# TRANSACTIONS

AND

# PROCEEDINGS

OF THE

# NEW ZEALAND INSTITUTE

1881

VOL. XIV.

EDITED AND PUBLISHED UNDER THE AUTHORITY OF THE BOARD OF GOVERNORS OF THE INSTITUTE

BY

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## ADDENDA ET CORRIGENDA.

PAGE

9, line 7 from bottom, *for* stored or food *read* stored for food
18, line 14 ,, *for* 42 *read* 40
22, line 4, *for* to Taane *read* of Taane
25, line 7, *for* boats *read* bouts
26, line 4 from bottom, *insert* " 51 " in blank space
41, line 10 ,, *for* horokio *read* Korokio; this with several tribes being the name for the fern *Polypodium pennigerum*
47, line 12 from bottom, *for* line 16 *read* line 46
107, in heading of Art. XI., *for* 1881 *read* 3rd August, 1880

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# NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND INTITULED "THE NEW ZEALAND INSTITUTE ACT, 1867."

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## ABSTRACTS OF RULES AND STATUTES.

GAZETTED IN THE "NEW ZEALAND GAZETTE," 9TH MARCH, 1868.

### SECTION I.

*Incorporation of Societies.*

1. No society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act, 1867," unless such society shall consist of not less than twenty-five members, subscribing in the aggregate a sum of not less than fifty pounds sterling annually, for the promotion of art, science, or such other branch of knowledge for which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the Chairman for the time being of the society.

2. Any society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the members of the said society shall at any time become less than twenty-five, or the amount of money annually subscribed by such members shall at any time be less than £50.

3. The bye-laws of every society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of its annual revenue in or towards the formation or support of some local public Museum or Library, or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the Museum and Library of the New Zealand Institute.

4. Any society incorporated as aforesaid, which shall in any one year fail to expend the proportion of revenue affixed in manner provided by Rule 3 aforesaid, shall from thenceforth cease to be incorporated with the Institute.

5. All papers read before any society for the time being incorporated with the Institute shall be deemed to be communications to the Institute, and may then be published as proceedings or transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications.

*Regulations regarding Publications.*

(*a.*) The publications of the Institute shall consist of a current abstract of the proceedings of the societies for the time being incorporated with the Institute, to be intituled "Proceedings of the New Zealand Institute," and of transactions comprising papers read before the incorporated societies (subject, however, to selection as hereinafter mentioned), to be intituled "Transactions of the New Zealand Institute."

(*b.*) The Institute shall have power to reject any papers read before any of the incorporated societies.

(*c.*) Papers so rejected will be returned to the society before which they were read.

(*d.*) A proportional contribution may be required from each society towards the cost of publishing the Proceedings and Transactions of the Institute.

(*e.*) Each incorporated society will be entitled to receive a *proportional* number of copies of the Proceedings and Transactions of the Institute, to be from time to time fixed by the Board of Governors.

(*f.*) Extra copies will be issued to any of the members of incorporated societies at the cost of publication.

6. All property accumulated by or with funds derived from incorporated societies, and placed in the charge of the Institute, shall be vested in the Institute, and be used and applied at the discretion of the Board of Governors for public advantage, in like manner with any other of the property of the Institute.

7. Subject to "The New Zealand Institute Act, 1867," and to the foregoing rules, all societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the bye-laws for their own management, and shall conduct their own affairs.

8. Upon application signed by the Chairman and countersigned by the Secretary of any society, accompanied by the certificate required under Rule No. 1, a certificate of incorporation will be granted under the Seal of the Institute, and will remain in force as long as the foregoing rules of the Institute are complied with by the society.

## Section II.

*For the Management of the Property of the Institute.*

9. All donations by societies, public departments, or private individuals, to the Museum of the Institute shall be acknowledged by a printed form of receipt, and shall be duly entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

10. Deposits of articles for the Museum may be accepted by the Institute, subject to a fortnight's notice of removal to be given either by the owner of the articles or by the Manager of the Institute, and such deposits shall be duly entered in a separate catalogue.

11. Books relating to Natural Science may be deposited in the Library of the Institute, subject to the following conditions:—

(*a.*) Such books are not to be withdrawn by the owner under six months' notice, if such notice shall be required by the Board of Governors.

(*b.*) Any funds specially expended on binding and preserving such deposited books, at the request of the depositor, shall be charged against the books, and must be refunded to the Institute before their withdrawal, always subject to special arrangements made with the Board of Governors at the time of deposit.

(*c.*) No books deposited in the Library of the Institute shall be removed for temporary use except on the written authority or receipt of the owner, and then only for a period not exceeding seven days at any one time.

12. All books in the Library of the Institute shall be duly entered in a catalogue, which shall be accessible to the public.

13. The public shall be admitted to the use of the Museum and Library, subject to bye-laws to be framed by the Board.

## Section III.

14. The Laboratory shall, for the time being, be and remain under the exclusive management of the Manager of the Institute.

## Section IV.

### Of Date 23rd September, 1870.

*Honorary Members.*

Whereas the rules of the Societies incorporated under the New Zealand Institute Act provide for the election of Honorary Members of such Societies; but inasmuch as such Honorary Members would not thereby become members of the New Zealand Institute, and whereas it is expedient to make provision for the election of Honorary Members of the New Zealand Institute, it is hereby declared—

1st. Each incorporated Society may, in the month of November next, nominate for election as Honorary Members of the New Zealand Institute three persons, and in the month of November in each succeeding year, one person, not residing in the colony.

2nd. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as Honorary Members is recommended, shall be forthwith forwarded to the Manager of the New Zealand Institute, and shall by him be submitted to the Governors at the next succeeding meeting.

3rd. From the persons so nominated the Governors may select in the first year not more than nine, and in each succeeding year not more than three, who shall from thenceforth be Honorary Members of the New Zealand Institute, provided that the total number of Honorary Members shall not exceed thirty.

## LIST OF INCORPORATED SOCIETIES.

| NAME OF SOCIETY. | DATE OF INCORPORATION. |
|---|---|
| Wellington Philosophical Society | 10th June, 1868. |
| Auckland Institute | 10th June, 1868. |
| Philosophical Institute of Canterbury | 22nd October, 1868. |
| Otago Institute | 18th October, 1869. |
| Westland Institute | 21st December, 1874. |
| Hawke's Bay Philosophical Institute | 31st March, 1875. |
| Southland Institute | 21st July, 1880. |

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### WELLINGTON PHILOSOPHICAL SOCIETY.

Office-bearers for 1881:—*President*—James Hector, C.M.G., M.D., F.R.S.; *Vice-presidents*—Dr. Buller, C.M.G., F.R.S., Hon. G. Randall Johnson, M.L.C.; *Council*—W. T. L. Travers, F.L.S., T. Kirk, F.L.S., A. K. Newman, M.B., M.R.C.P., J. P. Maxwell, A.I.C.E., F. W. Frankland, R. H Govett, Martin Chapman; *Auditor*—W. M. Bannatyne; *Secretary and Treasurer*—R. B. Gore.

Office-bearers for 1882:—*President*—W. T. L. Travers, F.L.S.; *Vice-presidents*—Hon. G. R. Johnson, Dr. Buller, C.M.G., F.R.S.; *Council*—A. K. Newman, M.B., M.R.C.P., J. P. Maxwell, A.I.C.E., R. Govett, M. Chapman, James Hector, M.D., C.M.G., F.R.S., S. H. Cox, F.G.S., F.C.S., T. King; *Auditor*—Oliver Wakefield; *Secretary and Treasurer*—R. B. Gore.

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*Extracts from the Rules of the Wellington Philosophical Society.*

5. Every member shall contribute annually to the funds of the Society the sum of one guinea.

6. The annual contribution shall be due on the first day of January in each year.

7. The sum of ten pounds may be paid at any time as a composition for life of the ordinary annual payment.

14. The time and place of the General Meetings of members of the Society shall be fixed by the Council and duly announced by the Secretary.

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### AUCKLAND INSTITUTE.

Office-bearers for 1881:—*President*—T. Peacock; *Council*—G. Aicken, Rev. J. Bates, J. L. Campbell, M.D., J. C. Firth, Hon. Colonel Haultain, Neil Heath, F.G.S., E. A. Mackechnie, J. Martin, F.G.S., J. A. Pond, Rev. A. G. Purchas, S. P. Smith; *Auditor*—T. Macffarlane; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S.

Office-bearers for 1882:—*President*—E. A. Mackechnie; *Council*—G. Aicken, J. M. Clark, Rt. Rev. W. G. Cowie, D.D., His Honour Mr. Justice Gillies, Hon. Colonel Haultain, Neil Heath, J. Martin, F.G.S., T. Peacock, J. A. Pond, Rev. A. G. Purchas, M.R.C.S.E., S. Percy Smith, F.R.G.S.; *Auditor*—T. Macffarlane; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S.

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*Extracts from the Rules of the Auckland Institute.*

1. Any person desiring to become a member of the Institute, shall be proposed in writing by two members, and shall be ballotted for at the next meeting of the Council.

4. New members on election to pay one guinea entrance fee, in addition to the annual subscription of one guinea, the annual subscriptions being payable in advance on the first day of April for the then current year.

5. Members may at any time become life-members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

10. Annual General Meeting of the Society on the third Monday of February in each year. Ordinary Business Meetings are called by the Council from time to time.

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## PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Office-bearers for 1881:—*President*—Professor J. von Haast, F.R.S.; *Vice-presidents*—Rev. J. W. Stack, R. W. Fereday; *Council*—Professor A. W. Bickerton, J. Inglis, E. Dobson, T. S. Lambert, N. K. Cherrill: *Hon. Treasurer*—W. M. Maskell; *Hon. Secretary*—G. Gray; *Auditors*—C. R. Blakiston, W. D. Carruthers.

Office-bearers for 1882:—*President*—Professor J. von Haast, F.R.S.; *Vice-presidents*—R. W. Fereday, Professor F. W. Hutton; *Hon. Secretary*—G. Gray; *Hon. Treasurer*—W. M. Maskell; *Council*—E. Dobson, J. Inglis, Professor A. W. Bickerton, T. Crook, T. S. Lambert, H. R. Webb; *Auditors*—C. R. Blakiston, W. D. Carruthers.

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*Extracts from the Rules of the Philosophical Institute of Canterbury.*

21. The Ordinary Meetings of the Institute shall be held on the first Thursday of each month during the months from March to November inclusive.

35. Members of the Institute shall pay one guinea annually as a subscription to the funds of the Institute. The subscription shall be due on the first of November in every year. Any member whose subscription shall be twelve months in arrears, shall cease to be a member of the Institute, but he may be restored by the Council if it sees fit.

37. Members may compound for all annual subscriptions of the current and future years by paying ten guineas.

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## OTAGO INSTITUTE.

Office-bearers for 1881 :—*President*—G. M. Thomson, F.L.S.; *Vice-presidents*—Dr. Hocken, A. Montgomery ; *Hon. Secretary*—Professor Parker ; *Hon. Treasurer*—D. Petrie, M.A.; *Auditor*—D. Brent, M.A.; *Council*—Dr. Coughtrey, R. Gillies, F.L.S., W. Arthur, C.E., G. Joachim, H. Skey, W. M. Hodgkins, W. N. Blair, C.E.

Office-bearers for 1882 :—*President*—W. Arthur, C.E. ; *Vice-presidents*—G. M. Thomson, F.L.S., G. Joachim ; *Hon. Secretary*—Professor Parker ; *Hon. Treasurer*—D. Petrie, M.A. ; *Auditor*—D. Brent, M.A. ; *Council*—Right Rev. Bishop Nevill, Rev. Dr. Roseby, Professor Mainwaring Brown, Professor Scott, W. N. Blair, C.E., A. Montgomery, R. Gillies, F.L.S.

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*Extracts from the Constitution and Rules of the Otago Institute.*

2. Any person desiring to join the Society may be elected by ballot, on being proposed in writing at any meeting of the Council or Society by two members, on payment of the annual subscription of one guinea for the year then current.

5. Members may at any time become life-members by one payment of ten pounds and ten shillings in lieu of future annual subscriptions.

8. An Annual General Meeting of the members of the Society shall be held in January in each year, at which meeting not less than ten members must be present, otherwise the meeting shall be adjourned by the members present from time to time, until the requisite number of members is present.

(5.) The session of the Otago Institute shall be during the winter months, from May to October, both inclusive.

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## WESTLAND INSTITUTE.

Office-bearers for 1881 :—*President*—Dr. Giles, R.M. ; *Vice-president*—W. A. Spence ; *Hon. Treasurer*—T. O. W. Croft ; *Secretary*—R. Hilldrup ; *Council*—R. C. Reid, M.H.R., A. H. King, E. F. Rich, J. Pearson, G. A. Paterson, J. Nicholson, D. McDonald, H. R. Rae, McL. W. Jack, F. A. Learmonth, R. W. Wade, Dr. James.

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*Extracts from the Rules of the Westland Institute.*

3. The Institute shall consist :—(1) Of life-members *i.e.*, persons who have at any one time made a donation to the Institute of ten pounds ten shillings or upwards; or persons who, in reward of special services rendered to the Institute, have been unanimously elected as such by the Committee or at the general half-yearly meeting. (2) Of members who pay two pounds two shillings each year. (3) Of members paying smaller sums, not less than ten shillings.

5. The Institute shall hold a half-yearly meeting on the third Monday in the months of December and June.

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## HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

Office-bearers for 1881:—*President*—The Right Rev. the Bishop of Waiapu; *Vice-president*—E. H. Bold; *Hon. Secretary* and *Treasurer*—W. Colenso; *Auditor*—T. K. Newton; *Council*—H. Baker, — Carlile, S. Locke, W. Colenso, — Spencer, F. W. C. Sturm, — Weber.

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*Extracts from the Rules of the Hawke's Bay Philosophical Institute.*

3. The annual subscription for each member shall be one guinea, payable in advance, on the first day of January in every year.

4. Members may at any time become life-members by one payment of ten pounds ten shillings in lieu of future annual subscriptions.

(4) The session of the Hawke's Bay Philosophical Institute shall be during the winter months from May to October, both inclusive; and general meetings shall be held on the second Monday in each of those six months, at 8 p.m.

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## SOUTHLAND INSTITUTE.

Office-bearers for 1882:—*President*—J. T. Thomson, F.R.G.S.; *Vice-president*—W. S. Hamilton; *Hon. Treasurer*—J. C. Thomson; *Hon. Secretary*—P. Goyen; *Council*—Dr. Galbraith, T. Denniston, W. B. Scandrett, — Robertson, W. G. Mchaffey.

# TRANSACTIONS.

# TRANSACTIONS

OF THE

# NEW ZEALAND INSTITUTE,

## 1881.

## I.—MISCELLANEOUS.

Art. I.—*Historical Incidents and Traditions of the Olden Times, pertaining to the Maoris of the North Island, (East Coast), New Zealand; highly illustrative of their national Character, and containing many peculiar, curious, and little-known Customs and Circumstances, and Matters firmly believed by them. Now, for the first time, faithfully translated from old Maori Writings and Recitals; with explanatory Notes.* Part II.* By W. Colenso, F.L.S.

[*Read before the Hawke's Bay Philosophical Institute, 9th May, and* 12*th June,* 1881.]

Last year I had the honour and pleasure of reading some historical and traditional papers before you respecting the ancient Maoris of this East Coast. At that time I did so with some diffidence; for, first, I did not know how you might receive them; and, secondly, I did not know whether such papers would be published by the Parent Society. Now, however, we know, that those papers, read here and approved of by you, have been also published in the forthcoming volume (xiii.) of the "Transactions of the New Zealand Institute;" and this encourages me to bring some others of the same class, and obtained from the same sources, before you, during this winter's session; only these are still more ancient, and, I think, more curious and interesting. Of course I have only very recently known of those papers having been printed. Had I earlier known of it, or of their having been approved of, I might have got some more ready during the autumn; for, I confess, the translating of some portions of them is exceedingly difficult, being written (or handed down) in language which, in some places, contains words and phrases that are very old, and have almost become obsolete.†

* For Part I. see "Trans. N.Z. Inst.," Vol. XIII., p. 38.

† Particularly in the matter of charms, spells, invocations, exorcisms, etc.;—also, owing to their allusions (often by a single word) to still more ancient events, persons, (ancestors and semi-deities), and things; and to their largely abounding in ellipses and aposiopesis;—as I have formerly observed when on this subject.

For my own part I may again repeat (what, I believe, I have said to you before), that it is to such sources we have primarily and mainly to look for much that relates to the manners and customs of the ancient New Zealander. In those old narrations we get to know what they really were; and even then more, perhaps, from casual or incidental matters than from the main subject itself. But then such must have been related by the ancient men themselves, chiefs and priests *(tohungas)* of the olden time, and not by the present loquacious and mendacious generation, be their position what it may,—for all such are not only grossly ignorant of the past, but are also more or less vitiated concerning the same, through their intercourse with Europeans, both willingly and unwillingly. And when, in addition to all this, what they may have to say is frequently taken down and translated by "free and easy" young interpreters,—often ignorant of the first principles of the noble Maori language, and too much inclined to dress up what they hear, as if writing a novel or romance,—the result may be easily guessed.

