

2. That it ought to suffice to indicate the general directions or forms—with the degree—of variation.

3. That book-species are equally unnecessarily and mischievously abundant.†

4. That many of these may be more philosophically considered mere forms of variation of a comparatively few types.

5. That these types should be fixed ideals—abstractions—representatives of what all observation points to as the probable normal average condition of the head of a group; rather than prevalent natural forms, which necessarily vary with place and the conditions of growth.

6. That book-species, varieties, and genera—and that all botanical systematology—are necessarily artificial and arbitrary.

7. That nature is illimitable in her forms, and that other than an approximate and general cataloguing, naming, and description thereof, is unattainable; and were it attainable, is unnecessary for the purposes of the student.

8. That the local Botanist in New Zealand has it in his power to contribute important data towards the simplification of classification,—the reduction of names,—the establishment of fewer and more comprehensive types (whether genera or species), by the study of living forms over extensive areas, and under every modification of external conditions.

9. To him, therefore, is commended the careful revision of such genera as *Asplenium*, *Lomaria*, and *Lycopodium*, in reference especially to the philosophical nomenclature and arrangement of the groups which occur in nature, as contradistinguished from those which are described in books.

* Dr Hooker states that the varieties of *Lomaria procera* keep their characters under cultivation.—Handbook, p. 366.

† If in some genera we eliminate those plants, which have really good pretensions to be separately named as species—that is, are distinctly recognisable by well-marked constant characters of adequate value—it will be found that good species amount to a very small proportion compared with those, which cannot be so limited or defined—which pass more or less freely into each other. In *Asplenium*, e.g., good species are not more than 25 per cent., or one-fourth of the whole.

I. FERNS.

I. CYATHEACEÆ.

Gen. 1. *Cyathea*.

- Sp. 1. *C. dealbata*, Swartz. Christie's Bush, Saddlehill; Anderson's Bay Bush; November, in fruit.

The familiar "Tree-fern," or "Fern tree," or "Silver Tree-fern" of the Otago settler; the "White Fern" of the Wellington settler; the "Ponga"* of the North Island Maori; characterised by the white under-surface of the fronds.

About Wellington its maximum height is 24 feet, the fronds varying from 8 to 12 feet long by 2 to 3 broad. It is there found at all elevations between the sea-level and the tops of the highest hills, in which latter position it appears more disposed to become gregarious than at lower levels.

Two or three forms or states occur scarcely deserving of rank as named varieties.

- Sp. 2. *C. medullaris*, Swartz. Saddlehill Bush (Martin).

The "Grey Tree-fern" of southern, the "Black Fern" of northern, settlers (*e.g.*, in Wellington); the "Korau," "Pitau,"† "Mamāku," ‡ or "Mamāgu" (East Cape and Waikato dialects) of the Maoris, to whom the stem-pith was formerly a familiar article of food, and still is to a limited extent in the North Island. In the Wanganui district, the tree is cut down in spring, and sections of it are steamed in the native ovens; when sufficiently cooked, what is equivalent to the bark is stripped off, when the pith is found to be a soft spongy mass, having, says Dr Tuke, "a faint taste of apple-pie."

Cultivated in the new Conservatory, Kew.

Ralph § states that about Wellington its stem attains a height of 40 to 80 feet, with a girth of 6 to 7 feet. It there generally grows on the sides of gullies or dells—sometimes capriciously preferring one side only. The very different appearance of the young and old fronds has probably given rise to the idea that they belong to two separate species.

II. HYMENOPHYLLACEÆ.

Gen. 2. *Hymenophyllum*.

- Sp. 3. *H. multifidum*, Swartz. On ground, Saddlehill Bush; October, in fruit; approaches in size and in general aspect our *Trichomanes radicans*, Sw.

- Sp. 4. *H. crispatum*, Wallich. In the Bush, Chain Hill ravines; among moss in damp shady places, East Taieri Bush; November, in fruit.

* A term probably also generic, applicable to "Tree-ferns" as a class.

† Sometimes applied also or only to the pith (Mantell).

‡ Corrupted into "Mamuk" by the settlers on the west coast of Otago and Canterbury.

