

ART. XXXII.—*Pteridophytes of Banks Peninsula (Eastern Portion).*

By W. MARTIN, B.Sc.

[Read before the Philosophical Institute of Canterbury, 3rd December, 1919; received by Editor, 31st December, 1919; issued separately, 30th June, 1920.]

OWING to its isolated geographical position, Banks Peninsula affords special opportunity for ecological investigation, yet few botanists have given it the attention it invites. Our present knowledge of the florula and of the distribution of the species has been admirably summed up in a recent paper by Laing (1919).

In his list of indigenous plants Laing refers to a large number of species of the former existence of which there can be little doubt, but whose presence is not now known with certainty. Such plants are recorded as "*species inquirendae*." Reference is also made to a number of species recorded by previous investigators, regarding the identification of which some doubt is expressed. Laing describes these as "*species excludendae*." It therefore seems desirable that an intensive study of the plants of this district should be conducted before further denudation of the primitive vegetation takes place.

Laing in his paper expresses the hope that "before the remnants of the primitive flora disappear every opportunity will be taken by local students to complete the work here outlined." The scope of the present paper is limited to an investigation of the past and present distribution of the pteridophytes of the Akaroa caldera and its immediate neighbourhood. The district examined consists of that portion of Banks Peninsula lying to the east of a line joining Peraki and Pigeon Bay. Practically every remnant of the ancient forest within the caldera itself has been visited since December, 1916, as well as the majority of similar areas that flank the outer walls. Most of the accessible cliffs within the harbour have also been examined, but the whole of the slopes facing the open sea require further and closer examination than I have been able to give to them.

The earliest existing records of distribution are contained in the writings of Raoul (1846), Armstrong (1880 and 1882), and Potts (1882); but for much additional information I am specially indebted to Mr. D. G. Riches, of Akaroa, who since about 1880, while engaged on survey work that took him to every corner of the area under discussion, has been a close student of the ferns of Banks Peninsula and has made copious collections exclusively from this area. Many of the localities cited by Riches have been corroborated by Mr. Louis J. Vangioni, of Akaroa, and Mr. George Penlington, of Christchurch, to both of whom I am indebted for valuable information. In several instances I have been able, from information thus obtained, to locate ferns included by Laing in his list of doubtful inhabitants. Species recorded in this paper are represented by specimens from the localities named, and now in the possession of Mr. Riches or myself.

PROBABLE CAUSES OF DIMINUTION OR EXTINCTION OF SPECIES.

Before the days of colonization the hills about Akaroa were clad with forest right to the water's edge, and it seems safe to assume that the atmosphere was more humid than it now is; but even if the annual

rainfall had changed but little, there is to-day an almost entire lack of those taller and denser timber areas which were the home of the majority of the more delicate species of *Hymenophyllum* and *Trichomanes*, and I venture to suggest that the humidity within those areas that remain is also lower than it formerly was. For instance, in December, 1916, the stream that usually flowed through Le Bon's Bush, though never of large dimensions, had actually dried up, and the forest-floor could scarcely have been described as damp; yet there are evidences that this piece of forest was particularly rich both in wealth of fern-growth and in number of species.

To the wholesale destruction of the bush that accompanied the cutting-out of the timber and the conversion of these areas into pasture the disappearance or partial disappearance of many ferns is undoubtedly due, as, e.g., *Gleichenia Cunninghamii* and *Pteris tremula*, both of which appear to have been abundant. Then, again, where cattle have had access to the bush the undergrowth, with its wealth of terrestrial ferns, has disappeared save for a few hardy species that seem able to accommodate themselves very rapidly to new and harsher conditions, as, e.g., *Asplenium bulbiferum*, *Pellaea rotundifolia*, *Polystichum Richardi*, *P. vestitum*, *Blechnum lanceolatum*, *B. fluviatile*, *B. discolor*.

Most of the larger Hymenophylla seem to have disappeared entirely, though the smaller species may still be found. The reason for this I am unable to state. It has to be remembered, however, that the favourite haunts for these ferns were the valleys between Le Bon's Bay and Damon's Bay, and that the bush has been practically cleared away from these areas. Further, it seems more than probable that these ferns cannot endure wind, which now blows freely through bush where formerly the air was perpetually still.