And here, perhaps, I may be permitted briefly to mention that—(as it is pretty well known I have collected, during my long residence among the Maoris, very much of their old history, traditions, etc.)—I have been often requested to publish, in a separate form, what I have so amassed and known; but that I have hitherto refused to do so, for I seek neither pelf nor fame (as a book-maker), but merely to relate, in plain words, what I believe to be genuine and authentic, leaving it for those who may come after me to "make the book,"—to fuse together the ores I may have laboriously sought out, and collected, and brought to the surface.

In all those historical traditions we shall find much of war,—of bloody, desolating wars, with all their hideous and savage accompaniments! far more indeed than we could wish.* But war, as Cook early and sagaciously detected, was the very life and genius of the people; hence, too, they did not fear death. Not, however, but that it might have been better among them, for it will be found that, in almost all cases, their wars arose from some thoughtless or gross infringement of common rights. Yet even here we shall meet with much of extreme courtesy, and of fine feelings, which would have adorned a chivalrous European age; and that, too, in the midst of dreadful harrowing recitals of burning revenge for wrongs,—of extreme cruelty,—of great, yet simple superstition,—and of hair-breadth and marvellous escapes.

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* But the most famed and civilized nations of antiquity were, in this respect, quite as bad,—*e.g.*, the Assyrian and Egyptian "Records;" and Polybius, (who had himself seen the savage doings of the Romans), says, "when a town is taken by storm by the Romans, not only human beings are massacred, but even dogs cut in two, and other animals hewn limb from limb," (x. 15.) Note, also, Saul's slaying of the Amalekites, (1 Sam. xv.)

Of their human sacrifices and cannibalism, which always and everywhere *nationally* accompanied their battles, I would say nothing at present; only (as I have before observed),* that I never could consider those savage customs as even approaching, in cruelty and abomination, the well-known doings of that thrice-accursed institution of the so-called Christian Church—"the Holy Inquisition!" in which Christian kings and queens, bishops, priests, and saints (!!) took their unholy and murderous parts with a zest! Indeed, I hesitate not to affirm, that all such conduct as that of the New Zealand savage towards the *dead*—and that, too, in hot blood, after a deadly hand-to-hand combat with sticks and stones,—is as nothing when fairly compared with the modern and Christian (!) modes of wholesale mangling and destroying the *living!* (it may often be innocent and unoffending women and children, in the sieges and assaults of towns!) with shells, bombs, mines, mitrailleuses, dynamite, torpedoes, etc., etc.

Those historical stories will also show much of the cool courage, stratagem, endurance, patience, etc., of the ancient Maoris. From them we shall gather not a little every-way applicable to the so-called "Spiritualists" of the present day, showing, at least, that their modern lying "mediums'" deception was known long ago to the savage New Zealander! From those narrations we may also learn that such preternatural doings as that of Joshua commanding the sun to stand still,—of Jonah and the whale,—of supernatural visitants from the sky,—of wonderful achievements and miracles,—of miraculous conceptions,—of resurrections from the dead,—and even of ascensions into heaven, were not unknown to the ancient New Zealander. From them we may learn not a little of their (supposed) skill and belief in controlling and commanding the higher powers of Nature; and all this, too, both quietly and unostentatiously done and related without a single extra remark of the wonderful, or a note of admiration! And from them we shall also learn a good deal of their prayers (?), charms, spells, exorcisms, adjurations, and religious ceremonies—of their great simplicity and (may I not add?) utter uselessness. Or, rather, perhaps, not quite "utter uselessness" in one sense at least, for they, no doubt, felt strengthened in their belief, that, having followed closely in the footsteps of their forefathers, having done all that was required, they should certainly reap a corresponding benefit. And this belief would naturally re-act upon them, and stimulate them to continuous and future exertions to bring about the same, and thus would prove beneficial. In all those charms, spells, etc., we shall find (if I mistake not), *three* things, like three golden threads, always running through them; viz., (1) their firm belief in their knowledge

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* "Essay on the Maori Races," "Trans. N. Z. Inst.," Vol. I., § 29 of Essay.

and use of the powers of Nature; (2) their relying on their own strength and ability as able men; and (3) their often invoking their deceased ancestors to help them in times of great need; or, more frequently, encouraging themselves, at such times, with the bare recital or recollection of their ancestors' names* and prowess.

Now all this strong and common, yet (if I may so term it) quiescent belief in the supernatural or miraculous, in my opinion forms a very peculiar and characteristic trait in the old New Zealander. (I know, of course, of those miracles related in the Old Testament, and that, too, generally, in like simple manner, without note or comment). No doubt all ancient nations felt more or less the influence of the Divine in Nature, or of the power of Nature; but as they knew her but imperfectly, all remarkable or unusual phenomena appeared to them as manifestations of supernatural powers, divine or demoniac (as the case might be), or as miracles, which, while they inspired some peoples with awe, did not so act on the minds of the ancient Maori. Not but that they had plenty of signs and wonders, akin to the Roman fictions of *prodigia* and *portenta*,† which served to announce important events; but, while they saw and observed, talked of and magnified them, they never feared them; rather ridiculed them, or treated them lightly; and even when all things turned out well and satisfactory, and in keeping with their belief in, or expectations from, those higher powers, no such thing as thanksgiving to them was ever dreamt of!

Moreover, it should also be briefly noticed, that while they laughed and mocked at earthquakes, at pealing thunder, at vivid lightnings, and at terrific storms, they exhibited great dread at merely unexpectedly seeing a small, common, and harmless lizard; at a gaseous flame suddenly shooting forth, with crackling noise, from their private fire towards them; and at a big spark bouncing therefrom in a similar direction! etc., etc.

The subject of my paper this evening will be some of the doings (and their consequences) of a powerful chief, named Uenuku,‡ who dwelt here on the East Coast of New Zealand, between Table and East Capes, about twenty-five generations back,§ or (say) A.D. 1000,—time of our Danish

* See "Paikea's Spell," in the Story of Ruatapu and Paikea. *(infra.)*

† Livy, III., 10: XLIII., etc.; Lucan, Phars., I.; Pliny, H.N., II., VIII., XVI., etc; Plutarch, Cæs., 63.

‡ There were several chiefs and personages of ancient days named Uenuku; some of them bearing an additional suffix to distinguish them. One is said to have dwelt at "Hawaiki" before the so-called migration hither. (See Grey's "*Polynesian Mythology*," p., 123, etc.) Uenuku is, also, a name for the rainbow.

§ One of the genealogies gives twenty-eight generations, (viz., three additional names). This may be owing to an early branch, commencing with the son of another wife. (See Appendix, Genealogy).

kings. His descendants are still residing there, who, also, rest their claims to their ancestral estates through their being such. The beginning, however, of their genealogical line goes much further back.

I may also add that this remarkable traditional story I have received in *two* separate narrations from two sources; and, further, that they wonderfully agree in all their main points, including, also, the charms, spells, and prayers (?) used.

## I. Stories concerning Uenuku.

Uenuku was a very great chief of the olden time; he lived many generations back on the East Coast. One of his wives was named Takarita; she was the sister of a great chief named Tawheta, who dwelt at large towns (*pas*) of his own, called Matikotai and Porangahau,* also on the East Coast.

I shall begin my narration with the death of Takarita, the wife of Uenuku, who was killed by him because of her great offence; she having committed adultery with two men, named Tumahunuku, and Tumahurangi. Uenuku, being very powerful, not only killed her, but also her two paramours. When she was dead, Uenuku cut her open and took out her heart, and broiled it on a sacred fire, made at the foot of the carved centre-post of his own big house; the name of that house was Te-pokinga-o-te-rangi—the overspreading of the sky. While it was cooking at the sacred fire, kindled purposely for the solitary bit, namely, at the fire of Takarita, Uenuku recited the following spell:—

1. My fire is newly kindled by friction;
2. The land approves of it (*or* desires it);
3. Let a fire burn to eat up (a) great chief;
4. Let a fire burn to eat up (a) first-born;
5. Let a fire burn to eat up (a) principal chief (*ariki*);
6. Let a fire burn to eat up (a) priest (*tohunga*);
7. Let (it) burn;—but, by whom is the fire?
8. Let (it) burn; it is (by) Hineikukutirangi;
9. Let (it) burn; it is (by) Hineheheirangi.
10. Let (it) burn, (throughout) two long considerations of the close-quarter-fighting of the Sky.
11. Let (it) burn;—on, on, onwards!
12. My sacred fire is verily kindled by friction.
13. Above, abroad, (*or*, on the outside), towards the west;
14. Towards the west; a vengeful desolating principal chief.
15. Never shall the great chiefs be forgotten by me; never!
16. Never shall the firstborns be forgotten by me;
17. (An) eater of scraps and leavings!
18. The cooking-oven is baking slowly.
19. (I am) roasting away; naked, waiting!

* Not, however, the present Porangahau, but a place of the same name north of Table Cape.

20. The cooking-oven is baking badly;
21. Go on, bake away the baking-oven!
22. The oven baking above!
23. The oven baking below!
24. Rush to the fight, O Space!
25. Rush to the fight, O Sky!
26. Show forth (thy) valour;
27. Show forth (thy) valour (*or*, let it be seen);
28. Return from the charge—return;
29. Cause (it) to return.—It is ended.*

His spell finished, he fed his own son Ira with the cooked heart of his mother. Hence arose the proverb,—"Ira, devourer of the rich soft interior,"† And that same saying has descended to his offspring, namely, the tribe of Ngati Ira.

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* A few explanatory remarks on this spell are here offered:—

v. 1 & 12. All sacred fires were necessarily *fresh* kindled, and that by fire then and there obtained by friction.

,, 2. Meaning, in accordance with national customs and observances.

,, 3-6. Showing the high rank of the deceased lady.

,, 8, 9. By (*or* according to,—in conformity with), Hineikukutirangi, etc. These female personages were great ones of old; Hineikukutirangi was often invocated on their going to the deep-sea-fishing. This name means the young-lady-who-drew-the-heavens- (*or* skies, *or* clouds) together, (? to prevent the storms and squalls from bursting forth): see the charm recited over Rongoua (p. 11), line 6, and note thereon; where, I think, these two personages are also alluded to: see, also, a similar sacrifice made by Uenuku (p. 15), and note the like names of his two mysterious ceremonial garments.

,, 10, 24-29. Celestial signs, of warring clouds, etc., are here referred to, as finally denoting approval. See *Notes* 2 and 4 to Paikea's spell (p. 21).

,, 13, 14. "Towards the west,"—the quarter of the setting sun, and of death, etc. See Essay on the Maori Races, "Trans. N. Z. Inst.," Vol. I., § 39.

,, 15, 16. Indicating his being a strenuous upholder of their ancient traditions, customs, etc.

,, 17. As said by the hero Whakatau,—War-song, 3, p. 68, "Trans. N. Z. Inst.," Vol. XIII.,—and always meaning the *opposite*.

,, 22, 23. May mean oneness of action; *i.e.* what I am doing here on earth is also now being done in the sky.

† The word used here is a curious and uncommon one, especially in this sense, and, as such, it is almost obsolete. Primarily it denotes the soft, prized, central parts of the Maori gourd *(hue)*, of a water-melon, etc., though it has several other allied root-meanings.

When the news of her death first reached her brothers, they mourned greatly over their sister. Afterwards, Tawheta proceeded formally to enquire the particulars of the relater (of the tidings),*—"Why she was killed by him, Uenuku?" He replied, "Because she had committed adultery with two men, Tumahunuku and Tumahurangi." Then Tawheta said, "It is all right enough, no doubt, (according to his way of thinking); nevertheless, his doings shall be repaid him to-morrow. Verily, to-morrow he himself shall be eaten by grass-hoppers! Here, near me, are his food preserves, which will be sure to draw his children and people this way, in the season; to-morrow, also, he shall be full of trouble, when he shall desire the little bit of property that is lying on the ground;† the women shall be as a cliff for the men to flee over!" And so this last word (or phrase) became a proverbial saying; and for a long time Tawheta dwelt quietly, brooding over his anger.

Now Uenuku did not think at all of his cruel killing *(kohuru)*, or of the possible consequences. Another year came round, and Uenuku had forgotten all about his murder. So he sent his children and people to obtain the fruit (*or* product) of his preserves at Matikotai, and at Porangahau. They went, a large number, both men and women, 70 in all;‡ and on their arrival at Tawheta's town *(pa)*, he took them unawares and killed them, they being all unarmed and unapprehensive. Hence arose the deadly feud between Uenuku and Tawheta. Four of Uenuku's sons were slain on this occasion, namely, Maputukiterangi, Ropanui, Mahinaiteata, and Whiwhingaiterangi, while the fifth, named Rongouaroa, hardly escaped with his life, being the only survivor of the whole party. He, however, had been severely wounded; his skull was hacked and broken in, and he was left for dead by the foe, on the ground among the others. Tawheta and his people,

* Heralds, or messengers, on such high occasions, acted in a very careful and formal ceremonious manner, and only (at first) answered the questions put to them by the chief of the place. Instances have been known where they have been severely beaten, and wounded, and even killed! at the first outbursts of grief and passion, for their sudden and abrupt relation of bad tidings. Hence, such news was almost invariably carried by a relative or a chief.

† By "the property *(taonga)* lying on the ground," I understand the fruits of the *karaka* trees, which were rigidly preserved, and were gathered up in large quantities to be stored or food in the late autumn season. (See "Trans. N. Z. Inst.," Vol. XIII., p. 25, last paragraph). The close of Tawheta's passionate sentence may have reference to his slain sister, *or* to the women who would be sure to come thither in the *karaka* gathering party. At all events, the meaning is,—a full, stern, and dreadful revenge!

‡ "70" *(passim)* always means a large and fully complete number for that particular purpose; sometimes, when a very large number was required, it would be twice 70=140; and, also, 170; but always so as to take in the 7 unit.

after their cruel slaughter, went into their *pa* to eat their food; it was then that Rongouaroa came to himself, and opening his eyes and looking around, he saw his brothers and companions all dead on the ground; on seeing this he summoned all his remaining strength, and crawled away and hid himself among some thick bushes close by. While there, he heard them (Tawheta and his people) vaunting loudly over their doings, and Tawheta said, "To-morrow, early, we will all go to Uenuku's *pa;* we will deceive him, and kill him, too, that he and his may all die together." Their meal and talk over, they all came out to drag the bodies of the slain into the town *(pa)*, to cut them up (for food). When it was night, Rongouaroa crept out of his hiding-place and crawled into one of their large canoes, and stowed himself snugly away in the forehold (under the nose of the canoe); and this was his charm which he uttered for his safe concealment:—

> "Tu! overspread the face of the sky, that (I) may be hidden; let their eyes be dazzled (*or* flash waveringly) in looking at the stars, and at the moon, and at the light."

And so, sure enough, he was hidden securely; and he, having uttered his charm, laid himself quietly down.*

Early in the morning the cajoling party was on the move, to go and kill Uenuku. They quickly put their things into their canoes, and paddled away, with vigour, to Uenuku's town *(pa)*. Arriving there, they hastened to disembark and to drag up their canoes on the beach, when they all proceeded quietly into Uenuku's *pa*, amid the wavings, and shouts, and cries of welcome of Uenuku's people,—"Come hither, come hither, O ye most welcome stranger-visitors!" And so the visiting party went into the *pa*, and entered the big reception house of the chief and sat down. The people of the place were now all very busy in preparing a plentiful meal for their unexpected visitors; the cooking-fires and ovens were everywhere lighted, and great preparations were being made, for Uenuku and his people supposed them to have come with good intentions only, and, therefore, they were most welcome; but it was not so, as it soon appeared, for they had come to murder Uenuku, and also to eat him, which they had thought to bring to pass through their deceit. While the food was preparing, Uenuku arose, in the large open space before the house, to address his visitors; and thus he began: "Come hither, welcome hither; art thou indeed Tawheta?"†

* "Quietly down:"—Notice here the very great influence of Rongoua's firm faith in his simple charm! (See the story of Houmea, *(infra)*, p. 26). It was a desperate step to take, but his only possible chance of saving his people from destruction.

† Uenuku saying, "Art thou," etc., meaning, Is it possible that Tawheta is come *at last* to see *me!* Tawheta, in reply, saying, "Thou thyself!" meaning, Thou alone by thy conduct wert the cause of our being so long estranged from each other.

which Tawheta interrupted (from within) by exclaiming, "Thou thyself! thou thyself!" Then Uenuku said, "Welcome hither! Dids't thou come hither from our children and young people (leaving them well)?" To this, Tawheta replied,—"They are all there enjoying themselves at their usual games of play; spinning tops, flying kites, making cats' cradles, darting reeds, and all manner of games."*

Now it came to pass that, when all those visitors had entered the *pa*, the wounded man, Rongouaroa, had managed, though with great difficulty, to get out of the canoe in which he had been hidden, and to crawl a little way on to a bush of cutting-grass, where he lay down in the sun. Now the food for the visitors having been deposited in the ovens, and covered over with stones and earth to be cooked, the women engaged therein went outside to gather green leaves of shrubs and flax *(Phormium)* and sedges, on which to place the food when cooked for their visitors; and so they got to the place where Rongouaroa was lying with his smashed head! On seeing him, and hearing in a few faint words his tale, they soon went back to the *pa*, and calling Uenuku aside, told him, "Master! master! it is all a false story (*or* supposition); they are come hither with a different design. The whole of our people have been killed by Tawheta; one only escaped, Rongouaroa! They are come to cajole and destroy thee!" On hearing this, Uenuku demanded, "Where is that survivor?" "Oh! there he is, lying down outside on the tuft of cutting-grass *(toetoe)*, with his head all broken and smashed with a club!" Then Uenuku said, "Fetch him, lead him hither into the *pa*." So he was fetched; but, first of all, he was led to the sacred place *(tuaahu)* close by, where the charms, and recitals, and all proper sacred ceremonies were performed over him, including the feeding the demon with his blood, and the hanging-up of his blood in that spot; and this was the charm which was recited for him:—

1. Provoking irascible sinew, striving (to) kill!
2. Hither is come the one (they) sought to murder.
3. Verily thy own skilful priests (are here):
4. Thou and I together indeed! (as one).
5. Thy wound is sacred;—
6. The celebrated first-born priestesses shall cause the lips of the wounds to incline inwardly towards each other;
7. Of (*or* by) the evening, lo! thy wound shall become as nothing!
8. The stone axe (which caused it) was verily (as) the strong tide rushing on to the shores, and tearing up the beds of shell-fish.
9. Striving, provoking sinew! eager after food for (their) baking

* This second interjected reply of Tawheta (who was still within the house, and who, according to etiquette, had no need then to speak), was, I think, mainly made to amuse his own party there with him.