§ On the Arborescent Ferns of New Zealand," Journ. Linn. Soc., vol. iii., Botany, p. 163.

III. POLYPODIACEÆ.

Gen. 3. *Adiantum*.

- Sp. 5. *A. affine*, Willd. Caves in crag (limestone), Woodburn, Saddlehill; caves and crevices in cliffs of tertiary sandstone—conglomerate, seaward shoulder of Saddlehill; in crevices of tertiary calcareous sandstone, Greenisland Bush; October to December, in fruit.

Gen. 4. *Hypolepis*.

- Sp. 6. *H. Millefolium*, Hook. Banks of the stream, Glen Martin, Saddlehill; December, in fruit. Somewhat resembles, as does also the following species, our *Cystopteris fragilis*, Bernh., than which both, however, are generally taller. It appears to be common in the western districts of Nelson.
- Sp. 7. *H. tenuifolia*, Bernhardi. On ground in damp shady places, East Taeri Bush; November, young, barren.

Gen. 5. *Pellaea* (*Pteris*, pr. p. Fl. N.Z.)

- Sp. 8. *P. rotundifolia*, Forst. On ground, Greenisland Bush; November, in fruit.

Gen. 6. *Pteris*.

- Sp. 9. *P. aquilina*, L., var. *esculenta*, Forst. Chain Hill ranges; November, young and barren; Stonehill Bush; December, in fruit.

In every district of Otago visited by me I found this fern covering large tracts of open, dry, hilly land, just as our "Bracken" does in the Highlands of Scotland.

Its rhizomes contain a considerable amount of starch—a circumstance which has led to their having been largely used by the Maoris as an article of food; and, to a limited extent, in the North Island, they are still so used. The rhizomes are either simply dried, or also roasted, and then pounded with mallets.*

So familiar is the Fern, with its economical applications, to the Maoris, that not only the plant itself, but different parts thereof, have special native names, as is the case in the parallel instances of *Phormium tenax* and *Typha angustifolia*. The Fern plant, as a whole, is the "Rāhurāhu"† (its common name in the North Island); "Rarāhu" or "Rarāuhe" (Waik. dialect); the first sprout of the plant after its stalks have been burned is "Koeāta" or "Mōnehu;" the rhizome itself is the "Pākakōhi," "Aruhe," "Ngarue,"‡ "Arue," "Arohi," "Aroi" (Dieffenbach), or "Roi," "Rohi," "Maroi," "Kaka" (Dieffenbach), of the North Island natives; the juice of the rhizome "Pararohi," (Dieffenbach); and the pounded rhizome, "Meke."

- Sp. 10. *P. incisa*, Thunb. (which includes *P. Vespertilionis*, Lab., and *P. Brunoniana*, Endl., of Fl. N.Z.). In the Bush, Manuka Gully,

* An excellent account of their preparation and use as food will be found in Dr Thomson's "Story of New Zealand," vol. i. p. 153.

† Also a generic term for Ferns (Dieffenbach).

‡ Also applied to Fern-roots in general (Dieffb.)

Scroggs' Hill; November, young and barren; on ground, Saddle-hill Bush; December, in fruit.

Gen. 7. *Lomaria*.

Sp. 11. *L. procera*, Sprengel.

A. major forms (var. β . Hook. fil.).

In a damp shady wooded ravine in the Chain Hills; November, in fruit; 30 to 40 inches tall; very common and luxuriant in the Greenisland district.

B. minor forms (var. δ *minor*, Br., Hook. fil., Fl. N.Z. plate 75).

On ground, East Taeri Bush; November, in fruit; rachis, scaly, whereas in the major forms, in my specimens, it is naked; about 18 inches high; fertile frond, as usual, taller than the barren.

In my specimens, both in major and minor forms, the same frond is generally both fertile and barren, though separate fertile fronds also occur; in the former case it is invariably the *upper* or *terminal* pinnules, and the tips or outer half of the more median pinnules that are fertile; whereas Dr Hooker describes the *basal* pinnules only of the barren fronds as occasionally fertile. Pinnules subsessile.