On the coastal rocks the following ferns are much less common than they apparently were formerly: viz., *Gymnogramme leptophylla*, *G. rutae-folia*, *Blechnum Banksii*, *Asplenium Richardi*. In fact, no trace of either *Gymnogramme* was seen by me. Other ferns commonly met with on banks and slopes immediately above high-water mark seem to hold their own against such aggressive exotics as *Dactylis glomerata*, *Agrostis stolonifera*, &c., while the pastures have been invaded by *Blechnum penna marinum*. This fern must, in the district under consideration, have descended from its former subalpine station right down to sea-level, where it is now common in places from which in the past it seems to have been absent. The two species of *Gymnogramme* formerly grew on steep banks of partially decomposed rock, where introduced grasses have now obtained a footing, and this may, wholly or partially, explain their disappearance.‡

SUMMARY OF THE RESULTS OF THE INVESTIGATION.

It will be seen from the following lists that at least seven (possibly eight) of the twenty *species inquirendae* mentioned by Laing are still growing in the district investigated, while Riches has shown that fourteen at least were former inhabitants. Of the sixteen *species excludendae* four were present—viz., *Hymenophyllum scabrum*, *Hymenophyllum ferrugineum*, *Trichomanes humile*, *Trichomanes Colensoi*.

Riches informs me that a considerable patch of a small-leaved umbrella-fern (*Gleichenia dicarpa*?) formerly grew near the summit of the hills at the head of O'Kain's, while he has specimens of *Lindsaya linearis* Swartz and *Lindsaya cuneata* Forst. var. *Lessonii* Hook. f. collected somewhere in

this neighbourhood and sent to him by a Mr. Craig about 1880. *Athyrium umbrosum* and *Asplenium Hookerianum* var. *Colensoi* were both collected by Riches and are now recorded for the first time.

In the accompanying list of existing species I give unrecorded habitats for at least thirty ferns and lycopods. There is ample evidence that some species now comparatively rare were once common—e.g., *Leptolepia novae-zelandiae* and *Polystichum adiantiforme*. The former I have noted in nine separate localities, and the latter in four, though no other recent investigator has recorded them at all. *Adiantum affine* was once common over the whole area and is still widely distributed, but is plentiful only in a few localities, such as at Waterfall Gully on Mount Bossu, Nikau-palm Gully, and the cliffs near Mat. Wight's Bay. *Polystichum adiantiforme* has apparently not been recorded since Raoul first mentioned Akaroa as a habitat, though Mr. Louis J. Vangioni has it growing in his fernery on a fern-trunk from Grehan Valley, where I find it still fairly common. Laing regards Raoul's record as "probably an erroneous identification," but this species still exists in all the main Akaroa valleys, and near McDonald's, half-way up the Jubilee Road, at Wainui.

Referring to *Dicksonia fibrosa*, which he records from Wainui, Laing says, "As I have no specimens, I am somewhat doubtful of the identification." This fern is common in the Le Bon's Reserve, and has been obtained near the head of Barry's Bay by Mr. E. F. Stead. *Azolla rubra* is a new record on my own observation.

ABBREVIATIONS USED IN THIS PAPER.

D. G. R.	.. ..	D. G. Riches.
R. M. L.	.. ..	R. M. Laing.
L. J. V.	.. ..	L. J. Vangioni.
G. P.	.. ..	George Penlington.
W. M.	.. ..	William Martin.

EXISTING SPECIES NOT RECORDED SINCE 1882.

- Alsophila Colensoi* Hook. f. Head of Stony Bay,* W. M.
Hypolepis distans Hook. Near Ferris's, Akaroa, W. M.
Pteris tremula R. Br. Little Tikao Bay, L. J. V. and W. M.
Blechnum vulcanicum Kuhn. Grehan Valley, D. G. R., G. P., W. M.
Polystichum adiantiforme (Forst.) J. Sm. Akaroa and Wainui, L. J. V. and W. M.
Dryopteris velutina O. Ktz. Neighbourhood of Akaroa, W. M.
Lycopodium scariosum Forst. Head of Long Bay and Stony Bay, W. M.
Lycopodium Billardieri Spring (?)² Le Bon's Bay and Stony Bay, W. M.

FORMER HABITATS OF SPECIES NOT RECENTLY NOTED ON BANKS PENINSULA.

- Hymenophyllum dilatatum* Swartz. Hickory and Armstrong's Bush, D. G. R.
Hymenophyllum Malingii Mett. Long Bay and Stony Bay, D. G. R.
Hymenophyllum minimum A. Rich. Long Bay and Stony Bay, D. G. R.
Hymenophyllum tunbridgense Sm. Long Bay and Flea Bay, D. G. R.
Hymenophyllum multifidum Swartz. Long Bay and Stony Bay.
Hymenophyllum bivalve Swartz. Armstrong's Bush, D. G. R.
Hymenophyllum scabrum A. Rich. Long Bay and Hickory Bay, D. G. R.