10. The wounding, indeed, of the man who courageously enraged the demon!
11. Thy internal parts are all opened to view!
12. Verily, just as the stirring up of the big fire burning in the court-yard of a *pa!*
13. But, lo! thou and I together (are as one).*

This done, Rongouaroa was taken into the *pa;* that he might be shown publicly to Tawheta and his party.† Now Uenuku had returned to his oratory, keeping his son, Rongouaroa, out of sight, on one side behind his back; the visiting party (according to strict custom) being all within the big house, while the chief of the *pa*, Uenuku, was outside making his speech to them; moreover, they were tired with their paddling and wanted their morning's meal; and thus Uenuku recommenced his address:—"Come hither, come hither; thou art indeed Tawheta; yes, thou thyself (come at last to see me). Thou art indeed come hither from our children; but are they living, or are they *dead?* ‡ On hearing this, Tawheta bounded out from within the house, and said, "And who indeed is that demon from the sky who is able to kill our children?" Then it was that Uenuku said to Tawheta, "Our children are slain, killed by thee! behold, here is the only survivor!;" at the same time bringing forward Rongouaroa, and making him to stand in the open space before the door of the house, so that he might be fully seen by all those within it. On hearing those words of Uenuku, and seeing Rongouaroa, the whole party were seized with panic fear, and would have instantly fled, or have endeavoured to do so,—and at this time they could all have been very easily slain by Uenuku, but it was owing to his noble disposition that they were not. So he kept them until the food for

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* Of this charm, verses 4 and 13 are used to infuse hope and strength, and to assure the unity of the powerful and the weak. (See Paikea's spell, *(infra)* v. 5.) v. 6 no doubt refers to the two female personages mentioned before in Uenuku's spell, *(supra,)* vv. 8 and 9—see note there; v. 8 is a beautiful and strongly expressive metaphor tersely given in the original; v. 10 the "demon,"=*atua*, foe; vv. 11, 12, "internal parts,"—*i.e.* inner parts of the head; a severely fractured skull was common in the desperate hand-to-hand fights and massacres of old, where heavy clubs and stone axes were the weapons, and not unfrequently the sufferer recovered. (See Proverbs 155, 156, "Trans. N. Z. Inst.," Vol. XII., p. 137.

† There could be no fear, on the part of Uenuku, that Tawheta, or any of his party, would come out of the reception house while he was absent, as such would be against all custom, etc.

‡ "Are they living, or are they *dead?*" Note here the *last* word! This Tawheta well understood, although he could only then have supposed that Uenuku entertained a suspicion of something evil,—as from a dream, warning, omen, etc.; for, according to correct Maori idiom and syntax, that saying of Uenuku should have been reversed (if spoken at all?)—"are they dead, or are they living?"—which would have had a very different meaning, and Tawheta would have remained quietly in the house of reception. Hence, Tawheta broke the rules of etiquette, and bounded forth boldly to meet the implied and concealed charge against him.

them was cooked and properly served up and eaten, and then they might depart, saying to them, "Do not fear anything; remain quietly; let the food which has been purposely prepared for you be well and properly cooked and served; then eat it and depart." Therefore they did so; and when their meal was over, they left the *pa* in silence, and dragged down their canoes to the sea. While doing this, Uenuku's people were again very desirous to fall upon them and kill them, but Uenuku restrained them, and so they escaped without harm.* As, however, they were leaving the shore, Uenuku called out to Tawheta,—"Depart peaceably, O Tawheta! ere long, I, also, shall go thither to our children; thou art not a warrior, but an evil-doer." (*Lit.* Thou slayest not (thy foe) openly and manfully, but evilly and fraudulently). To this Tawheta replied,—"By what possible means indeed cans't thou venture to go thither; to the home of the many, of the multitude, of the numberless?"† On hearing this, Uenuku rejoined,—"Go away, depart; soon I shall be going thither; thou wilt not escape me; to-morrow thou shalt be devoured by grass-hoppers! thy bravery in battle is slippery; go away, depart!" These were the last parting words of Uenuku, and Tawheta and his party returned to their own place.

After this, Uenuku stirred up all his people to get ready his fighting canoes; so they were all newly caulked, and put together in order, and got ready, and launched to go to war. Then it was that one of his brave fighting

* This highly chivalrous (?) conduct,—or, rather, the noble trait in their character, never to allow the open public rites of hospitality to be infringed, (Uenuku, too, having loudly welcomed them into his village, or fort),—was sometimes strikingly exhibited. The Rev. S. Marsden, of Paramatta, informed me (in 1834) of a notable instance which had taken place while some head New Zealand chiefs were staying there at his house. It happened that two of them had come to Sydney by different ships, one was from the Thames, and one from the Bay of Islands,—two tribes who were then at deadly feud in their own country, and so it would have been between those two chiefs on their suddenly and unexpectedly meeting there; but the one said to the other,—"Here, thou and I will dwell quietly, and eat, every day, at the same table together; but when we return to New Zealand I will attack thy fort, and will kill and eat thee:" and all this was carried out to the very letter. It was from the utter want of this feeling on the part of the British (in the Maori estimation), that the early colonists were so greatly twitted by the Maoris during the war of 1860-6; notably by the chief Renata Te Kawepo, in his upbraiding letter to the first Superintendent of the Province of Hawke's Bay. (See, also, "Essay on the Maori Races," "Trans. N.Z. Inst.," Vol. I., § 34, end.

† This sentence deserves to be more particularly noticed:—"Ki te kaainga o tini, o te mano o te rororo, o tini o te hakuturi:" *lit.* to the dwelling place of (the) many, of the numberless of the ants, of (the) multitude of the imps (elves, or fairies). A curious figurative sentence, not however uncommon nor untruthful in the olden time, showing the very great number of his people. (See *Houmea*, *(infra)*, p. 27, and note there). The same simile of *ants*, to express a great number, is also used by the Greek and Roman poets: "THEOC. ID. XV., 45. VIRG. ÆN. IV., 402.

men, a chief named Whatiua, got up and made an oration against Uenuku going at once by sea to fight, saying,—" This is my opinion, first let the *kumara* and the *karaka* be ripe,* then do thou go by sea; but I and my party will go at once by land; we (my party) will first engage the enemy, and break off the tips of the branchlets of (the revenge for) our sad loss; to-morrow morning we will start." They did so; and as they were leaving the *pa*, Uenuku called out to them,—" Listen, friends; this is my word to you, if you succeed in capturing Poumatangatanga,† let her live, to become a wife for me." So the war-party, 70 in number, left on their march. They went away inland up over the high hills and kept on until night-fall, when they halted and slept; ‡ at break of day they recommenced their march, and again halted at night as before to sleep; the third morning, at daybreak, they resumed their march, and kept on until they came within sight of Rangikapiti, when they again halted until it was dark. In the night they went stealthily forward and surrounded the big house of that place; the people there kept watch also by night but badly. On there arrival there they found that the demon *(atua)* had joined with the people in the house, and that the priest *(tohunga)*, whose name was Hapopo, was encouraging his people by his questioning the demon as to the expected war-party, and they on the outside overheard their conversation going on between them. Hapopo, the priest, said to the demon,—" Speak, tell me, is the war-party at hand? for we are here dwelling in great fear, not daring to sleep soundly at night." The demon, whose name was Te Kanawa, replied to him,—" No, there is no war-party near; nothing of the kind; let us dwell together quietly, even as the ancient ones are, there far off away up in the sky."§ Those were the words spoken by the demon through the medium, whose name was Kahurangi. Hapopo, however, again asked, stirring (him) up, saying,—" Tell me, sir, is not the war-party at hand?" When (he) again replied, " Not a single bit of a war-party, respected sir; no fighting whatever, great sir, will come hither against you; rest quietly."|| All this conversation between those

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* That is, in the autumn, when the sea would be calm.

† Tawheta's daughter: a common practice. (See Vol. XIII., " Trans. N.Z. Inst.," p. 40.

‡ War-parties by land generally went forth by untrodden paths, forming a trail of their own, and often a circuitous one; their object being always to reach the place they were going to attack without being perceived, or even suspected, and to carefully avoid treading on, or walking over, a *kumara* root ceremonially deposited *in the common path.* (See below, Art II., " Contributions towards a better Knowledge of the Maori Race,' part IV., *Kumara*).

§ As the gods were (according to the ancient Greek mythology) up on Olympus.

|| I have studied to mark the great difference in the modes of address between the priest and the demon. (See, also, between Uenuku and his son Ruatapu, p. 18):—a matter much too little attended to in translations.

two, the demon and the priest, was overheard by the armed war-party, who were outside listening. Early in the morning, at break of day, they assaulted and rushed the big house from all sides. Great was the slaughter of Tawheta's people, he, however, escaped from within the big house; they pursued him, but he got clear off; whence arose this proverbial saying,—"Through flight only was Tawheta saved." The priest, Hapopo, they dragged outside, and they killed him there; his last word was, "Lying and deceiving demon! thou gettest clear off, leaving the trouble with Hapopo." Those words have ever since been used and handed down as a proverb. Paimahutanga* (Tawheta's daughter) was the only one whom Whatiua's band made prisoner and rescued from that great slaughter. The victors baked the slain in ovens, and feasted on them; some portions of their bodies were also carried away with them to their own *pa*. Thus was fully avenged the death of Maputukiterangi, of Mahinaiteata, of Ropanui, of Whiwhingaiterangi, of Rongouaroa, of Hotukura, of Inangatapukitewhao, of Rangiwhetu, and their companions, in that sad massacre by Tawheta. Those whose names are here given were all chiefs who fell on that occasion. On the return of that war-party to their home they handed over to Uenuku the daughter of Tawheta, Paimahutanga, to become his wife, and Uenuku took her to wife. And so this first assault and carnage ends here; this exterminating slaughter was accomplished by Whatiuatakamarae.†

After this was over, Uenuku, still thirsting for revenge for his many murdered children and people, commanded a war expedition to be got ready, that he might himself go and fight with Tawheta. So the warriors got themselves ready; the war canoes were dragged down and fitted up and launched, when Uenuku ordered that each canoe should also be provided with extra large stones (as anchors) and long ropes; and when this was also done, and all were ready, they set forth. On this occasion Uenuku took with him two celebrated garments of his ancestor Tumatauenga,‡ in order to become a defensive armour for him, that is for Uenuku; those famed garments were named Te Rangituitui and Te Rangikahupapa,§ and they

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* Notice, here, the change of her name, according to custom; and, at the same time, a play upon her former one as to its sound; her new name being also one of good omen,—*lit.* good-healing-of-the-sore, *or* wound.

† Here is also an addition made to the name of the leader of that band,—*lit.* prepared (*or* brought to pass) in the meeting in the open court,—which may have taken its origin from the prudent counsel he had given to Uenuku, which was also adopted, and led to victory.

‡ See "Contributions towards a better Knowledge of the Maori Race;" Part IV.,—Legends concerning the *Kumara* Plant—Art. II. *(infra)*.

§ *Lit.* the Sky-stitched (together), and the Sky-joined, *or* banded, *or* rafted (together); and, viewing the Sky as a *personage*, this may be taken in an *active* sense. See, also, Uenuku's first charm, vv. 10, 24-29 (*supra*).

had ever been taken great care of by the grandson* of Tumatauenga, Uenuku. The war expedition paddled away until they came to Matikotai and Porangahau, where was Tawheta's fort, or war *pa;* there, at Uenuku's command, all the canoes anchored just outside the swell of the waves, each being provided with stone anchors and long ropes for that purpose; this done they paddled in towards the shore. Then it was that Tawheta and his people, who were there assembled in great numbers, rushed down to meet Uenuku's party, and even waded out into the sea to fight them, and to oppose their landing! when Putuakiterangi, one of Tawheta's braves, was seized by Uenuku's party, dragged into the canoe and carried off! Uenuku giving the order to draw all the canoes outside by their long ropes. There, according to custom, they killed their *first* prisoner, cut him open, and tore out his heart; † then they made a sacred fire by friction, and when it was fully blazing they roasted the heart on the fire, and when it was cooked, they covered over both the heart and the sacred fire with the two garments already mentioned,—Te Rangituitui and Te Rangikahupapa. Then it was that Uenuku, standing up in his canoe, called on the mist from the summits of (the mountain) Tirikawa, saying, "Attend! fall down and encompass; fall down and cover up!" When, lo! it suddenly became very dark indeed, and the stars were seen in the sky. Uenuku and his people listened, and lo! Tawheta and his people were heard fighting among themselves in the darkness, and killing each other! the curses and the groans were heard, also the hollow blows on each other's heads from their clubs; not one of them, however, was struck by Uenuku's party, who were still in their canoes; they did it all themselves. After

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* The word *mokopuna* may mean, great great grandson, etc., or lineal descendant.

† A very similar proceeding to the first sacrifice, mentioned in the beginning of this story, only with different ceremonies. This custom was of universal application among the New Zealanders; hence, in war, it was of great importance (on either side) to seize the first prisoner for this purpose. Uenuku seems to have laid his plan well, by anchoring his canoes in the way he did, to bring the desired end so readily to pass. The student of Ancient History will know how extensively this custom was practised, both in the Old World and New (Mexico); the two things seem generally to have gone together,—the bloody offering (or *the life*), and the offering by fire; blood being, at all times and in every zone, supposed to be fitted to appease the gods! Sir Walter Scott has well worked upon this ancient belief in his poem of "The Lady of the Lake," Canto V.,—the combat between FitzJames and Roderick Dhu,—

> ———"Which spills the foremost foeman's life,
> That party conquers in the strife."

It is even said, that the Highlanders under Montrose were so deeply imbued with this notion, that, on the morning of the battle of Tippermoor, they murdered a defenceless herdsman, whom they found in the fields, merely to secure an advantage of so much consequence to their party.

some time, Uenuku again called on his preternatural power *(atua)*, the mist on the mountain—that is, to the mist on Tirikawa, saying: "Clear up!" And lo! it was all clear and bright day. Then the war party looked out from their canoes, and found that many of Tawheta's people were still alive. On this Uenuku again commanded the mist on Tirikawa, saying: "Fall on! cover up!" when, as before, it was again as dark as night, and Tawheta's people began afresh to fight and slay each other with greater fury than before. By-and-bye Uenuku again called on the mist, saying: "The mist of Tirikawa, break up, clear up, instantly!" And lo! it was again clear daylight. Then Uenuku, thinking they had destroyed each other, pulled off the garments from the roasted heart and sacred fire, and lo! on looking at the sea they saw it was covered with floating corpses and red with the blood of the many slain; deeply red all around them with blood! Three times did Uenuku call on his demons, before that his foes were destroyed. Then Uenuku and his party paddled their canoes to the shore, and landing, killed the few survivors whom they found there on the beach. Tawheta, however, and his remaining men, rallied, and came on, and renewed the fight, which was desperately taken up by Uenuku and his party, by whom Tawheta himself was also killed; but the great multitude of his people died by their own hands, and not by Uenuku's party. The fighting in the sea was named, "The lengthened day;" "the day (of) two sunsets;" and, again, because of the great amount of the blood of man in the sea, it was also called, "The sea of loathsome water;" and the name given to the last battle on land, in which Tawheta was slain, was, "The rising tide." These were the bloody battles of Uenuku; these were the desolations of Uenuku. The victors cooked and cooked human flesh day after day, and all day, but they could not cook all the food, so it was left and wasted because it became rotten. Here ends the relation of those fightings of Uenuku the man-eater; the evil murders of his children, however, were all sorely and fully avenged. Uenuku having taken Paimahutanga to wife, she bore him a son, whose name was Ruatapu, whose doings shall now also be narrated.

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## II. The Story of Ruatapu and Paikea.