Sp. 12. *L. fluviatilis*, Sprengel. In the Bush, ravines of the Chain Hills; November, in fruit; 20 to 24 inches tall; fronds straight.

Sp. 13. *L. pumila*, Raoul. Gullies in the Chain Hills; November, young and barren; 10 to 15 inches tall; common. So named in my Herbarium by Dr Hooker, who, however, in his "Handbook," gives Akaroa as the only station for it in New Zealand. Either the latter statement is a mistake, or the plant is not *L. pumila*. Its characters correspond better with those of *L. membranacea*, Colenso, with which seem to me to be allied *L. fluviatilis* and *L. alpina*, so far as I can judge from my own few specimens and the descriptions in the Handbook Fl. N.Z. I confess myself unable to see the propriety of establishing sections of the genus *Lomaria* distinguished by pinnate and pinnatifid fronds. The difference is only in degree—both modes of division occurring frequently in the same species, e.g., *fluviatilis*, *membranacea*, *pumila*, and *alpina*. In the lower portions of the frond the pinnate division is usual; in the upper the pinnatifid—the extent of each mode of division varying in different, as well as in the same, species.

Contrasting the four species above mentioned, there is a general resemblance—with variations of secondary significance only—in regard, e.g., to the length of stipe, clothing of the rachis, texture and consistence of the frond, size and form of the pinnules. In *pumila* the stipe is very short; in *fluviatilis* rather longer; in *alpina* sometimes nearly as long as the rachis. The rachis is much more scaly or chaffy in what Dr Hooker calls *pumila* than in *fluviatilis*; sometimes it is naked, and there are all variations between these conditions. The frond is more coriaceous in *alpina*; more membranous in *fluviatilis* and *pumila*; straight in *fluviatilis*, or flexuose in *membranacea*. It may be copiously or sparingly scaly; it may be scaly throughout its length, or only below. The pin-

nules are variously substipitate or sessile ; or adnate by a more or less broad base ; or confluent, or decurrent.

- Sp. 14. *L. lanceolata*, Spreng. On ground in the Bush, Chain Hills ; October, in fruit ; common.

Fertile frond about 12 inches, sterile 10 inches, high. In the barren fronds, which are variously pinnate or pinnatifid, as in other *Lomaria*, the segments are much more membranous and green than in *L. discolor*. The pinnules of the fertile fronds are generally opposite above, and alternate below. There is a great general resemblance, save as to size (the New Zealand fern being the larger and handsomer), between this species and our *Blechnum boreale*, Sw., whose former name was *Lomaria spicant*, Desv. They appear to me to be too closely allied to permit of any proper separation between the genera *Blechnum* and *Lomaria*.

- Sp. 15. *L. discolor*. Willd. Greenisland Bush ; in a damp shady ravine of the Chain Hills ; November, in fruit.

Fertile fronds upwards of 40 inches long, sterile 36 inches ; very handsome, short, coriaceous. Save as to size and other unimportant or secondary characters, it does not appear to differ from *L. lanceolata*.

- Sp. 16. *L. alpina*, Spreng. East Taeri Bush ; November, young and barren ; smaller forms 4 to 6 inches, larger 13 inches, high.

- Sp. 17. *L. Banksii*, Hook. fil. Dobbin's Creek, Greenisland, Martin, who describes it as "everywhere abundant, both fertile and sterile, in open lands and swamps," in the Greenisland and Dunedin districts. The habitat does not agree with that given by Dr Hooker in his "Handbook" ("dark woods"), and it is possible Mr Martin may have inadvertently confounded this with some of the foregoing species.

Gen. 8. *Asplenium*.

- Sp. 18. *A. obtusatum*, Forst. In clefts of the basaltic rock, Greenisland Bluff (or Peninsula) ; October, in fruit ; the "Paretao" of the North Island Maoris (Colenso).

In the Greenisland district it takes the place, with *A. lucidum*, of our *A. marinum*, L., than which, however, both are much larger and coarser. I find no characters sufficient to warrant separation of *A. obtusatum* and *A. lucidum* as species. In my specimens, the former has smaller, more oblong pinnules, rounded at the tips.

- Sp. 19. *A. lucidum*. Forst. On rocks, Ocean Beach, near Dunedin.