* The Stony Bay referred to in this paper, unless otherwise stated, is the bay over the saddle from Balgueri Valley, Akaroa.

- Hymenophyllum ferrugineum* Colla (= *H. subtilissimum* Kunze). Stony Bay, D. G. R.
- Trichomanes Colensoi* Hook. f. Seaward side of Akaroa Ridge.
- Trichomanes humile* Forst. Seaward side of Akaroa Ridge, D. G. R.
- Adiantum aethiopicum* Linn. Akaroa, Raoul. Mr. Riches has a specimen of this maidenhair, but does not recollect where he obtained it.
- Blechnum durum* C. Chr. There is little doubt that this fern is correctly reported from Banks Peninsula by J. B. Armstrong. Riches has it from the foot of the beech bush, Stony Bay, where he says it was common. This was its northernmost limit. Apparently it grew close to, but not on, the actual coast-line.
- Adiantum fulvum* Raoul Grehan Valley, D. G. R.
- Athyrium umbrosum* Presl. A small clump formerly grew at Three Point Rock, Wainui, D. G. R. This is therefore the southernmost record for this species.
- Dryopteris decomposita* O. Kze. Children's Bay, Akaroa, D. G. R.
- Polypodium dictyopteris* C., Chr. Akaroa, Raoul; Stony Bay, D. G. R. I have not seen specimens of this fern.
- Arthropteris tenella* J. Sm Exact locality forgotten, D. G. R.
- Gleichenia dicarpa* R. Br. (?). Near head of O'Kain's, D. G. R.
- Gleichenia Cunninghamii* Hew. Five years ago Mr. G. Penlington and I came on this fern near a small stream near the head of Le Bon's (Martin, 1918), whence it has now totally disappeared. It was at one time very commonly distributed. Long Bay and Hickory, G. P. and D. G. R.; Flea Bay and Le Bon's, L. J. V.
- Notholaena distans* R. Br. Mat. Wight's Bay, on spurs of the hills, D. G. R.
- Gymnogramme leptophylla* Desv. Rocks near creek at lighthouse and on Adam's Point, D. G. R.
- Gymnogramme rutaefolia* Hook. & Grev. Adam's Point, D. G. R.

LIST OF SPECIES STILL GROWING IN THE REGION INVESTIGATED.

The species named in the following list are still growing in the localities recorded by Laing or myself. Records by Riches were made prior to 1900. Other records are not given unless the exact habitat is mentioned.

- Hymenophyllum rarum* R. Br. Waikerikeri (Hickory), R. M. L.; Le Bon's, W. M., D. G. R. This species was once common, but is now difficult to find.
- Hymenophyllum sanguinolentum* Hook. f. Le Bon's Reserve. This fern may most easily be found by following up the stream-bed till it reaches the waterfall, where it is growing on the rock and on neighbouring tree-trunks.
- Hymenophyllum flabellatum* Lab. Peraki Reserve, R. M. L., W. M. This fern is easily found on the caudices of *Dicksonia squarrosa*, at Wainui, Akaroa, Takamatua, and Le Bon's.
- Hymenophyllum peltatum* Bearn (= *H. unilaterale* Willd.). Long Bay, D. G. R. and R. M. L.
- Trichomanes venosum* R. Br. Extremely common on the stems of tree-ferns in almost every valley, W. M.; Balgueri Valley, R. M. L.
- Cyathea dealbata* Swartz. Everywhere common, but less so from year to year.
- Cyathea medullaris* Swartz. Mr. Hooker and others at Wainui inform me that some half-dozen specimens exist about a mile towards the Heads from Wainui, but I have not seen them.