Many years after those fightings Uenuku got a large canoe made; Haeora was the name of the skilful man who made it; and Te Huripureiata was the name of that canoe. When the canoe was built and finished, it was painted red, and fully ornamented with pigeon's feathers, and all its many adornments. All this took a long time. Then it was that Uenuku ordered his sons, and the sons of other chiefs, to assemble, in order that the hair of their heads might be combed and anointed and neatly tied up in a knot on the crown, and ornamented with a high dress comb stuck in behind (worn only by chiefs), so as to be regular and look beautiful,* that they might all go together and paddle the new canoe out on the sea. Uenuku himself performed this work of preparing and dressing and tying-up their hair.† Those young men were 70 in number, all told, and Uenuku finished with Kahutiaterangi. All the 70 were fine able young men; there was not a boy among them. When all were done, Ruatapu called out to his father,—"O, honoured sir, see! tie up and dress my hair also." Uenuku replied to Ruatapu,—"Wherever shall a dress-comb be found for thy hair?" Ruatapu rejoined,—"Why not use one of those combs there by thee?" Then Uenuku said,—"Why dost thou not ornament thy hair with one of the combs of thy elder brothers?" On hearing that, Ruatapu cried out,—"O noble sir, O noble sir, I was supposing that I was indeed thine own (son)! but now I perceive that I am not thine!" Then his father said to him,—"O, sir,‡ thou art indeed verily my own (son); but a son of little consequence, an offspring of inferior birth:" (meaning, that his mother was of no rank, being only a slave saved alive in war).§ At this saying of

* Plenty of patterns of their hair so adorned are given in the plates of Cook's "Voyages," and in Parkinson's "Journal,"—*passim.* (See *Proverb*, No. 130, "Trans. N. Z. Inst.," Vol. XII., p. 133). When their heads were thus dressed they did not lay them down on pillows of any kind for several nights, lest they should disarrange them, but managed accordingly. This curious practice was also largely followed by other Polynesians. So in Africa, and, also, very anciently in Europe. (See Keller's "Lake Dwellings of Switzerland," pp. 175, 501, 565).

† This ceremony was always performed by a chief of rank, or by a priest *(tohunga)*; Uenuku was both; the head being pre-eminently sacred *(tapu)*, and never to be touched save by a *tapu* person.

‡ I have sought to keep up in a translation the great difference in the modes of address here used between the father and the son; (see, also, p. 14, and the note there).

§ In this dialogue three things are to be noticed: 1. Uenuku's quiet way of giving a gentle hint to his son, which tends to show that hitherto, throughout childhood and youth, no such great distinction had yet been made. 2. Ruatapu ought to have understood his father's meaning (see a similar mode of speaking, "Trans. N.Z. Inst.," Vol. XIII., p. 42, and note there); he knew, as well as his father, that he could not possibly use one of his elder brothers' combs, as all were *tapu*, and each one strictly confined to its owner's own private use. 3. Uenuku's last words were very bitter and galling to the young man, and, no doubt, were spoken openly before all; and as they were spoken in highly figurative language I give them here in the original, with a strictly literal translation and full explanation:—"Ehika, naku tonu koe; he tama meamea koe nahaku; he moenga rau-kawakawa, he moenga hau!" *lit.* "O, sir, thou art indeed my own (son); thou art a son of inferior rank begotten by me; a begetting—*or* sleeping, *or* cohabiting,—(among) the leaves and branches of the strong-smelling kawakawa shrub,—a begetting, etc.—out of doors in the high wind." The strong smell of the kawakawa *(Piper excelsum)* was particularly unpleasant to the New Zealanders; the whole also meaning, that Uenuku's taking Ruatapu's mother to wife was done without any festivities,—without any gifts of fine-woven mats for bedding,—and without a bride's house and other formalities. (See "Trans. N.Z. Inst.," Vol. XIII., p. 45, bottom).

Uenuku, Ruatapu was completely overcome with shame, and his whole heart was filled with grief and pain, and, loudly lamenting, he went away to the place where the canoe was, planning in his mind how he should best accomplish the murder of Uenuku's favourite sons, his elder brothers. He soon hit upon a plan; he got a stone chisel and he worked away with it at the bottom of the new canoe, until he had cut a hole through, which, when done, he plugged up and hid with wooden chips and scrapings, so that it should not be seen. Then he went back into the town, but he would not eat any food, for his heart was still deeply grieved at the lowering words which his father had used respecting him. The next morning early Ruatapu went and aroused and brought together the men of the place to drag the new canoe down to the sea. They all came and she was soon afloat, and then those young chiefs, 70 in number, who had been already prepared for that duty, entered on board of the canoe, he himself taking care that no boys* embarked with them, for some who came to do so he returned to their home. The canoe being well-manned with smart paddlers, and all being ready, away they paddled; Ruatapu himself going with them, seating himself in his own place on board, and keeping the heel of his foot firmly fixed on the hole which he had bored in her bottom. They paddled a very long way out to sea, when Ruatapu removed his foot from the hole, and the water rushed in. On seeing the water in the bottom of the canoe they cried out, "We shall be upset! turn her round to the shore!" but Ruatapu again fixing his heel on the hole, and also baling out the water, the canoe was soon free from it. They still paddled away further out, when some said, "Let us now return, for we have paddled to a very great distance." On hearing this, Ruatapu answered, "We will soon return; let us first go a little further out." So away they paddled, until they had got quite out of sight of land; then he again removed his heel from the hole, and the water rushed in! All immediately called out, "Where is the baler? hasten; bale out the water; we are lost!" But Ruatapu had hidden the baler; and soon the canoe was filled with water, and was upset.† Then Ruatapu made after his brothers, and quickly drowned several of them by plunging them under. Having done so, and seeing Paikea still swimming, he followed hard after him to drown him also; but Paikea repeatedly evaded him. At last Ruatapu said to Paikea, "Which of us two shall carry the tidings of our disaster to land?" And Paikea replied, "I will, for I can do it; for I am also a son of (*or* descended from) the sea." And this was both the reason of his so saying and of his escaping drowning,—Paikea being descended from Rongomaitahanui, who was also descended from Te Petipeti, and Te

* The word may mean—younger sons.

† See proverb, No. 181, "Trans. N.Z. Inst.," Vol. XII., p. 140.

Rangahua. Then Ruatapu cried out, "Go thou, swim away to land; and note well, if I am lost here, then thou wilt surely know that I am not descended from our father; but if I escape from this calamity, then, verily, I am from our father. Go thou on; let the crowded parties of the summer season ever remember me, that I am also there, (I) shall not be hidden. When the squid and the jelly-fishes shall have reached the sandy beaches (in the summer season), then look out, I am but a little way behind them, going also towards the shore. Go on, swim away, proceed thou to the land; those who should be the survivors from this wreck (are) become as a pile of slain in a day of bloody battle. This is another word of mine to thee, Let Kahutuanui have the striking-up of the song, so that when (ye), the ample broad-chested, may be sitting closely together in a row by the side of the fire,* it shall be sung in parts,—in fruitful seasons and in unfruitful ones,—at the times of assembling together in companies, and at the times of living separately (in families); through this I shall be ever remembered." Then Paikea said, "The tidings of our calamity shall be safely carried by me to our town, for I am verily descended from (those of) the sea,—Te Petipeti, Te Rangahua, and Te Aihumoana† being my ancestors." Here Ruatapu gave his last parting words to Paikea, "Go on, swim away to land, to the dear old home!" and so saying he held up his paddle.‡ So Paikea proceeded on, swimming towards land, reciting as he went his powerful spell; and this was it:—

1. "Now shall be shown, now revealed, the vigour of the trembling heart; now shall be known the force of the anxious heart; now shall be seen the strength of the fluttering weak female heart.[1]

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* For the common regular diversons of the evening, when the fires were lighted in their large houses.

† Paikea has now twice firmly asserted his descent from (beings of) the sea,—and he is not the first of the ancient Maori heroes who has done so. Of those four names of his ancestors here given by him, all are found in the Genealogical Roll (appended); but the first (Rongomaitahanui) and the last (Te Aihumoana) are, also, mythically known as ancient sea-demons *(atua)*, and, so far, pre-historical. Paikea is also the proper name of a species of whale. I saw one about 34 years ago, which had been driven on shore here in Hawke's Bay in a severe gale; it was very long, with a sharpish snout, and its white belly was regularly and closely longitudinally fluted throughout. Its appearance reminded me strongly of the plate of *Balæna boops* in Rees' Cyclopædia.

‡ There is a meaning here in this action of Ruatapu which should not be overlooked. To retain one's paddle (which was often highly carved and ornamented), in upsettings of canoes and in naval fights, was always an achievement, and a token of bravery, etc. Just as that of a young Spartan to retain his shield, or, in modern times, the colours, arms, etc.

[1] The very opposite feelings are to be here understood. Also in Uenuku's Spell, p. 7; and in Whakatau's Chant, "Trans. N.Z. Inst.," Vol. XIII., p. 68; and the last line of Songs, 1 and 4, pp. 65 and 70, *l.c.*

2. The big fish of the sea swims fleetly through strenuous exertion; blowing forth the blasts of sea-water from (its) nostrils; the big fish is lifted above the waters.

3. Space[2] makes (it) buoyant; Sky[2] upheaves (it) above the swell of Ocean.

4. Now, rushing forwards, a steep descent; anon (as if) climbing the fence of a fort! now a roughening squall of wind comes on; anon, as a bird's feather borne before it!

5. Ha! ha! thy heart (even as, *or* one with) my heart.[3]

6. Now the great enduring courageous heart of (the descendant from the) Sky, shall make itself to emerge through all difficulties and dangers to the habitable, to dwellings (of) light.

7. A full deliverance (for the) son of a chief, who was properly begotten the son of a chief.

8. Son above; son abroad; son according to the proper ceremonies (rightly *or* duly) performed; son according to the sign of the breaking-away of clouds, enlightening hitherwards from the outermost sides of the far-off horizon.[4]

9. Ha! abroad, far away on the deep (is) verily the place to exert strength, showing the straining of (one's) sinews.

10. Here, now, (is) the skid, I mount up on the top (of it); the very skid of Houtaiki;[5] the skid satisfying the heart; the skid (that is) sure and fast.

11. Ha! ha! the cold wind (is) laughed at, defied; (so is) the cutting icy wind to the skin; so (is) the bitter cold penetrating and numbing vapour; and so the fainting internal feeling of sickness.

12. Here (is) the skid! I get up on (it); verily the same skid of Houtaiki so greatly desired and looked for.

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[2] For Space and Sky, see "Trans. N.Z. Inst.," Vol. XIII., pp. 68, 69, etc.

[3] See the charm used for Rongoua's fractured skull, p. 11, Uenuku.

[4] These two verses (7 and 8) require explanation. Here there are six high reasons given by Paikea for asserting his nobility:—

(1) "Son of a chief"—*i.e.*, by *both* parents.

(2) "Properly begotten"—*i.e.*, with betrothal, and parental consent, and every proper preliminary arrangement;—see Kapi's wedding, "Trans. N.Z. Inst.," Vol. XIII., pp. 45, 46. (All this was wanting in the case of Paimahutanga, the mother of Ruatapu; see p. 18, note.)

(3) "Son above"—*i.e.*, in and with the approval of the Sky.

(4) "Son abroad"—*i.e.*, around,—in or with the approval of Space.

(5) "Son according to ceremonies duly performed—*i.e.*, by the priests (*tohunga*), at the early naming,—the cutting of hair,—the arriving at puberty, etc.

(6) "Son according to the celestial signs"—*i.e.*, these, such as are here referred to, were,—distant summer lightnings,—*aurora australis*,—peculiar red and other clouds, appearing on the horizon,—shooting stars, etc., etc.; and were always supposed and believed to have been given at, or shortly after, such ceremonial seasons, as tokens of approval, etc.

[5] The skid of Houtaiki." Houtaiki is the name of one of Paikea's ancestors. Here, however, an allusion is made to the canoe of Houtaiki getting safely drawn up on its skids on the shore; it is a very ancient story. It was also used to denote a fixed safe barrier, or bounds, which were not to be passed, as at Taupo, etc.; and, also, known as "te puru o Houtaiki"—*i.e.*, stoppage, obstacle, barrier. "Te rango o Houtaiki" is one of the names of the low isthmus connecting Table Cape Peninsula with the mainland. The name of Houtaiki often occurs in poetry, in connection with that of Houmea (*infra*).

13. Once, twice, thrice, four times, five times, six times, seven times, eight times, nine times, ten times.

14. Let not the fastening roots of Taane[6] be unloosed by thee: let not the hateful ill-omened winds to Taane be set free by thee.

15. Let the swimmings of a man in the ocean finally end; (let him) emerge at the habitable regions, at the lightsome (and) joyous dwellings.

16. Take up this descendant (of a line of chiefs); behold! he lives; (he) swims bravely.

17. Lo! he swims on; the head first-born chief keeps pursuing; he follows on still swimming away.

18. Lo! he swims; behold! he swims strongly; still swimming onwards, enabled, enduring.

19. A head first-born chief follows on; still keeping at the swimming; lo! he swims.

20. Behold! he swims away, even Paikea (a) first-born chief, who keeps going forwards, still keeping on swimming.

21. Lo! he swims; behold! he swims; upborne he swims; upborne he continues; he keeps at it, swimming onwards, toiling manfully.

22. Now above (the surface), then below! anon rolling between the billows; all that ends in the very reaching of the shore by Taane himself.[7]

23. Lo! look out! there it is; coming onwards towards (me), like a huge rolling wave. Ugh! strike it down! fell it! with the famed axe of ancient times,—that which overturned the land.

24. Ha! ha! his own mighty first-born chief appears (to his succour); that is, Rongomaruawhatu,[8] therefore it (the big) overwhelming wave, fled away, far off; ha!

25. The plugging and caulking stands good.

26. The fixing and lashing together stands good.[9]

27. Let (him *or* it) be uplifted and carefully carried.

28. Let (him *or* it) be raised and supported.

29. Let (him *or* it) be borne along.[10]

30. Alas! my distress, making me to toil laboriously at swimming; here, indeed, it is now being seen.

31. Make (thyself) to swim on courageously and well, as a skilful knowing one of old: truly so! here, indeed, is it now being shown.

32. In the midst of the great ocean; here, indeed, is it being seen.

33. In the midst of the desolate wild,[11] far away from man; here, indeed, it is shown.

34. In the ragged first-appearings of daylight,—far off on the horizon, when first seen away there (from the shore); here, such is now being seen.

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[6] Taane, the owner and creator of forests; (see "Trans. N.Z. Inst.," Vol. XIII., p. 65;) here metonymically used;—"roots of Taane,"—*i.e.*, of the trees of the forests. The strong westerly winds which often blow furiously in summer, sweeping down from the wooded heights and off the shore, East Coast, are here deprecated.

[7] Figurative, for a wooden canoe made out of a forest tree.

[8] One of Paikea's ancestors.

[9] These two verses (25 and 26) are spoken of a canoe.

[10] These last three verses (27-29) may mean, either Paikea, or the canoe coming to save him; there is nothing in the original to indicate gender.

[11] A term curiously used *here*,—as it means the uninhabited barren wilderness, far away from the dwellings of man.

35. My bird is verily met above; yes! there (it is) now returning; here, indeed, it is shown.

36. Ruatapu stood upright (in the sea) grasping his paddle, his last token! Alas! (it) was bad.

37. One chief dies (*or* disappears), another succeeds.

38. Kahutiarangi took Te Panipani to wife; he was a great chief's son, highly esteemed by Whangara.

39. Here am I, still swimming on; floating, but, alas! going in no certain direction.

40. The big fish is beaten stiff in the tide of quick dashing waves.

41. Lo! there it comes! the canoe of Pakia[12] is fleetly sailing hither.

42. O! big black-and-white sea-gull, flying aloft there; settle down hither on (the) sea from the sky.

43. O! Taane![13] enwrap (me), involve (me), with the garment of careless insensibility, that so I may quietly float to the shore.

44. Lie quietly down, O young chief, on the sea, which was purposely becalmed (for thee).

45. Carry safely forward thy brave swimming man to the shore.

[Possibly, there is some omission, or portion lost, here, W. C.] This, which follows, is the ending of the powerful and celebrated charm, which enabled Paikea to keep on swimming, and by it make his way through the ocean. In conclusion, he called on his ancestor, on Hikitaiorea; saying:—

46. "O Hikita! O! here am I making a great fish of myself.

47. O Hikita! O Hikitaiorea, O! lo! I am making a (drifting) waterlogged-white-pine canoe of myself.

48. O Hikita, O! O Hikitaiorea, O! I am making a sperm whale of myself, basking and rolling in the deep.

49. O Hikita, O! O Hikitaiorea, O! O Tuparara![14] seek me hither, carry me to the shore.

50. O Wehengakauki![14] fetch me hither, carry me to the shore.

51. Taane! fetch me hither, carry me to the shore, to my own land; on to the very shore there; to my father indeed, on the shore, there away: alas! alas!"

Then (he) warmed, cheered, and consoled himself, by remembering the name of another of his ancestors, who was called Mataiahuru, (*lit.* by, *or* through, the warm comforting sea, *or* tide,) and so recollecting, he cried:—

52. "Mataiahuru! Mataiahuru! through the warm sea, through the warm water-tide, let my own skin now become warm; (let it now) become as if it were verily basking in the heat of the noon-tide sun suddenly shining on my own skin; let it now be, as if by the blaze of the fire brightly kindled up, that it may become hot."

And with (*or* through) these last words, Paikea caused himself to possess comfortable and warm feelings. And so Paikea, at last, reached the shore, at (a place called) Ahuahu.

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[12] Another of Paikea's ancestors.