The "Hūruhūruwhēnua" of the North Island Maori. The lower pinnules in my specimens are $3\frac{1}{2}$ inches long ; there is a tendency to a cuneate form of base, to subpinnatifid division, and to irregular serration of the pinnules—characters which are more fully developed in the nearly allied *polyodon*. The serratures of the pinnules are sharper, deeper, and more distinct than in *obtusatum*.

Var. *β Lyallii*, Hook. fil. Fl. N.Z., plate 77. In limestone caves, Woodburn, Saddlehill ; November, fruit.

Whole plant about 10 inches high ; a much smaller, more delicate, flaccid, greener plant than the type ; approaching in some of its characters the *bulbiferum* group. Pinnules 1 to $1\frac{1}{4}$ inch long ; subcuneate ; sublobate—the upper base

more generally incised or lobed than the lower; margins irregularly sinuate rather than serrate; apices somewhat rounded or obtuse, whereas in the type they are generally more or less acute; uppermost pinnules confluent.

- Sp. 20. *A. polyodon*. Forst. Anderson's Bay Bush, near Dunedin (Martin). So named by Dr Hooker in my Herbarium. In his "Handbook," however, he refers the *polyodon*, Forst. to *A. falcatum*, Lamarek; which further he gives as a North Island plant only. My plant does not agree with the definition of *A. falcatum* as given in Handbook Fl. N.Z. If it belong to either, it falls more naturally under *A. caudatum*, Forst., which, however, is described in the "Handbook" as a Kermadec Island plant, not occurring at all in New Zealand. From the descriptions in the "Handbook," I should refer *A. falcatum* and *A. caudatum* to a single type.

My plant appears to me more nearly allied to *obtusatum* and *lucidum*; it is nearly as stout and coriaceous, taller and handsomer,—a circumstance due in some measure to its growth in the forest. The pinnules are, from their form and division, much handsomer; they are cuneate, sub-pinnatifid, deeply and irregularly serrate; sessile, or nearly so; longest pinnule in my single specimen, 3 inches; sori radiating from base of pinnule—the median ones extending nearly the whole length of the pinnule; stipes glabrous.

A. polyodon appears to me to be connected with *obtusatum* and *lucidum* by our *A. marinum*, as an intermediate form. The differences between the British and New Zealand species just mentioned seem to me very trivial—insufficient, indeed, to prevent their being referred to a single type. Our *A. marinum* is a widely diffused plant, in which considerable variation is to be looked for.

- Sp. 21. *A. flabellifolium*, Cavanilles. Glen Martin, Saddlehill; Myres Bush, Inch Clutha; November, in fruit. Distinguished by the prolongation of the frond into a tendril-like filament, which takes root at its tip like the runner of a strawberry.

- Sp. 22. *A. bulbiferum*, Forst. In limestone caves, Woodburn, Saddlehill; November, in fruit.

Var. β *laxa*, Br. Bush in the Chain Hills; November, fruit; common.

Var. δ *tripinnata*, Hook. fil. On ground, Greenisland Bush; November, fruit.

The variety so called in my Herbarium by Dr Hooker is not *tripinnate*, but has a frond nearly as decompound as in *laxa*, though it is stouter, with more lanceolate pinnæ, and more obtuse and symmetrically-cut segments. The distinction between *laxa* and *tripinnata* is not constant; and the naming of two such forms of an infinitely protean plant is simply confusing and unnecessary.

The definition of its variations, even with the aid of plates, I believe to be impossible; and were it possible, their separate naming would be absurd. It ought to suffice, in all plants

so variable, whether flowering or cryptogamic, to indicate the general directions or forms of variation only. New varieties or states are constantly being discovered, e.g., in the western districts of Nelson (Haast). On the west coast of Otago, where the climate is moist, the *A. bulbiferum* produces its characteristic germinating bulbs; whereas on the east coast, where the climate is much drier, these bulbs are rare (Buchanan). The main variations in my specimens relate to size and stoutness of the plant, and the size, form, and subdivision of the pinnules. Some of my plants are 1 foot, others 2 feet, high. The smaller forms are frequently very delicate, membranous, and green (bush-growers); while others are as stout as—and otherwise resemble in general characters—our *A. Adiantum-nigrum*, L. The frond is generally more or less decompound, the pinnules shortly stalked—the longest $3\frac{1}{2}$ to 4 inches, subdivided into six to thirty segments, varying in length and breadth; obtuse at ends—the segments being further variously divided.