- Hemitelia Smithii* Hook. f. Akaroa and Wainui, R. M. L., W. M. Commonly met with all round the harbour.
- Dicksonia squarrosa* Swartz. Everywhere common.
- Dicksonia fibrosa* Col. Wainui, R. M. L.; Le Bon's, W. M.; Barry's Bay, E. F. Stead.
- Alsophila Colensoi* Hook. f. Common in bush above the Summit Road at the head of Stony Bay, near Akaroa. I have a doubtful record from Le Bon's.
- Leptolepia novae-zelandiae* (Col.) Kuhn. This and the last species do not appear to have been collected in the last thirty years. I have noted this fern at Peraki Reserve, Wainui, Grehan Valley, French Farm, Le Bon's, and head of Robinson's Bay in the little tongue of bush that lies between the road and the summit, where it may easily be obtained.
- Adiantum affine* Willd. Nikau-palm Gully, R. M. L. All valleys round Mount Bossu, Wainui, French Farm, Rowe's Bush Waterfall, Akaroa, and especially on the coastal cliffs north of Mat. Wight's Bay. This fern must formerly have been widely distributed.
- Hypolepis tenuifolia* Bernh. Top of ridge, Akaroa to O'Kain's, W. M.
- Hypolepis distans* Hook. Neighbourhood of Akaroa, D. G. R., W. M.
- Cheilanthes Sieberi* Kunze. Spurs on Lucas Bay, D. G. R. Evidently less common than formerly.
- Pellaea rotundifolia* Hook. Everywhere abundant both in the bush and in the open.
- Pteridium esculentum* Cockayne. Common near the margin of the bush; covering many acres of valuable land on the spurs above Wainui and Akaroa, and increasing rapidly.
- Paesia scaberula* Kuhn. Mount Bossu, Wainui; R. M. L., W. M.; head of Balgueri Valley, W. M. and G. P.
- Histiopteris incisa* J. Sm. Stony Bay near O'Kain's, R. M. L.; Le Bon's, Stony Bay near Akaroa, and Long Bay, W. M.
- Pteris tremula* R. Br. Potts records this fern from "Tikao Bay," which is probably intended for Little Tikao Bay, where it is still growing, L. J. V., W. M.; foot of Peraki Reserve, W. M.; near top of range at Hickory and Stony Bay, D. G. R.
- Blechnum Patersoni* Mett. Peraki, Le Bon's, Balgueri and Grehan Valleys, Akaroa, Wainui; always at the higher levels and in damp-bush.
- Blechnum discolor* Keys. Common in bush above 1,000 ft.
- Blechnum lanceolatum* Sturm. Common in bush.
- Blechnum penna marinum* Kuhn. To be met with at all levels from sea-level, as at Maori Kaik, to the summit. This is a most abundant fern on open hillsides; 300 ft. is given as the lowest level by Laing, but I have seen it almost on the sea-shore at Maori Kaik and at Wainui.
- Blechnum Banksii* Mett. Squally Bay and Stony Bay, D. G. R.; light-house, Akaroa, L. Cockayne; Stony Bay, W. M.
- Blechnum capense* Schlecht. Common, especially in bush above 1,000 ft. level.
- Blechnum fluviatile* Lowe. Common near bush-streams
- Blechnum membranaceum* Mett. Brough's Bay, D. G. R., G. P. I have not visited this locality, but have reason to believe it still exists there.
- Blechnum vulcanicum* Kuhn. This fern has eluded collectors and investigators for many years. It is growing freely on some rocks in a piece of bush bordering a small tributary of the main stream in Grehan Valley. Elsewhere on the peninsula it occurs in Kaituna Bush.

Asplenium flabellifolium Cav. A cosmopolitan fern in the district examined.
Asplenium obtusatum Forst. f. On coastal cliffs. Within the harbour this fern presents all manner of intermediate gradations between *A. obtusatum* and *A. lucidum*. Wall (see Laing, 1919, p. 376) considers the coastal fern of Lyttelton Harbour to be a form of *A. lucidum* rather than of *A. obtusatum*. I hold the same view in respect to the *Asplenium* of Akaroa Harbour.

Asplenium lucidum Forst. f. Wainui, French Farm, Barry's Bay, Pigeon Bay, Akaroa, Little Tikao Bay. The typical form is met with flanking the streams for a few chains from their entry into the harbour wherever these are shaded by bush. Fronds 5 ft. 6 in. long were recently exhibited by me in Christchurch from Barry's Bay. On Adam's Point a gradual transition towards *A. obtusatum* may be noted, the pinnae becoming more and more oblique and erect, more coriaceous, and shorter, and the fronds more dwarf and compact. An examination of these localities leads me to think that the most potent factors in causing this transition are the degree of exposure and the degree of salinity at the roots. The degree of shade and moisture are also factors of importance.

Asplenium Lyallii (Moore) Cockayne. I obtained two specimens of this fern within a chain of typical *A. lucidum* and the fern here called *A. obtusatum* on Adam's Point. Head of Duvauchelles, W. M.