[13] Taane is now, at last, invoked, to make him just as a tree-trunk, or log of wood, that so he may float unconsciously to the shore; (see, also, verses 22, 51;) Taane, is, also, used figuratively, for the Mainland, and is always placed in direct opposition to his enemy the Ocean.

[14] Names of two more of his ancestors.

After some time residing there, he took to wife a woman of that place named Parawhenuamea, who bore him several children; one was named Marumuri, and there were others also named Maru (with some other affix). Afterwards he came further south to Whakatane, where he took another wife, who was named Te Manawatina; whence came the name of Whakatane from Manawatina. Thence he travelled still further south to Ohiwa, where he saw Muriwai within a cave; from which circumstance arose the name of Te Whakatohea, who dwelt at Opotiki. In course of time, and still travelling south, he came to Waiapu, where he took another woman named Hutu to wife; and she came on with him to his own place. She bore him Pouheni, etc., etc. (See *Genealogy* appended.)

This highly curious and ancient Maori rhapsody, *the Spell of Paikea*, is among the longest of the kind known to me, and was possibly thrown into its present semi-poetical form (in the original) the better to remember it. Although I have already given copious explanatory notes, a few of its more prominent features may further be briefly noticed.

Throughout it possesses just such words and imagery, as a man (particularly a Maori) in such a situation might be supposed to use and entertain. It seems, to me, very natural that one should speak (talk aloud) to himself in that manner, if only to keep his courage up! Many of the similes used are very natural and proper.

A kind of regular and progressive sequence almost dramatic runs through it.

There is great freedom from fear, both natural and superstitious; great dependence on himself; and little looking to any higher power for aid (save in one instance) other than to his own ancestors, whose names he repeats and also calls on, but mainly (as it seems) to encourage himself by reflecting on their meanings; this latter is an old peculiar trait in the Maori character, of which I have known many curious instances.

The invocation to Taane (v. 43), is evidently favourably answered by Taane (vv. 44, 45): there is also a second call on Taane (v. 51). It also appears, in other verses, as if some one supernatural power or personage were speaking to him, or for him (vv. 16, 27–29, 31).*

It is not said how long Paikea was struggling at sea; but, no doubt, the canoe had put off, according to their custom, in the calm of early morning, (indeed, such is nearly said in the story,) and Paikea, after long battling with the waves, feelingly alludes to the dawn of another day breaking; and to the early morning bird (of hope to him) appearing (vv. 34, 35).

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* See, also, "Trans. N.Z. Inst.," Vol. XIII., p. 59, bottom.

In "the ragged first appearings of daylight," is another very peculiar and poetical use of a common term; *lit.* it is, the ends of the irregular strands of scraped flax yarns (ravelings), hanging from the beginning of the weaving of a dress flax garment.

There are, also, some highly curious coincidences here, agreeing with several interesting particulars in Homer's two descriptions of Ulysses and his two long-shipwrecked boats at sea, each of many days continuance—one in reaching, and one in leaving Ogygia, Calypso's isle (Od., *lib.* V. and XII.); though Ulysses was at one time on a raft, and on another, at first, on part of the wreck of his ship, and afterwards for "two days and two nights" swimming. The coincidences are, (1) Ulysses spurting the brine from his nostrils, etc.; (2) his thoughts, words, and modes of encouraging himself; (3) the goddess, Leucothea, appearing to him in the shape of a cormorant, and alighting by him (giving him hope); and (4) Neptune's big billow, purposely sent, smiting Ulysses;—though, here, the "big billow," rolling on to do so to Paikea, fled before his invoked ancestor. Of Paul, also, we read, of his having been "a night and a day in the deep;" probably floating on part of the wreck of his ship.

I would also offer a few brief remarks on this story of Uenuku's son, Ruatapu.

And first, I would premise, that while the details of a legend are always false, the legend itself always contains a kernel of truth; a mere invention never becomes a legend.

Ruatapu's revenge is terrible; but, as I take it, it was not carried out merely to avenge the great insult he had then received from his father, but to avenge his mother's and his tribe's great wrongs.

If he had succeeded in drowning Paikea also, and then had got safely back to land, which he might have done, in all probability he would have been the head young chief of Uenuku's people; as no one could have told the secret,—that he alone knew. No doubt he was very strong and brave.

His parting allusions to their *home* and people; his belief, and his directions, as to how he should live in their memories and songs; and his remarks on the annual recurrence of nature's signs on the sandy shore in the summer season, (which he must have often seen there when a merry boy, and perhaps that very time of the year!) and of his being also with them *in spirit*, and of their festal meetings, and simple home evening diversions,—are all of an affecting kind. He left a wife (named Te Kiteora) and (at least) one son (named Hau), who are duly mentioned in several genealogical rolls, and from him some of the present East Coast Maoris trace their descent.

In some other old legends which I have heard, Ruatapu is said to have foretold to Paikea, at their parting, of a great approaching flood, which would cover all the low-lying lands of the North Island of New Zealand; and that when its signs should appear, the people were to flee to the mountain, Hikurangi, near the East Cape. But this, in my opinion, is merely a straining and embellishing (after the usual manner) of what Ruatapu had said about his own returning (in spirit) to land from the sea in the summer seasons;—immensely strengthened, also, from his high rank, and from the fact of those sayings having been his *last* parting words, which always had great weight with the Maori people.

## III. The Story of Houmea.

In bringing this paper before you to-night, perhaps I should state, in a few words, my reasons for selecting this story of Houmea out of many such.

1. Because that the name and doings of Houmea are often mentioned, or alluded to, in old Maori poetry, and that, too, in connection with the name of Paikea. Her name is also still used as a warning by the Maoris, in their current "household words" and proverbial sayings.

2. Because that, according to their genealogies, Houmea was a very ancient ancestress of Paikea. (See the Genealogy.)

3. Because of its high antiquity; for while (as I have already said) the time of Uenuku and Paikea goes back to about A.D. 1000, or 25–27 generations, the time of Houmea (as derived from their genealogical rolls) goes back to nearly 50 generations!!

4. Because of the very great scarceness of this ancient tale; it is, I think, unique; as with all my endeavours I could only obtain this one relation or copy.

5. Because it contains a few more of their Charms, Wonders, and Miracles.

### The Story of Houmea, a Female Thief: a very ancient Tale.

#### Part I.

Here is the narration concerning a certain female thief; the name of that woman was Houmea, and she was a very extraordinary person, a pest. The name of her husband was Uta.

One day her husband went out to sea in his canoe* to catch fish for himself and his wife and their two children; the name of one was Tuta-

* Here, throughout (as has been before observed, "Trans. N.Z. Inst.," Vol. XIII., p. ), only the persons themselves immediately concerned are mentioned; but it should be understood there were plenty of others,—plebeians, etc. A chief, for instance, could not go out alone to the deep sea-fishing in a large canoe.

whake, and of the other Nini. The husband went out a long distance to fish, and having caught a plenty he paddled back to the shore; on landing he waited some time for his wife to come down to the canoe, to fetch the fish he had caught;* but she did not come. At last he walked to their village, and said to his wife, "O mother! mother! there was I on the beach long waiting for thee, but thou didst not come forth!" On hearing this, Houmea replied, "O, sir, it is entirely owing to the disobedience of these two children." Then Houmea went down to the sea-shore to the sandy beach, to fetch the fish, and when she got to the canoe, she swallowed all the fish,—every one went into her own stomach, being devoured by her. This feat done, she went to pull up bushes of coarse sedgy plants, and of sow-thistles, which she brought on to the sands, and dragged and scattered them about; she also made big and small footsteps of her own footmarks, and trod all over the beach, and greatly trampled and tore it up, that it might be inferred a marauding-party had been there and stolen the fish. This done, she returned to the village, quite out of breath, sighing and panting; and said to her husband, "O sir, alas! there are no fish left, the fruits of thy fishing! have they been taken away (quietly) by men,—or by a marauding party,—or by thieves?" Then the husband said, "Who, I should like to know, can that thievish people be? here residing near the dwellings of men."† When Houmea rejoined, "The numberless multitudes of imps."‡ To this remark her husband replied, "Perhaps so." Then they all went to rest.

* Or, as the mistress, to superintend the taking them to the village; the distribution, etc.

† Meaning,—well able to protect their own property.

‡ Many are the stories—curious, droll, and interesting—related of these little folks,—"imps," elves, goblins, or fairies. I have never yet been able to decide, what particular English, German, or European term to give them as an equivalent. They are said to swarm in countless numbers; (see Story of Uenuku *(supra)*, and Tawheta's figurative and proverbial expression respecting them (p. 13); and to be just as ready to do good to men in difficulty, as to do mischief. Indeed it is said, in some of their old Myths, that it was from those little cunning beings that the Maoris learnt the art of making nets. Their various relations concerning them have always served to remind me of Gulliver's active Lilliputians. They were found, also, in the depths of the forests, as well as on the sea-sands,—though rarely ever seen by men. Mr. Locke tells me that when he was engaged in surveying for the Government at Portland Island (Hawke's Bay), the older Maoris residing there assured him that they had often in the early morning seen the countless footsteps of those imps on the sandy shore, by the sides of the fresh-water streamlet, where they had been holding their night revels. They bore different names (family or generic) among the old Maoris; which *may* also mean a difference in kind, dispositions, powers, etc.

In the morning, early, he again went out on the sea in his canoe to fish, and having caught a quantity paddled back to the shore; there he waited a long time for the woman (or wife), Houmea, to come down to fetch the fish he had caught, but finding she did not come, he went on to the village; and, entering, said to her, "O, mother, mother! am I to remain ever on the sands? there was I waiting for thee, and thou didst not appear; nor, indeed, hast thou done any thing at all!" (*i.e.*, towards preparing for my return). Then Houmea arose, and went forth, and when she got to the canoe, she swallowed all the fish! But, on her going thither, her husband had sent their two children to watch her, and when they got there (within sight but hidden), they saw her swallowing the fish. So those children returned running to their father, and said to him, "O sir, O sir! it was verily Houmea herself who swallowed the caught fish of thy canoe!" Shortly after this Houmea returned to the village, panting and blowing, and said to her husband, "Never a single scrap was there left in thy canoe of all the fish thou didst catch! All have been taken away by some man or other." Then her husband replied, "O lady-daughter! who, indeed, is that man thou speakest of? The children were verily there, and on their looking-out they saw thee—thy own very self—swallowing the fishes of my canoe." On hearing this she was overwhelmed with shame; nevertheless she strove hard at her own proper work, winding about, doubling and equivocating, that her theft of fish-stealing might be wholly concealed. In addition thereto she also loudly said, that she was guiltless of this charge, for she had never known anything whatever of crime, whether of adultery or of stealing the food of any man; (therefore, was she likely to begin now?) And then she also said to herself, within her heart, concerning her children, "All right and straight, no doubt, your doings, but I'll equal them yet!"

On another morning, after this, the father went again out to sea in his canoe to fish, and when his canoe had got out to the fishing-ground and had anchored there, Houmea said to one of her children, "O child, go for some water for us, we are all very thirsty;" and so the child went. Then she called to the other of her children, saying, "O child, come hither to me, that the lice (of thy head) may be caught and killed."* So this child went to her, and squatted down by her, and she caught some lice, and then she swallowed the child whole down into her stomach! Just afterwards the other child returned with the water, and this one was also swallowed up by her. Verily the two children were thus destroyed by her, swallowed

* The head of a chief's child being rigidly *tapu* (tabooed, or sacred), could only be touched by a *tapu* person, and so with its vermin; through which the poor children were often great sufferers.

alive, within her own stomach there to dwell! By-and-bye the canoe with her husband returned from the fishing. On his coming into the village he found her groaning audibly, while the big flies were also buzzing in numbers about her lips. On seeing this the husband said, "O mother dear, art thou ill?" She replied, "Yes, very much so." Then he rejoined, "Where (within) is the demon (*atua*), that is now gnawing thee?" She replied, "Within my stomach, within my bowels." Then he said to her, "Wherever can the children be, as they are not here present?" To this she replied, "Gone away somewhere, from the early morning; wherever can they be, wherever can they possibly be!" Then he closely examined her lips, and having done so, he recited a powerful spell: these are the words of that spell:—

> —— "Attack, strike end on, hit away upwards, turn (it), ward (it) off on one side; cause the food swallowed by the big cormorant* to be disgorged without; (let it) be open, clear; the obstruction is already uplifted by the charm, the obstruction is now securely noosed in a running loop of flax and carried off,—that is to say, the obstruction hindering (*or* confining) Tutawhake."

At the close of those words, lo! out of her mouth came those two children she had swallowed; Tutawhake bearing a carved staff of rank (*taiaha*), and Nini bearing a spear (*huata.*) And this is the tale of old concerning the woman who was both a thief and a murderess of her own children.

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## Part II.

This which follows is the second part of that tale of Houmea; which, however, is more concerning her husband Uta.

Now it came to pass that Uta very greatly feared his wife, lest both himself and his two children should be swallowed up alive by Houmea; and, therefore, he one day said to his two children, "My dear children, this is my word to you two; whenever I may send you to fetch drinking water, be very sure that you two do not go; when I shall threaten you (for not going), be sure that you two do not go; when I shall strongly order you to go, saying also that I will beat you with a stick if you continue disobedient, be sure you two do not go for any water; and even when, with a high voice and severe threatenings, I make you two to feel afraid, still, be very sure that you two do not go." It was not long after this, that their father ordered them to go (for water), when those two children paid no heed and stirred not at hearing the commands of their father. Then Uta turned to his wife and said, "O mother dear, O mother dear, wilt thou not go and fetch me some water to drink? Verily I am dying through want of water. Here, also, have I been repeatedly ordering those children to go, and they

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* *Graculus varius.*

will not move, nor do anything, remaining as if deaf to my commands." On hearing this, Houmea went herself to fetch the water; and when she was gone forth, Uta began to say his spell; and this was it:—

> —— "Be the water absorbed (sunk into the earth), be the water decreased, be the water dried up; proceed onwards, O Hou,* proceed onwards; away, away, up to the very head of the streamlet, to the distant hill-country."

And so it came to pass, for, as Houmea went onwards, the water also retreated before her, going out of sight, sinking into the earth, and drying up. Then Uta said to his two children that they should all go away together; so the children went on to the sandy beach where their father's big canoe was. Then Uta taught and showed (by gestures) to the village, to the houses, to the clumps of trees growing near, to the privy, and to the brow on the hill (*or* place of look-out), that when Houmea should return and seek and call out the names of those three who were now leaving, they (the fixed residents) should all respectively answer to her calling,† and that not one of them was to remain silent; and so he ended his indications (showing-forth by gestures) to them. Then he, also, went to the sandy beach, and dragged down the canoe to the sea, and when she was fairly afloat, they all got on board and hoisted the sail, and away fled their canoe before the wind! away, away, to a very far-off distance indeed.

About this time it was that Houmea returned to the village, and not finding her husband and children, she went about calling them loudly, saying, "O sir, O sir, wherever can you all be; thou and our children?" Then the response came forth from the privy; the response came also forth from the houses, from the clumps of trees and shrubs, and from the crest of the hill. At last her heart failed her and became weak, and she began to pant and to cry. Then she went up onto the top of the hill and looked out towards the sea, and looking long and closely she saw the canoe far off, as a mere speck on the horizon. Then she walked to the low sandy tidal-bank and entered into a shag,‡ and went away out to sea floating upon the ripple of the tide. The two children in the canoe kept looking towards the land, and by-and-bye they, through their sharp look-out, saw Houmea coming on after them. On seeing her they cried to their father, "O sir, O sir, here verily is the demon *(atua)* coming hither!" At this time their father was asleep. He, awaking from sleep, said to them, "O (my) dear children, whatever shall I do, lest (I) be destroyed by that demon, swallowed down alive into her big stomach?" The two children rejoined, "Lo! we two

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* Abbreviated and familiar for Houmea.

† By way of echo. Note how careful the narrator is here,—Uta does not teach them by words, but by significant gestures, etc.

‡ *Graculus varius.*

will hide thee below the platform-deck of our canoe, that thou mayest be surely concealed." So they accordingly hid him there, and he was out of sight. All this time Houmea was coming rapidly on to kill Uta to become food for her. As she neared the canoe her big throat opened wide to swallow them all! Coming close up, she cried out, "Where is my food?" The two children replied, "There, indeed, left behind upon the land; we two came out to sea to catch fish, and were carried away hither by the force of the wind." Then she called to them, "I am nearly dead from want of food!" On hearing this the children gave her some roasted fish. She ate up all the fish and was not satiated. Then she cried again to them, "Have you not plenty of fish, for I am not satisfied?" The children said to her, "O mother, O mother, here indeed is the thumping big morsel of food for thee, still upon the fire." On this she cried out, "Give (it) hither, give (it) hither, that it may be eaten up at once." Then they said to her, "Open thy mouth wide!" And, on her doing so, they flung an immensely big hot stone, by means of a pair of wooden tongs, right into her open throat, which went down into her stomach and burnt it! So Houmea perished there upon the ocean. But her offspring (representative or *alter idem*) is the big shag which still lives here among us. These related are the doings of Houmea of old. Of Houmea* that now dwells here in the habitable world (among men), this is the proverbial saying,—"Houmea, rough and ugly flesh!" And so the name of Houmea still remains among us, and is used and applied to all evil women; that is, all adulteresses and thieves found dwelling among men.