- Sp. 23. *A. flaccidum*, Forst. Corticolous, terricolous, and saxicolous; abounding in the Greenisland district; on old "Broad-leaf" trees, Greenisland Bush; on rotten tree-trunks, East Taieri Bush; on trees, but also on the ground, Stoneyhill Bush; in crevices of mica-slate rocks, gullies of the Chain Hills; October and November, fruit. "Pohutukawa" of the North Island Maoris; a term also applied to *Metrosideros tomentosa* (Colenso).

Some of the pendent, larger tree-forms, are very elegant, and are known to settlers as the "Stag's horn Fern." The definition, description, or naming of all its variations, is utterly vain and futile. In size it varies from 6 to 10 inches. The larger forms have frequently a long naked stipe, terminating in a few linear pinnules, notched into a series of comparatively simple segments. The smaller forms generally have only a short stipe; the frond is broadly lanceolate; the pinnules numerous and also lanceolate, with crenate or sinuate margins. It is these forms especially which resemble our *A. Adiantum-nigrum*. The colour is sometimes peculiarly whitish or glaucous in the longer slender forms, with sub-linear pinnules; in the smaller it is more generally the dull green of *A. Adiantum-nigrum*. The frond is sometimes distinctly bipinnate.

Gen. 9. *Aspidium* (including the genus *Polystichum*, Fl. N.Z.)

- Sp. 24. *A. aculeatum*, Swartz.

Var. *vestitum*, Hook. Bush in the Chain Hills, 50 inches tall; Greenisland Bush, 24 to 30 inches high; October and November, fruit. A very stout, rigid, handsome fern—resembling our *A. lobatum*, Sw., and the stronger forms of our *A. aculeatum*. Larger forms generally 25 to 40 inches, smaller 15 to 18 inches, high.

- Sp. 25. *A. Richardi*, Hook. Named by Dr Hooker in my Herbarium *Polystichum aristatum*, Presl. (Fl. N.Z., plate 78). On rocks, Stoneyhill Bush; December, fruit.

In specimens cultivated by Mr Gorrie at Trinity, Edinburgh, the

frond is dark in hue ; sub-rigid and coriaceous, though not more so than is *A. aculeatum* ; under surface sparingly covered with chaffy tomentum ; brownish-black scales of stipe much mixed with long, chaffy hairs ; lower pinnules again pinnate at base ; upper pinnules all pinnatifid, there being a gradation from base to apex between the pinnate and pinnatifid characters ; some of the secondary pinnæ occasionally with a very short obscure pedicel. I am not at all satisfied of the specific distinction between *aculeatum* and *Richardi*.

Gen. 10. *Nephrodium*.

- Sp. 26. *N. hispidum*, Hook. (*Polystichum*, Fl. N.Z.) On ground, Anderson's Bay Bush (Martin).

Gen. 11. *Polypodium* (including the genera *Grammitis*, *Goniopteris*, *Niphobolus*, and *Phymatodes*, pr. p. Fl. N.Z.)

- Sp. 27. *P. australe*, Mettenius (*Grammitis australis*, Br., Fl. N.Z.) On dead tree-trunks, East Taeri Bush ; November, fruit.

In the form of its leaf it somewhat resembles young plants of *Scolopendrium vulgare*, Sm. It is saxicolous as well as corticolous, growing in the open, ascending to elevations of 5000 feet, and to a certain extent representing in Otago such of our ferns as *Ceterach officinarum*, Willd., and the *Woodsias*. Alpine forms grow frequently or generally in dense moss-like patches.

- Sp. 28. *P. Grammitidis*, Br. On dead tree-trunks, East Taeri Bush ; November, fruit.