Asplenium Hookerianum Col. Three very distinct forms of this composite species exist in the locality. The typical form is abundant in Akaroa itself, at Maori Kaik, and at Wainui; it is well distributed generally. Superficially, a second form, found in Balgueri Valley, almost exactly matches the plate given by Field for *A. umbrosum* var. *parvifolium*. Var. *Colensoi* is found at Tikao Bay, D. G. R.

Asplenium bulbiferum Forst. f. The commonest bush-fern, but, like a number of others, it may often be seen growing in a crevice in a rock exposed to the full effects of sun and wind, in which situation it becomes extremely coriaceous.

Asplenium Richardi Hook f. Waikerikeri, R. M. L.; coastal cliffs on the seaward side, D. G. R.

Asplenium flaccidum Forst. f. This fern is everywhere abundant.

Polystichum vestitum Presl. Very common in the upper regions of the bush—i.e., above 1,000 ft. Where the bush has been cleared this fern often continues to thrive in the open.

Polystichum Richardi J. Sm. A very hardy cosmopolitan type, thriving equally well on the coastal cliffs, open pasture, and dense bush. It thrives at all levels. The *Aspidium oculatum* of the *Handbook* (Hooker) does not seem to be a fixed type, as considerable variation in the disc of the involucre and in the margin of the scales occurs sometimes in a single clump of *P. Richardi*.

Polystichum hispidum J. Sm. Maori Kaik, Newton's Valley, Balgueri Valley, Le Bon's, W. M. Nowhere common.

Polystichum adiantiforme (Forst.) J. Sm. Regarded by Laing as "probably an erroneous identification," but undoubted specimens may easily be obtained on the caudices of *Dicksonia squarrosa* about a mile up Grehan Valley. I have obtained it in Newton's Valley, and also in the valley below the Jubilee Road, a quarter of a mile above McDonald's, at Wainui, where it was growing luxuriantly, though only two specimens were seen.

- Dryopteris glabella* C. Chr. Balgueri Valley, R. M. L., W. M.; Maori Kaik, Newton's Valley, Grehan Valley, and Rowe's Bush on Adam's Point, W. M.
- Dryopteris punctata* C. Cr. Common on the margins of the bush.
- Dryopteris pennigera* C. Chr. Common in shaded stream-beds below 1,000 ft.
- Dryopteris velutina* O. Ktze. This handsome fern still grows where it was discovered by Raoul. Akaroa, Rowe's Bush, Maori Kaik, W. M.
- Polypodium Billardieri* (Willd.) C. Chr. (= *P. australe* Mett.). Common on rocks and tree-trunks all round the summit.
- Polypodium pustulatum* Forst. f. Long Bay, D. G. R.; Stony Bay, W. M.
- Polypodium graminifolium* R. Br. Common on tree-trunks and on rock near the summit from Stony Bay to Wainui. Specimens from Le Bon's measured 12 in. in length.
- Polypodium diversifolium* Willd. Everywhere abundant.
- Cyclophorus serpens* C. Chr. Akaroa, Peraki, Island Bay, W. M.
- Leptopteris hymenophylloides* Presl. Abundant in the denser areas of bush, as at Peraki, Le Bon's, Stony Bay, &c. It also grows in the beech forest at the head of Balgueri Valley, facing full to the sun.
- Ophioglossum coriaceum* A. Cunn. Hills behind Wainui, ridge between Le Bon's and Hickory, R. M. L.
- Botrychium australe* R. Br. Grehan Valley. Mr. G. Penlington conducted me to a spot where it formerly grew abundantly, and we were fortunate enough to find a specimen about 400 ft. above sea-level. Brasenose (lower levels), G. P., D. G. R.
- Lycopodium varium* R. Br. Waikerikeri, R. L. M.; head of Le Bon's and Barry's Bays, W. M. Specimens superficially resembling *L. Billardieri* Spring were obtained by me growing as epiphytes both at Stony Bay and at Le Bon's. At first I could find no fertile fronds; and, referring to barren fronds sent to him, Dr. J. E. Holloway wrote me, "Almost certainly *L. Billardieri*." Writing later, after I had secured fertile fronds, he says, "I agree with you that the fertile plants you send are more of the form of *L. varium* than of *L. Billardieri*. These two species grade into one another so that it is quite possible to speak of an intermediate form as being a variation of the one as much as of the other. Seeing that they are recognized as two distinct species . . . and judging from the fertile specimens they deserve the name *L. varium*." The barren fronds were obtained from *Griselinia littoralis* and *Podocarpus totara*, while the fertile plants were epiphytic on *Dicksonia fibrosa*. All had a tendency to upward or erect growth, but the longer fronds drooped by reason of their weight.
- Lycopodium Billardieri* Spring (?). See preceding note.
- Lycopodium scariosum* Forst. Head of Long Bay and Stony Bay, D. G. R., W. M.
- Lycopodium volubile* Forst. f. Wainui hilltops, above Le Bon's Bay, near Hilltop Hotel, R. M. L., W. M.
- Tmesipteris tannensis* Bernh. This pteridophyte grows plentifully in the stream-valleys at Akaroa, and more sparingly at Le Bon's and Peraki. Plants over 1 ft. in length are not uncommon on the tree-fern stems in Newton's Valley at Akaroa.
- Azolla rubra* R. Br. Pigeon Bay, W. M. This little floating water-fern frequents the surface of fairly stationary water, which is seldom provided in the Akaroa area, hence the probable reason for its not having been reported previously.