A few things mentioned in this tale may be briefly noticed.

1. The invariably kind and courteous words used by the husband, Uta, in addressing his erring wife, even when having received from her great provocation. Also, his kindness to his children.

2. The fishing-canoe must have been of large size, and of a different build from those of modern times (of Cook's days), for it had a platform-deck, under which the chief, Uta, was stowed away. So in the case of Rongoua, who snugly stowed himself away in the bow of the enemy's canoe, which was also a fishing-canoe, for a war-canoe on that occasion would have told its own tale. (See, Uenuku, *(supra)*, p. 10).

3. That their deep-sea fishing canoes also carried a fire-place, and had fires and heated stones used for roasting fish.

4. The charming simplicity of their spells! and yet their (believed) great powers! and consequent value.

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* Meaning the bad women to whom the term is applied.

## A Genealogical Appendix.

### I. *Of Houmea.*

This is a genealogical line of descent direct from Houmea, to show her offspring; which line also includes Paikea.

Houmea.
Tutawhake.
Nana.
Nioi.
Tangaroa.
Te Meha.
Te Toi.
Te Ihimoana.
Te Rapumoana.
Tumaikawa.
Matangiteunga.
Ranginumia.
Rangiwhetuma.
Rangiwherara.
Tangaroapatiere.
Tangaroawhakamautai.
Te Petipeti.
Te Rangahua.
Te Aihumoana.
Te Aihumowairaka.
Rongomaitahanui.
*Paikea.*
Pouheni.
Rangitekiwa.
Rakaitapu.
Te Aowhakamaru.
Uetekoroheke.
Niwaniwa.
Porourangi.
Hau.
Rakaipo.
Rakaiwhetenga.
Tapuatehaurangi.
Tawhakeurunga.
Hinekehu.
Whaene.
Te Atakura.
Tuwhakairiora.
Te Aotiraroa.
Tumokai.
Tamaauahi.
Te Rangikatoiwaho.
Huiwhenua.
Rongotukiwaho.
Porourangi.
Potae.
Henere Potae.
Wiremu Potae. = 48 generations.

Some other of Paikea's ancestors, whom he had called on, and, also, recollected in his distress,—as Houtaiki, Pakia, Hikitaiorea, Mataiahuru, etc., — are yet more ancient than those mentioned in this list, and run, also, in two other lines of descent ; those lines, however, are not here given.

II. *Of Pani.*

The genealogical line of descent from Pani down to Uenuku contains 38 generations ; and there are several other generations enumerated which preceded Pani, besides others before the first of that line, which are evidently wholly, or in part, mythological.

III. *Of Uenuku.*

The line of descent from Uenuku to the present time contains 25 to 28 generations ; *i.e.*, I have several lines of descent of several families strictly enumerated and all allowed, from Uenuku down to the present time, and they thus vary ; which, however, can easily be accounted for. These lines give also the principal wife of each chief ; and all of them descend from Uenuku direct through Ruatapu and his son Hau.

In the line, also, from Houmea (above), there are 27 generations from Paikea to the present time.

" Quid prodest, Pontice, longo
Sanguine censeri, pictosque ostendere vultus
Majorum ? "—Juv.

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Art. II.—*Contributions towards a better Knowledge of the Maori Race.*
By W. Colenso, F.L.S.
[continued*]

[*Read before the Hawke's Bay Philosophical Institute*, 8*th August*, 1881.]

——" For, I, too, agree with Solon, that ' I would fain grow old learning many things.' "—Plato : *Laches.*

## On the Ideality of the Ancient New Zealander.

### Part IV.—On their Legends, Myths, quasi-religious Ceremonies and Invocations, concerning the Kumara Plant.

In a paper which I was honoured with reading before you last year,† some account was given of the Kumara plant (*Ipomœa chrysorrhiza*), its use, high value, and manner of cultivation by the ancient Maoris, and of its several distinct varieties known to them : so much for the *real* concerning it.

* See " Trans. N.Z. Inst.," Vol. XI., Art. V., p. 77 ; and Vol. XII., Art. VII., p. 108 ; also, Vol. XIII., Art. III., p. 57.

† " On the Vegetable Food of the ancient New Zealanders," " Trans. N.Z. Inst.," Vol. XIII., p. 3.

I now purpose in this paper to lay before you somewhat of its *ideal*,—according to the notions and belief of the ancient Maoris.

In so doing I shall have to narrate much that is strange and highly figurative, if not sometimes fanciful; yet, in general, simply so, and containing nothing objectionable. And here it should be remembered, that while the specialities and dress of a myth or legend are always false, the legend itself always contains a kernel of truth. A mere invention scarcely ever becomes a legend. Narratives, such as some I shall bring before you, were by the ancient nations never wholly invented. And I think it will appear to the thoughtful mind that some of the main incidents involved in these stories were derived from legends based on real occurrences; disguised, partly intentionally and partly not so, through their having been handed down by mere oral tradition through a long course of ages.

It is well-known that the kumara is not indigenous to New Zealand, therefore it must have been introduced into the country at some past period; but when, whence, and by whom, is, I fear, wholly lost in the hoary ages of antiquity. And here I may remark, in passing, another peculiarity concerning this plant,—one that serves to increase the difficulty in pursuing enquiries after it, (one, too, that I have long felt), viz.—that its true native country is unknown. In many parts of the New World, and those, too, isolated and widely apart from each other,—as New Zealand, Tahiti, the Sandwich Islands, Easter Island, and intertropical South America,—this plant is, and long has been, assiduously cultivated, (as it was here among the New Zealanders when first visited by Europeans); but its real indigenous habitat whence it first sprang is still unknown.* In this respect it much resembles those other useful annual plants ever cultivated by man from the earliest historical times,—maize, wheat, barley, oats, etc.

And here I should also, perhaps, mention (in connection with the heading of this paper, or this series of papers), that its name, as far as is known to me, is, and ever has been, much the same, if not identically so, in all those lands where it was found a prized plant of cultivation by their inhabitants.† And its *Maori* name of kumara may be a highly and very proper figurative one, well derived and full of meaning, and one quite in unison with the modes of thinking and of naming once so congenial to the ancient New Zealander, viz.—lord of the plantation, *or* cultivation, *i.e.* of all cultivated food plants; by the mere changing of the first letter *k* into *t*, as is not

* See Essay on the Maori Race, "Trans. N.Z. Inst.," Vol. I., § 53, xi.

† "It is singular that the Quichua name for sweet potatos, which I found in the high lands of Ecuador, is *Cumar;* identical with the Polynesian Kumara, or Umara, and perhaps pointing to the country whence the South Sea Islanders originally obtained this esculent."—Dr. Seemann, in *Flora Vitiensis*, p. 170. See, also, my "Essay," *loc. cit.*, of an earlier date, § 53, pars xi.-xv.

unfrequently done in their language; and not only so in Maori, but such a conversion of these two letters obtains more or less in the Polynesian dialects generally. This conjecture seems also to be borne out, or further supported, by one of the similar figurative names given to the fern-root,—*infra.*

In bringing before you some of the legends and tales concerning this valuable root, I shall relate them in the following order:—1. Some of their earliest traditions concerning it;—2. Some of the beliefs of the Maoris respecting it; and—3. One, or more, of their quasi-religious prayers, or spells, anciently used by them in their planting it; all of which, especially the last, are of great interest.

(1.)

*Of their earliest Traditions concerning the Kumara.*

First, it has a place in their primitive cosmogony, wherein it is stated, that it descended from the first elements, (or first male and female pair, whence all beings and things came), *Rangi* and *Papa*—Sky and Earth, being one of their numerous progeny, equally so with the fern-root.* This, however, is denied by some *tohungas* (priests and skilled men), but mainly through the kumara being a *tapu* (tabooed, or sacred) plant, while the fern-root is not so; or, as I take it, the one is a plant only propagated through careful and particular cultivation and preserving, aided by charms; while the other is indigenous, common, grows wild, and is never cultivated; notwithstanding, the fern-root also carried a great and high figurative name, viz.—*Arikinoanoa* = little first-born lord, *or* lord of lesser rank, *or* lord of common things.

Another curious old legend has the following:—"This is the reason why the kumara was never joined together with the fern-root. The *Kumara* is *Rongomaraeroa*,† and the *Aruhe* (fern-root) is *Arikinoanoa;* they are both children of Sky and Earth. Rongomaraeroa, or the kumara, was placed as an *atua* (superior being) to *Tumatauenga*, or the man; so that, in case the foe should come against him, the kumara should be ceremonially carried forth and laid in the road the war-party was to come, and there spells were also uttered, through which the war-party, in coming on over the sacred and charmed kumara, would be sure to be defeated, and caused to retreat, through their sacrilegiously trampling on the sacred kumara and spot,‡ etc.

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* See "Trans. N.Z. Inst.," Vol. XIII., p. 23.

† See, below (p. 37) for meaning of this, etc.

‡ Hence, war-parties by land were careful not to travel over the old roads or common tracks, if there were any. See my paper "Historical Incidents and Traditions," Part II., Uenuku, and the note there, (p. 14 *supra*).

That the kumara must have been known to the Maoris from very ancient times (from their historical traditionary beginnings, or even earlier times), may be also logically inferred,—(1) from their ancient common belief, that their deceased ancestors (chiefs) fed on it in the nether world, the Maori Hades *(Reinga)*; and (2) from their strange stories of persons who had been ill and had died, and had gone thither, and came back again to life, bringing kumara with them (though generally losing them by the way!); and (3) from their state during dreams, when they firmly believed that the spirit left the body and wandered at will, sometimes even visiting the nether world, when, of course, it saw goodly visions of kumara; and (4) from the marvellous exploits of their pre-historic hero, Tawhaki, who, among other things, having climbed up into the sky, visited his ancestress, Whaitiri, who was blind from age, and on his arriving at her place of abode, he found her engaged in carefully counting her seed-kumara roots.*

Another quaint old ancient legend concerning the kumara, which partakes a little more of the historical element, runs thus:—

*The Story of the fighting of Tumatauenga with his elder Brother Rongomaraeroa.*

(Literally translated.)

Their angry contention arose about their kumara plantation; the name of that plantation was Pohutukawa. Then Tumatauenga went to see Rurutangiakau, to fetch weapons for himself; and Rurutangiakau gave to him his own child Te Akerautangi; it had two mouths, four eyes, four ears, and four nostrils to its two noses. Then their fighting began in earnest, and Rongomaraeroa with his people were killed, all slain by Tumatauenga. The name given to that battle was Moenga-toto (sleeping-in-blood, *or* bloody sleep). Tumatauenga also baked in an oven and ate his elder brother Rongomaraeroa, so that he was wholly devoured as food. Now the plain interpretation, or meaning, of these names in common words, is, that Rongomaraeroa is the kumara (root), and that Tumatauenga is man.

A remnant, however, of the Kumara (tribe) escaped destruction, and fled into a great lady named Pani to dwell; her stomach *(puku)* was wholly the storehouse for the kumara, and the kumara plantation was also the stomach of Pani. When the people of her town were greatly in want of vegetable food, Pani lit the firewood of her cooking-oven, as if for cooking largely, and it burnt well, and the oven was getting ready. The men (of the place) looking on, said, one to another, "Where can the vegetable food

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* See Grey's "Polynesian Mythology," p. 70: there, however, it is stated that they were "*taro* roots" which the old lady was counting; who, also, there bears a different name, or nick-name, *Matakerepo*—Totally blind, from her blindness. This is the only instance I have ever heard of *taro* being used for *kumara*-roots.

possibly be for that big oven, now being prepared by that woman ?" They did not know of her storehouse, she herself only knew. She went outside to the stream of water, and collected it (the food) in two gatherings only (*or*, two scrapings together with her hands) ; she filled her basket, and she returned to the village *(pa)*, to place her food in the oven, and to attend to the baking of it ; and when the kumara was properly cooked, she served it out to her people, distributing it evenly. And thus she did every morning and every evening for many days. Now the vegetable food of the time of war is fern-root (pounded and prepared in a mass), which (root) the Maoris commonly call, the Permanent-running-root-of-the-soil. In the morning of another day, Pani again went and lit the fire of her cooking-oven, to bake food for all her people ; then she went outside, as before, to the stream of water, and seizing her big basket she sat down in the water, groping and collecting beneath her with her hands. While she was thus engaged in gathering the kumara together, there was a man hidden on the other side of that stream, his name was Patatai, and he was a *moho;* he, seeing her and her doings, suddenly made a loud startling noise with his lips (such as Maoris make to startle wood-pigeons), which Pani heard, and was wholly overcome with shame, at herself and her actions having been seen. The name of that water was Monariki. The woman returned crying to the village, through her great shame ; and hence it was that the kumara was secured for man. The name of her husband was Mauiwhare-kino. From Pani came the several sacred forms of words *(nga karakia)* used ceremonially by the wise men *(tohungas)* at planting and at harvesting the kumara. It was Tumatauenga who destroyed the kumara, lest the strengthening virtues of Rongomaraeroa should come down (*or* become known) to the habitable earth (*or* to this land).

For the probable time of Pani, see Genealogical Appendix, p. 33, (supra) "Historical Incidents and Traditions."

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*Explanatory Notes to the foregoing.*

The names and personages here mentioned are to be first noticed.

1. Tumatauenga* was the favourite and powerful son of *Rangi* and *Papa* (Sky and Earth); his name may mean, Lord-(with-the)-fierce (*or* strongly-emotioned)-countenance. Rongomaraeroa means, Fame-resounding-(in)-long-open-courts (*or* squares). Courts, here, are the fenced-in open plots before the several chiefs' houses in a town (*pa*), and have just the same meaning as "gates" in Oriental language, or of forums,

* See Grey's "Polynesian Mythology," pp. 4-13, for much concerning Tumatauenga, with *Western* embellishments.

public- or market-places, with us. Rongomaraeroa,—though, sometimes, under an abbreviated or different name,—was always considered to be the patron, precursor, or master of the kumara.

2. Pohutukawa,—the name of the sea-side tree in the North Island (north of Table Cape), *Metrosideros tomentosa;* also, of a variety of the kumara with reddish flesh, something like the colour of the wood of that tree; and the name (according to some legends) of the *first* kumara on the West Coast; and, also, of an old variety of kumara, universally known in the North Island.

3. Rurutangiakau,—this quaint and ludicrous figurative name, literally means, (The)-owl-crying-(by-the)-rocky-sides-(of-the)-sea! It may, however, also, mean, (The)-thicket-(by-the)-resounding-sea-cliffs; *or*, (The)-sheltered-resonant-clump-(of-the)-sea-side. (The word *ruru* being equally common for owl, and for shelter, or sheltered; and here given by metonymy to the wood, or thicket, which yields the shelter.) I incline to this last meaning, in connection with the name of "his own child" (see, No. 4, *infra*); which tree also often grows on dry spots near the sea. The sea-side name is also quite in keeping with the former name of Pohutukawa.

4. Te Akerautangi,—the rustling-leaved-*ake* (*Dodonæa viscosa*), a small tree, so-called from the sounding of its harsh dry leaves striking against each other when set in motion by the wind. (Another proof of the high discriminating faculties of hearing and of observation of the ancient Maoris.) Of the hard wood of this tree (their hardest), their digging-spades (*koo*) used in planting the kumara, and their staffs of rank (*taiaha*, and *hani*), sometimes used as weapons of offence, were made.* This "child" of the thicket, is such a digging-spade, or staff, carved and ornamented in the usual manner, as described, with its four eyes, etc. There is, however, something more here, hidden,—some esoteric meaning,—in the Janus-like ornaments of those implements,—especially in the one used only in cultivation,—indicative of a looking-both-ways, and of working diligently,—and that, too, always under strictly tabooed regulations.

5. Pani,—this word has several meanings,—(1) To paint, daub, anoint, etc.; (2) To close, or obstruct, an entrance, way, etc.; (3) To be friendless, forsaken, to be deprived of parents, etc.; also, a widow, orphan, etc. Possibly here it may be taken to indicate that this personage, Pani, was at first

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* This is commemorated in their poetry, thus:—

—— "Ko ta namata riri,
He kahikatoa, he paraoa,
He Akerautangi."

The fighting weapons in the days of old were (made of) the *kahikatoa* (wood), and sperm-whale bones, and the *akerautangi* (tree).

a widow of rank (one of those whose husbands were killed in those fightings before related), who had by her prudence, economy, and forethought secured the kumara; or it may indicate that the kumara, the child so saved by her, was itself an *orphan* there; and, as is not unfrequently the case, the name for it was given to, or taken by, its preserver, patroness, or mother. I incline to this latter conjecture. (See, below, The Invocation to Pani, and notes there.)

6. Patatai,—whether this was a man, or a bird bearing that name, I cannot definitely say; for the word "*moho*" means,—(1) the various birds of the Rail family (of which there were several species),—generically, or as a natural class,—of which one species also bears the name of *patatai*, and of *moho-patatai*;—(2) a wood- or bush-man; a man, a remnant, a survivor of some unfortunate tribe or family, living far away from men, through fear, solitarily in the "bush." Both man and bird are now alike extinct. I am, however, inclined to believe that a man was intended, who, probably, obtained that name from his so solitarily acting, concealed, rail-like, among the rank untrodden vegetation on the margin of the stream.