- Sp. 29. *P. pennigerum*, Forst. (*Goniopteris*, Fl. N.Z.) On ground, Greenisland Bush (Martin). Young, imperfect, and sterile. The "Piupiu" of the North Island Maori (from the Maori verb to tremble, wave, or vibrate—in allusion to its delicacy and elegance).

My only specimen was labelled by Dr Hooker *Goniopteris pennigera*, J. Sm. ; but in the "Handbook" he gives its southern limit as Akaroa, and says he has seen no Otago specimen.

- Sp. 30. *P. rupestre*, Br. (*Niphobolus*, Fl. N.Z.) On old or dead tree-trunks, Greenisland Bush ; November, young ; a climber, twining round tree-trunks like ivy, whose representative in that sense it may here be held to be.

- Sp. 31. *P. Billardieri*, Br. (*Phymatodes*, Fl. N.Z.) On dead tree-trunks, Saddlehill Bush ; East Taeri Bush ; Bush in the Chain Hills ; October and November, fruit. A climber, like *P. rupestre*, and still more than it resembling our ivy, in so far as it sometimes possesses an ivy-like palmatifid frond.

Even in the same plant the sterile frond is extremely variable. It is generally more delicate and membranous than the fertile frond—broader, and more simple in its divisions. It may be quite simple and sub-lanceolate, as in the young *Scolopendrium vulgare* ; or it may be entire and sub-ovate below, dividing into two or three sub-simple and short segments terminally ; or sub-lyrate ; or irregularly pinnatifid at its apex ; or it may be regularly or irregularly 5-fid or sub-palmate—the broader forms in the young state being very membranous. The fertile frond is in my speci-

mens pinnatifid, like that of our *Polypodium vulgare*, L.; the segments being lanceolate, sub-simple, with sub-sinuate margins, more or less coriaceous and stout.

IV. OSMUNDEÆ.

Gen. 12. *Leptopteris*.

- Sp. 32. *L. Hymenophylloides*, Presl. (*Todea pellucida*, Carm., Fl. N.Z.) In the damp shady Bush, ravines of the Chain Hills; 24 to 30 inches high; October to November, fruit; common; "Heruberu" of the natives (Colenso).

The frond is translucent, as in the genus *Hymenophyllum*; hence its very appropriate name. A very handsome fern, with a very dark-green deeply-cut frond; somewhat resembling, save in its greater size, our *Trichomanes radicans*, Sw. The smaller forms are 12 to 18 inches, the larger 30 to 36 inches, tall.

V. OPHIOGLOSSÆ.

Gen. 13. *Ophioglossum*.

- Sp. 33. *O. vulgatum*, L.

Var. *costatum*, Br. Chain Hill ranges; January, fruit.

A small delicate form, compared with the larger coarser British plant, whose representative it here is; frequenting the same open hill pastures.

Gen. 14. *Botrychium*.

- Sp. 34. *B. cicutarium*, Swartz.

Var. *virginicum*, Hook. fil. Tuapeka ranges; ranges about south base of Kaikorai Hill; December and January, fruit. The "Patotara" of the North Island Maoris; a term also applied to certain Phœnogams (*Leucopogon Frazeri* and *Cyathodes acerosa*), f. Colenso and Lyall.

I found it mistaken for a young phœnogamous plant, even by settlers possessed of considerable botanical knowledge and experience. It is certainly, especially in its young, undeveloped state, a puzzling plant, apt to be overlooked as a Fern. The whole plant, including root and fruit, is 3 to 3½ inches high. The root, like that of *Ophioglossum*, is bulb-like, resembling, on a miniature scale, the roots of various terrestrial Orchids.

II. LYCOPODIACEÆ.

Gen. 1. *Lycopodium*.

- Sp. 1. *L. Billardieri*, Spreng. Pendent from old trees, Greenisland Bush; rare in Otago, according to Martin. Somewhat resembles in appearance our *L. selaginoides*, L., than which, however, it is a stronger plant.

- Sp. 2. *L. clavatum*, L.

Var. *Magellanicum*, Swartz. North shoulder of Saddlehill, above Renwick's Station; Chain Hill ranges; January, fruit; common. The representative in Otago, both as regards its abundance, habitats, and general aspect, of our common British *L. clavatum*.