LITERATURE CONSULTED OR REFERRED TO.

- ARMSTRONG, J. B., 1880. A Short Sketch of the Flora of the Province of Canterbury, with Catalogue of Species, *Trans. N.Z. Inst.*, vol. 12, pp. 325-53.
 — 1882. New Zealand Ferns (a series of fifteen chapters in the *Canterbury Times*).
 CHEESEMAN, T. F., 1906. *Manual of the New Zealand Flora*.
 COCKAYNE, L., 1907. Some Hitherto-unrecorded Plant-habitats, *Trans. N.Z. Inst.*, vol. 39, pp. 361-78.
 FIELD, H. C., 1891. *Ferns of New Zealand*.
 HOOKER, Sir J. D., 1864. *Handbook of the New Zealand Flora*.
 LAING, R. M., 1919. Vegetation of Banks Peninsula, *Trans. N.Z. Inst.*, vol. 51, pp. 355-498.
 MARTIN, W., 1918. Ferns of the Port Hills, *Lyttelton Times*, 17th August, 1918.
 POTTS, T. H., 1882. *Out in the Open*.
 RAOUL, A., 1846. *Choix de plantes de la Nouvelle-Zélande*.

ART. XXXIII.—*The Notocene Geology of the Middle Waipara and Weka Pass District, North Canterbury, New Zealand.*

By Dr. J. ALLAN THOMSON, F.G.S., F.N.Z.Inst., Director of the Dominion Museum.

[Read before the Wellington Philosophical Society, 22nd October, 1919; received by Editor, 31st December, 1919; issued separately, 16th July, 1920.]

Plates XVI-XXVII.

CONTENTS.

INTRODUCTION	322	PART II.—PALAEONTOLOGY	367
PART I.—DESCRIPTIVE GEOLOGY—		Tertiary Mollusca	367.
Geological Exploration of the District	324	Brachiopoda—	
General Account of the Geology and Physiography	335	Rhynchonellidae	368
Structure	336	Terebratulidae	369
Physiography	338	Terebratellidae	369
Detailed Stratigraphy—		PART III.—CORRELATION AND THE CLASSIFICATION OF THE NOTOCENE—	
Pirapauan—		Clarentian	383
Coal-measures and <i>Ostrea</i> Bed	341	Pirapauan	384
“Saurian Beds” and Waipara Greensands	343	Kaitangatan-Amuri Limestone	385
Kaitangatan—		Oamaruan	386
Amuri Limestone	348	Wanganuian	397
Oamaruan—		Diastrophic Provinces in New Zealand	398
Weka Pass Greensand and Weka Pass Stone	352	The Cretaceous-Tertiary Formation of Hector	400
“Grey Marls” and Mount Brown Beds	356	Hutton’s Classification and its Successors	405
Wanganuian—		Marshall’s Classification	407
Greta Beds	363	Diastrophic History of the East Coast of the South Island	410
Kowhai Beds	366	BIBLIOGRAPHY	412

INTRODUCTION.

THE younger rocks of New Zealand, embracing all marine strata from Albian to Pliocene, consist in nearly all localities of accordant rock-series, and form, broadly speaking, a structural and physiographical unit. The rocks composing them—viz., conglomerates, sandstones, greensands, mudstones, and limestones—are much less indurated than the unconformably underlying greywackes, argillites, phyllites, schists, or granites, and physiographically form a weak cover to a resistant undermass. Unlike the latter,