7. Mauiwharekino,—Pani's husband, Maui-(of-the)-evil-house. There were several heroes of old named Maui; this one, however, is distinct from the great hero, who bound the Sun, and who fished up the North Island, etc., etc.*

8. Tumatauenga's destroying the kumara may here indicate,—(1) that man, at first, did not know how to cultivate and to preserve that valuable root, through ignorance;† and (2) that fierce fighting man was an enemy to the quiet cultivator, and cared nothing for the arts of peace,—showing plainly, in other words,—"Their feet are swift to shed blood; destruction and misery are in their paths; and the way of peace have they not known."

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(2.)

*Some of the more prevalent Beliefs of the Maoris concerning the Introduction of the Kumara into New Zealand.*

These vary considerably in detail with almost every great tribe, or people, of New Zealand,—as to the time when, the persons by whom, the name of the "canoe" *(waka)*, and the name of the sort, or kind, of kumara brought; also, its having been purposely sought or fetched from

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* In another ancient legend of Pani (principally found in the more northern parts of New Zealand), it is stated that Tiki was Pani's husband. Tiki, also, being the first man, or progenitor, or precursor of man. In *Dieff.*, Vol. II., pp. 47, 116, this is noticed. Dieffenbach obtained this information at Kaitaia Mission Station.

† See a similar figurative indication in the ancient legend respecting the beginnings of the fern-root, "Trans. N.Z. Inst.," Vol. XIII., p. 24, first three lines.

abroad; or casually brought into New Zealand. And here I should mention (lest it might be considered to be a matter of small moment), that with the Maoris, the name or names of the persons (chiefs) engaged,—including their wives, their canoes, their paddles, and their balers; and also the name of the plantation first planted, and even of their wooden digging-spades used,—is almost everything! Many of them are said to be still preserved in their legends, and with them (the Maoris) their possession is unanswerable!

*(a.)* According to the Maoris of the East Coast (Table Cape to Cape Runaway), especially the large Ngatiporou tribe,—a New Zealand chief named Kahukura went in his canoe from New Zealand to "Hawaiki" to fetch the kumara for planting. Arriving there, he found the kumara-crop had been already harvested; but he turned-to and cut down a portion of the cliff where the kumara grew spontaneously; when, aided by his powerful spells, the kumara fell, and soon filled his canoe, which was called Horouta. This done, he again laid his spells on that spot, to stop the kumara from falling down the cliff, and then brought the kumara with him to New Zealand. On returning to the East Coast, he first landed at Cape Runaway, where he first planted some of his kumara; thence he carried them, coasting south, to Waiapu (East Cape), to Poverty Bay, to Table Cape, to Hawke's Bay (south side), and across the straits to the coast between Cape Campbell and Kaikoura:—"all this distribution of the kumara to those several places, was done by that one person Kahukura." This statement, however, is stoutly denied by other Maori tribes, especially by those residing on the West Coast, and at the Thames. Here the names of both the chief and his canoe should be noted; that of the chief being one of the Maori names for the rainbow, and that of the canoe meaning, (The)-falling-down-(of-the)-mainland (cliff). Also, a statement which is firmly believed by the Maoris, and which I have often heard from several of them, who asserted they had themselves seen it, namely,—that at Cape Runaway the kumara grows indigenously,*—that is, without annual planting; the scattered small tubers left in the ground in the cultivations invariably spring the following season, which they never do anywhere else, and this, they say, is another proof of the first imported kumara having been planted there. From the very favourable position, however, of the sea-side lands inside Cape Runaway, lying so far to the east and so protected from the south, such may very well be accounted for naturally.

*(b.)* According to the Maoris of the West Coast, the kumara was first brought by their progenitor, Turi, in his canoe named Aotea, on his emigrating from "Hawaiki;" when he came to New Zealand, and landed

* See this alluded to, in Grey's "Polynesian Mythology," p. 143.

and remained there at Patea on the West Coast. He also, they say, brought with him on that occasion, the other cultivated edible root, the *taro (Caladium esculentum)*, and the *karaka (Corynocarpus lævigata)*, also the swamp-bird, *pukeko (Porphyrio melanotus)*, some green parrots *(Platycercus pacificus*, and *P. auriceps)*, the Maori rat, "and many other good things for food."* Unfortunately, however, for them, nature is against them, for the *karaka*-tree is believed to be purely endemic; so also are the two green parrots, and the blue rail, *pukeko*.

(*c*.) The Thames Maoris deny all the preceding, and assert that the kumara was first brought from "Hawaiki" by the chiefs Hotunui and Hoturoa, in their canoe called Tainui, which they say was also the *first* canoe of emigrants thence to New Zealand. Or, as some others say, the kumara was brought by the lady-wives of those two chiefs, named Marama and Whakaotirangi, together with the *hue* (*Cucurbita* sp.), the *aute* (*Broussonetia papyrifera*), and the *para* (*Marattia salicina*),—and, also, the *karaka;* but this last plant grew accidentally, as it were, the timber having been shipped merely as skids to be used for drawing up their canoe on their landing. Those identical poles, or skids, planted by them, and now grown into trees, are still shown at Manukau! (A suitable match for Dr. Hector's newly-discovered plant at Kawhia—*Pomaderris tainui*,—of which a similar legend is told.)† A portion of this story is so good that it deserves to be fully translated. I therefore, give it.

"When the canoe, Tainui, had been dragged across the portage at Tamaki (near the head of the Hauraki Gulf), and reached Manukau (on the West Coast), they coasted south to Kawhia; landing there, those two ladies (Marama and Whakaotirangi) proceeded to plant the various roots they had brought with them from 'Hawaiki.' This they did in two separate plantations, at a place called Te Papa-o-karewa in Kawhia; but when those several roots sprung and grew up, they all turned out differently. Of those planted by Marama, the kumara produced a *pohue* (*Convolvulus sepium*), the *hue* produced a *mawhai* (*Sicyos angulatus*), the *aute* produced a *whau* (*Entelea arborescens*), and the *para* produced a *horokio*.‡ All the plantings of Marama grew wrong

* See Grey's "Polynesian Mythology," p. 212, for this in part.

† See "Trans. N.Z. Inst.," Vol. XI., p. 428.

‡ Here, the correct natural discrimination of the old Maoris, in according plants of a similar appearance and manner of growth to those planted, as their simulated substitutes in mockery, is very apparent, and is worthy of a brief passing notice. Indeed, the first two counterfeits belong severally and botanically to the same natural order (and one of them to just the very same genus) as the two plants which had been planted and failed. The third counterfeit, *Entelea arborescens*, though far separated botanically, has been often planted by Europeans in the early Napier gardens as being the real *aute (Broussonetia*

and strangely, and that was owing to her having transgressed with one of her male slaves. But the plantings of Whakaotirangi all came up true to their various sorts, and from them the whole island was subsequently supplied. Hence, too, arose the proverb, which has been handed down to us,—'Greatly blessed (*or* gladdened) art thou, O food-basket of Whakaotirangi!'* So let all Maoris know, that from the canoe Tainui came her kumaras, her *hues*, her *autes*, and her *paras*, and her *karakas* (which last, sprang from the used skids which her crew had brought away in her), and, also, her *kiores* (rats)."

*(d.)* Another still more strange and far-fetched tale, concerning the introduction of the kumara into New Zealand, is also related by the Maoris of Hawke's Bay (south), which may also be briefly mentioned here, if only for its singularity. A chief of old, named Pourangahua, was getting his canoe ready to go to sea, to seek some better-relished food for his infant son, Kahukura;† the child having rejected with fearfully loud noises its own mother's milk, also the soft liver of the fish *kahawai (Arripis salar)*, with which it had been fed. (From that liver, however, so rejected by him, sprang the flying-fish.) The canoe being dragged down and all ready, the chief, Pourangahua, returned to his house for something forgotten, and while absent his four brothers-in-law (Kanoae, Paeaki, Rongoiamoa, and Taikamatua), embarked in the canoe and sailed away. Pourangahua, nothing daunted, went after them on a canoe (or float) made of a duck's feather; a squall, however, coming on, he was soon sent to the bottom! Emerging to the surface, he swam and battled away against the seas, and finally got on to a whale's back, on which he managed to keep himself by means of his powerful spells. Afterwards, he met his own canoe with his brothers-in-law returning, he joined them, and on reaching the shore, and calling the kumara which they had brought by its own proper and special name of Kakau§ (to which the kumara itself answered, by asking, "Who he was that had spoken—or divulged—its name?" etc.), he obtained from

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*papyrifera)*, and called, also, by its name, "Paper Mulberry;" there being a great common superficial likeness in the leaf, bark, size, etc., of the two shrubs. While the fourth counterfeit is evidently a fern, and very likely one of the large common tufted thick-growing coalescent ferns,—*e.g.*, *Polypodium pennigerum*, *Lomaria discolor*, or *L. gigantea*, the smaller *Dicksoniæ*, etc. The Maori name of Horokio is now variously given by different tribes to different plants.

* This circumstance, however, is very differently related in Grey's "Polynesian Mythology," p. 142.

† Same name as under (*a.*) *supra*.

§ Curiously enough, this is the same special name that is given to the kind of kumara said to have been brought from "Hawaiki" by Turi in his canoe (*b.*, supra). See Grey's "Polynesian Mythology," p. 212.

them two roots of kumara, which he planted with the proper charms and ceremonies, and from these the whole country was in course of time supplied, so that both his own son, Kahukura, and all besides were amply fed with this good vegetable food.

(*e.*) A still more romantic version of this last story is the one held by the Urewera tribes living in the mountainous interior, which would be hardly worth relating were it not for their isolated situation, shut up far away from other tribes among the mountains and forests, and for the fact of its containing several of the very special names of the prized varieties of kumara formerly cultivated by the Maoris, both North and South: those very varieties, too, belonging to the widely different sorts—showing their antiquity. They say,—" that Pourangahua went after his brothers-in-law to 'Hawaiki;' that his canoe being gone, he went thither on two pet birds, named Tiurangi and Harorangi, the property of a chief named Ruakapanga, who lent them to him for the occasion. That Pourangahua brought away thence from two cliffs, called Pari-nui-te-ra, and Pari-nui-te-rangi,* the following seven varieties of kumara, viz., Kawakawatawhiti, Toroamahoe, te Tutaanga, te Kiokiorangi, te Tutaetara, te Monenehu, and te Anutai.† That the roots brought to New Zealand by Pourangahua lived and flourished; but that those which had been brought by his brothers-in-law did not grow."

I remember well, when first travelling in those parts in the interior, 43 years back, (being the first European visitor among them), the many questions respecting the kumara and its first introducers which were put to me by the *tohungas*, "as posers to test my knowledge," (as they subsequently informed me), and their great earnestness respecting them.

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(3.)

*A Charm, or Invocation, used at the Planting of the Kumara Roots.*

1. Now (is) the planting-season favourably indicated from the sky (of the) mainland;
2. Now (is) the season (for) planting favourably indicated from the sky (of the) ocean.
3. Verily, and now it is from (*or* according to) Raukatauri, together with Raukatamea,
4. (And) Maitiiti,‡ (and) Marekareka:—
5. Ye sought it out;
6. And it was divulged (*or* caused to creep silently) abroad by thee

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* Great-cliff-(of-the)-sun, and Great-cliff-(of-the)-sky. The name of a high cliff on the East Coast, between Tolaga Bay and Poverty Bay, is Pari-nui-te-ra; this is, also, Cook's Gable-end-foreland.

† See "Trans. N.Z. Inst.," Vol. XIII., pp. 34, 35. In the list there given, however, there is *Anurangi* for *Anutai;* but the root-meaning of both words is the same.

‡ One MS. has it, Mahitihiti.

7. At Waeroti (and) at Waerota.
8. At early dawn let the attendance here be numerous ;
9. Let the appearing of the sun be waited for here ;
10. Be ye all coming-in hither from every-where round about.
11. Here, indeed, shall be Regular-Distribution (of seed) ;
12. Here, Abundance (of seed) ;
13. Here, Visiting-little-hillocks (with the seed).
14. The little hillocks shall be all severally visited,—
15. Throughout—through all—far on—round about.
16. Thinly-encumbered (*or* scantily clad with earth),
17. O Son of noble birth !
18. Incline thyself towards the warm sea-breezes ;
19. Thy face shall be favourably marked with the waters causing vegetable growth ;
20. Be (thou) soon seizing, grasping the soil with thy rootlets,
21. Even as a bird lays hold,—*or* grasps,—(with its claws) ;—
22. For thou art naked, unclothed, having only thy skin !
23. Therefore, be thou seizing, laying fast hold (of the earth) ;
24. For thou art naked, possessing only thy skin !
25. Whence shall the future fruit,—*or* increase,—be obtained ?
26. Let the proper fruit,—*or* increase,—be seized, be laid fast hold of through me ;
27. That is, the proper fruit,—*or* increase,—from without ;
28. That is, the proper fruit,—*or* increase,—with Pani,—*or*, which Pani has in her possession.
29. O Pani ! O ! come hither now, welcome hither !
30. Fill up my basket (with seed kumara roots) placed carefully in, one by one ;
31. Pile up loosely my seed-basket to overflowing :
32. Give hither, and that abundantly !
33. Open and expanded awaiting (is) my seed-basket :
34. Give hither, and that abundantly !
35. By the prepared little hillocks in the cultivation (is) my seed-basket placed ;
36. Give hither, and that abundantly !
37. According to the spell of Space (is) my seed-basket awaiting ;
38. Give hither, and that abundantly !
39. By the sides of the borders of the plots (in the) cultivation, (is) my seed-basket placed ;
40 Give hither, and that abundantly !
41 By,—*or* according to,—the proper form of power and influence,—*or* potential power,—(is) my seed-basket placed ;
42. Give hither, and that abundantly !
43. The (doors of the) row of seed-kumara store-pits are not yet closed hitherwards ;
44. The floors of the same are not yet in view, *or* seen (*lit.* met—with the eye).
45. Let all the roots (for planting) be spread about carefully.
46. Let the whole be everywhere properly done.
47. Now, jump ! move your legs and arms briskly ;
48. Carry the roots for planting throughout the plantation.
49. Go forth ! (ye) selected food-bearing seed (of) Whaitiri, into the plantation ;
50. (There) to be carefully set in the soil one by one.
51. Let the fruitful seed go hither and thither ;

52. Let them be carefully carried about.
53. Be (you) diligently occupied in planting carefully.
54. Planted, verily planted (are the seed of) my baskets.
55. Spread open, empty, verily scattered around, (are) my (empty) used seed-baskets!
56. Above (there) in the sky (thou art) far away out of sight, hidden;—
57. Give, therefore, here in this place, as a reward
58. Of the believing this,—*or* our making it (to be) real and truthful,—
59. And let it be alike truthful and real (to us);
60. Yes; just so, indeed.

(The figures beginning each verse, are added merely for the sake of reference:—See Analysis, *infra.*)

Few subjects among the many of this class known to me have afforded half the satisfaction I have obtained from this one; but I have only gained it through a long, patient, and tedious amount of heavy labour! The translation of this semi-poetical charm, or invocation, being exceedingly difficult, owing to so many archaisms, allusions and ellipses. Desirous, however, of laying it before you in its original beauty—of meaning and arrangement—I have studied to translate it as literally as possible, consistent with perspicuity and the dissonant idioms of the two languages.

Of the various spells, etc., anciently used in planting the kumara, that I have acquired from several *tohungas* during many years, there are no less than three which contain this direct invocation to Pani; and while the introductory words of those three forms vary a little, the kernel—the invocation itself—is almost literally the same in them all! This circumstance, together with its evident antiquity (as shown from their genealogical tables), the fact of its being one of the *very few* known forms of direct invocation to any being or personification ever used by the ancient Maoris,* its poetical structure, and its regular fitting and progressive disposition,—make it a subject of extreme interest if not of importance.

Those charms, when used, were always muttered in an under-tone by the *tohunga*, who performed this duty while walking about the plantation, *solus.* This one, used in the spring, at the first planting season, serves to remind us of the vernal sacrifices and prayers of the ancient Egyptians and Romans,† and other ancient Northern nations; and like those by them, it was used to precure fertility; and when simple, (as in this instance), they may be regarded as among the most beautiful and becoming of the rites of natural religion.

* I should, however, also state, that besides those three charms, or invocations, already mentioned, containing direct invocations to Pani, I possess, among several charms, etc., from the North, another charm used for the restoring of a sick person to health, in which Pani is also invoked together with her husband Tiki, and both simply and separately called on to grant health to the patient.

† Virgil, Ec. V., 74, 75: Georg. I., 335-350.

For this purpose, also, another strange plan was long observed by the Maoris of the interior. A portion of an ancient relation I received from them runs thus:—" Tia* and his party " (who, it is said, had come to New Zealand from "Hawaiki" in the canoe Arawa), "did not return from Taupo (inland), whither they had gone, to Maketu (on the coast); they all died inland at Titiraupenga, where their bones and skulls long were, and were, indeed, also seen by the Maoris of this generation just past. Those skulls were annually brought out, with much ceremony, and placed in the kumara plantations, by the margins of the plots, that the plants might become fertile and bear many tubers."

Captain Cook also relates, that in the plantations of kumara at Tolaga Bay, which he and his companions visited (on his first voyage to New Zealand),—" they saw there, a small area of a square figure, surrounded with stones, in the middle of which one of the sharpened stakes which they use as a spade [*koo*] was set up, and upon it was hung a basket of fern-roots: upon enquiry the natives told us, that it was an offering to the gods, [?] by which the owner hoped to render them propitious and obtain a plentiful crop."† This is in the main correct, as I have myself proved,—omitting the words " an offering to the gods."

It is just possible, that the kernel of this charm or invocation to Pani, may be among the very oldest known!

And here, to make it still more plain, I will just briefly give a simple analysis of the contents of this Invocation, with a few explanatory notes; through which, I think, its suitability, beauty, and regularity, will be the more clearly perceived.

ANALYSIS.

I. A statement of the celestial signs of Spring being fortunate, or favourable, for their work, according to tokens discerned by the *tohunga* from over both land and ocean: lines, 1-2.

II. Of their work being begun according to old descended custom; mentioning the names of four of Tinirau's eight sisters,—who were sent over the sea in their canoe to carry off Ngae (or Kae) for his theft of Tinirau's pet whale.‡ Possibly they were here mentioned, on account of that memorable night of high glee and jollity spent in all manner of games by those women and their assistants, through which plan they also succeeded in detecting and carrying off Ngae;—the bare mention of this always caused pleasing mirthful ideas to the Maoris and was just as politically useful to the working-class among them at the beginning of their heavy annual working-season, as the festival

* Tia's name is mentioned in connection with the Arawa, p. 146, Grey's "Polynesian Mythology."

† First Voyage, Vol. III., p. 472.

‡ See Grey's " Polynesian Mythology," p. 90.

of the Carnival in some countries preceding Lent! "Waeroti and Waerota" are the names of two places out of New Zealand (real or mythical) not unfrequently referred to, in this way, in their old poetry and myths; and often in conjunction with "Hawaiki:" lines, 3-7.

III. A direction to the workmen to be ready early; another indication of their industrious agricultural habits: lines, 8-10.

IV. A promise, that what was really necessary, on the part of the owners, or chiefs, should be there, allegorically personified: lines, 11-13.

V. That the work should be throughout regularly performed: lines, 14-15.

VI. A quiet, stately, fitting address, abounding in natural truths, made to the kumara sets, personified,* about to be planted; reminding them whence their beneficial growth, etc., were to be obtained: (1) from nature, the sea-breezes or summer-winds, and rains; and (2) from their own action,—growing and holding-on to the soil; great need of this advice, as they were always planted in the tops of raised light gravelly hillocks†: lines, 16-24.

VII. The question proposed,—Whence the crop, or future increase? (Carefully note the response, made by the *tohunga* (priest),—the old, old, story! *semper idem*): lines, 25-28.

VIII. The invocation proper to Pani; note its great simplicity, its gradations, and its recurring refrain, repeated regularly six times: lines, 29-42. (The tubers were to be placed "carefully and loosely, one by one," into the seed-baskets, because they had commenced sprouting, and the sprouts were of slender and delicate growth.)

IX. A premonition to the working-party: here are two statements made to the workmen, as if from a pilot, or master, occupying a more commanding situation, each one pregnant with suitable meaning: (1) the doors not yet being closed, and (2) the bare floors not yet exposed to view; meaning, the seed not all planted, the work not yet finished: lines, 43-46.

X. The command to the working-party, to act on the favourable moment: lines, 47-48.

XI. Again an address to the kumara sets, still personified; as if mollifying the command just given (somewhat of a lowering nature), and reminding them of their ancient heavenly origin‡: lines, 49-50.

XII. Another admonition to the working-party: lines, 51-53.

XIII. The work (viewed as) done: lines, 54-55.

XIV. A remark as to Pani's residence in the sky, out of sight: line, 16.

XV. A reminder to Pani, to reward them after the manner of their own readily believing her,—or the ancient legend, etc.,—and, of their having acted upon it: lines, 57-60. (*N.B.* This is the earliest meaning, in this sense, of the word *whakapono*, that I have ever met with. It is now, and for the last 60 years, similarly used by the missionaries and others (also, in the Maori translation of the Scriptures), for *faith;*—the believing the matter spoken of, or taught;—the making-it-to-be-a-reality. A word, however, extremely rarely used in their ancient recitals.)

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* See my conjecture, as to possible meaming of the name kumara, p. 34.

† See "Trans. N.Z. Inst.," Vol. XIII., pp. 8, 9.

‡ See, *supra*, pp. 35, 36.

And here we should also bear in mind, that all this eminently peaceful industrious and pleasing agricultural work was the common yearly occupation of this people,—of the whole Maori nation throughout the North Island, by whom it was heartily loved and passionately followed.* To me, the consideration of the manifold useful patient and ornamental industry of the ancient New Zealanders,—their untiring interest, the pains, the love, formerly bestowed upon the scrupulous selecting, the perfecting, carving and decorating of almost all objects of daily use, even when the service itself was most common and material (including their wooden spades and axe handles, their canoe paddles and balers!), was truly wonderful; and all done without tools of iron or any metal, and ever without thought of pay or reward! And all that, too, amid the frequent disturbing and contrary heavy labours arising from fratricidal and murderous wars, building of forts, storming of towns, and general desolating violence, in which their strong natural and uncontrolled passions were too often wholly engaged.

In conclusion, another curious superstition relating to Pani, sometimes observed on the harvesting of the crop of kumara, may also be mentioned. At such seasons, a peculiarly shaped abnormal and rather large kumara root was met with, though by no means frequently (sometimes not one such in the whole cultivation), this was called "*Pani's canoe*"=Pani's medium, between her and the priest and the crop; and was consequently highly sacred, and never eaten by the people. To do so would be to insult Pani, and sure to cause the rotting of the whole crop when stowed away for keeping and winter use in the kumara store-house (a thing to be greatly dreaded); besides other serious visitations on the people. It, therefore, became the peculiar property of the priest, and was set aside to be cooked at a sacred fire as a kind of offering of first-fruits. The finding such a root was matter of great gratulation, for now it was made evident that Pani had heard and visited and blessed them. And as (from what I could learn) such a kumara root was chiefly, if not only, to be found when the crop was a very prolific one (which, indeed, was highly natural); this fertility was also taken as another proof of Pani's gracious visit, and, of course, placed to the account of the knowing and fortunate priest, who had initiated all things so well as to bring it to pass, and so to secure a good crop!

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* See, "Trans. N.Z. Inst.," Vol. XIII., pp. 5-10, 33, 34, etc.

Art III.—*On the fine Perception of Colours possessed by the ancient Maoris.*
By W. Colenso, F.L.S.

[*Read before the Hawke's Bay Philosophical Institute, 10th October*, 1881.]

In a paper which I had the honour of reading here before you last year, ("On a better Knowledge of the Maori Race,") I alluded to the surprisingly powerful natural faculties of the Maoris; particularly instancing those of Memory, Sight, and Hearing; and ending my remarks in that place by saying,—"their fine discrimination of the various shades and hues of colours—particularly of blacks, browns, reds, greens, etc.,—was truly wonderful. On this subject and its relatives I hope to write a paper."*

I should not, however, have chosen to do so at the present time, (for I had desired to finish a paper on "Hawaiki," which I had been preparing), had I not seen a paper by Mr. Stack, of Christchurch,—"On the Colour Sense of the Maoris,"† in which, according to my certain knowledge and long experience, there is no small amount of error; and believing this, though reluctant to suspend other work, I have deemed it to be my duty to lose no time in bringing my promised paper before you.

And here I would briefly remark, that what I shall now bring forward in this paper is from my own individual experience only; derived, not merely during an extra long period of dwelling among the Maoris, and that before the country became settled, (for others have resided in New Zealand as long, or even longer than I have), but mainly from my having travelled so very much among them; very frequently in parts where no white man had ever been before me; sometimes on the battle-field, both during and after the fight; and always in the additional capacity of a "doctor" or medical man, and ever on foot and with them; always having, also, several of their best head men (chiefs and priests) voluntarily and heartily travelling with me as companions from their own *pa*, or village, to the next *pa*, or halting place, or bounds of their tribe (as the case might be); and all this, too, at a period in their history when *they had no extraneous foreign matters to trouble them or to talk about.* And so I have had very many fine and profitable opportunities of hearing and observing many things that naturally and spontaneously occurred, which otherwise, probably, I should never have known; and which (as far as I know) no other European has ever had so many advantages and opportunities of knowing. Moreover, owing to Mr. Stack's paper, and to do the old Maoris justice, I shall have to relate many pleasing

* "Trans. N.Z. Inst.," Vol. XIII., p. 63.

† "Trans N.Z. Inst.," Vol. XII., p. 153.

little confirmatory incidents,—more, in number, than I had originally intended to do,—as there is nothing like a concrete example for testing an abstract theory.

(1.)

*Of their universal national taste concerning colour.*

I have already slightly touched upon this in a former paper ;* notwithstanding, I may again state, that the colours of black, white, red, and brown, were the prized and favourite ones,—the purer states especially of each of those colours were highly valued,—to which may also be added yellow and green. Those several colours, and their differing shades, comprised nearly all that pertained to their dresses and personal decorations, to their (principal) houses and canoes, and moveable property generally. Indeed, a chief's house, in the olden time, might truly be called a house "of many colours ;"† which, within, were artistically and laboriously displayed. Of course, there were very many shades of each colour ; as, for instance, of white,—from pure white *(candidus)* to whitish-brown ; of yellow,—from bright yellow (gamboge, almost orange) to a faint tint of that colour ; and of green,—in its many hues exhibited in the several varying specimens of

* "Trans. N.Z. Inst.," Vol. XI., p. 81.

† In 1844 (on my coming hither to reside) the Maoris built several houses for me ; one, in particular, as a library and study, in my garden, deserves a brief passing notice by way of an example. This one was to be built and finished in their best old style (omitting all carved work) without my interference ; and, therefore, their skilled old *tohungas* were gathered together over the job from the interior and as far north as Poverty Bay. The building, composed of two rooms, was 10 feet high to the wall-plate. The frame-work and massy dubbed pilasters were composed of dark old *totara* wood, which they laboriously dug up from the bed of the Tukituki river, many miles away. It had three separate layers of *raupo (Typha)* in its sides, (besides the outer coating of a stiff and hard, yet fine, Restiaceous plant *(Leptocarpus simplex)*. The *raupo* was first separated leaf by leaf, without breaking, and so carefully dried ; but the panelling work between the pilasters (each panel being about 2 feet wide) was the curious part. First, the horizontal layers of narrow black and red bands, or laths, three of each colour, placed at regular distances ; behind these was the close facing of selected yellow reeds (culms of *Arundo conspicua*) longitudinally and regularly placed ; to these, and to a cylindrical black rod running down the whole length in front of the laths, the coloured laths were beautifully and elaborately laced by fine white, grey and yellow strips (excessively narrow, $\frac{1}{8}$ to $\frac{1}{10}$ of an inch wide) of *kiekie*, *pingao*, and *harakeke* leaves, each panel being also wrought in a different regular pattern of raised filagree work. For years this house was the wonder of all visitors (European and Maori) : Bishop Selwyn often admired it, and so did Mr. (afterwards Sir) Donald McLean, on his first visiting Hawke's Bay as Government Land Commissioner, in 1851 ; indeed he told me he had never seen its equal ; and he also gave orders for a similar one to be constructed for him at Port Ahuriri. This was also done ; but it was but a poor imitation, as the skilled old builders were no longer here. In this latter house Mr. Domett, as Resident Magistrate and Crown Lands Commissioner, resided for several years. Mine stood over 25 years, when it was burnt down accidentally.

*pounamu* (jade), etc. Each tint or shade of colour bore its own peculiar name plainly and naturally, or figuratively, and sometimes both. Their love, or great desire, for the possession of those colours, is best shown in their zealous and heavy labours in seeking and obtaining them *(infra)*.

(2.)

*Of their fine general discrimination of the various shades and hues and tints of colours.*

This, with me, was always a very pleasing subject. The bare present writing of what I have seen and heard serves to conjure up a host of pleasant reminiscences of the long past! indeed, I find it difficult to make a selection from many an interesting narration and discussion,—by night around our bivouac fires in the forest and in the wilderness; by day in travelling, and in resting, and (sometimes) when shut up for days together in their *pas* through rains and storms and swollen rivers. Foremost, here, I would mention their accurate description of a rainbow, of all its various colours, and of the difference between a bright and a faint one,—of the *cause* of its being so shown, and of its *meaning*, too (in their estimation),—and of the animated discussion that would sometimes arise upon it; not unfrequently proved by me to be correct (as to its colours) when a double rainbow appeared,—as then the colours were inverted. Their quick discernment of the iridescent hues of the feathers of a pigeon's neck glancing in the sunshine, when snugly ensconced aloft among the foliage of a tall white pine tree; and their subsequent accurate description of them, and their comparison of those changing tints (as to colours) with the ever-varying nacreous ones of the mother-of-pearl of shells (particularly *Haliotidæ** and some *Trochidæ*), and with the delicate evanescent hues of the bellies of several fishes when first caught,—as the mackerel, the scad, and the elephant-fish; and also with the prismatic bubbles and scum of coal-tar floating away on the calm surface of the tide,—which, on a few occasions, some of my own domestic travelling Maoris had early seen at the Bay of Islands. Also, when sitting, resting on the edge of a cliff near the sea, to note their observations on the changes in the colours of its surface caused

* Hence it was that the old Maoris devised and fitted out their admirable lure, made of a long cut and carved slip of the shell of the *Haliotis iris*, for sea-fishing with hook and line, particularly in the summer season for the *kahawai* (*Arripis salar*); when they paddled their little canoes, each manned by a single fisher, briskly through the water, with their line and lure towing astern. And here, I should further observe, that it was not every shell of the *Haliotis* that would serve the skilled Maori fisher's purpose; no, he would turn over and examine a score or two until he had found one which, to his searching eye, gave the exact tint of colour he required. And just so it also was in their painfully selecting a bit of the same shell for the artificial eyes of their staffs, etc.—See "Trans. N.Z. Inst.," Vol. XII., p. 77, *note* B.

by a passing cloud; and then to hear of how, in former days, the proper skilled scout* perched on a cliff would descry the approaching shoal of mackerel, or *kahawai*, or other annual summer fish, from the change in the colour of the sea, and would direct accordingly the takers with the big seine nets in their canoes.† From similar positions, too, we ourselves, when perched on the cliffy heights overlooking the deeply-embayed tidal arms and reaches of the sea,—whether at the Bay of Islands, on the many inlets and branches of the Kawakawa, Waikare, Waitangi, or Kerikeri rivers,—or at Rangaunu,—or at Whangaruru, or at Ngunguru,—or at Kaipara!—or at Whangarei, with its multitude of inlets, creeks and branches,—we ourselves have often received great benefits from their accurate sight, well-knowing, even from a distance, the precise state of the tide on those muddy flats and in those mouths of rivers below, and that solely from the hue of the water there; and, in so-doing we were often saved a considerable part of what was always a disagreeable job. For, in all those places, owing to there being no beaches, and the banks clothed with dense vegetation to the water's edge, with a belt, or thicket, of close-growing outlying mangroves, the usual rise and fall of the tide could not be seen.

Their quickness of vision also instantaneously and correctly detected what kind of fish it was that had fleetly passed us at sea, when out together in our boat or canoe, and that more from its peculiar colour, than from its form and manner of swimming. And so with their small fresh-water fishes, many of which closely resemble each other (including not only the various species, but, also, the differing varieties of those species, some of which also change their colours with age, as well as before and after the spawning season); these were all respectively known by their hues and mottlings, and each kind and variety bore its proper distinctive name. More than once, in my early travelling, has some kind Maori with me (either before or behind, in the long straggling single file), gathered a flowering branch of *Solanum aviculare*, and of *Wahlenbergia gracilis*, and of *W. saxicola*, and kept it for me; because his quick eye had noticed the change of colour in their flowers, from blue, and from lilac to white; which change in those two genera is not unfrequently the case: and not unfrequently was my attention loudly called to a large spider (of the species so very common and unpleasant in the open shrubby wilderness) whose main colouring and markings were different from others. Sometimes, also, in our journeyings, we should find a few large stray tail or wing feathers (generally one at a time), all more or less of a common brown colour, but with different light

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* "Huer," in Cornwall, on the pilchard seine-fishery; and done by the old Maoris, by signs, much as it is still practised there.

† See "Trans. N.Z. Inst.," Vol. XIII., p. 44, for an instance.

or dark markings; these would be collected and preserved, and talked over, and decided by the older men to belong to the parrot, sparrow-hawk, common hawk, long-tailed cuckoo, wood-hen, bittern, etc., etc. And here I may mention (as being probably but little known), that each separate feather (primaries) of the wing, and also of the tail, bore its own distinct and proper name. Distant trees, whether standing alone, or in clumps and thickets, or growing with others in the forests, were also accurately known by their colour—their peculiar and specific hue of green. So were distant plains, and marshes, and open hills of a country wholly unknown to us; which, sometimes, lay before us, stretching out some miles away! Such would be sure to form an interesting theme to all of us; particularly to my Maori companions, who (poor fellows) always had to traverse those unknown and trackless wilds,—hills, plains, and marshes,—with bare feet and legs; not to mention our often not knowing where sunset would find us travelling, and so compel us to halt for the night. From their general hues alone the Maoris could accurately tell whether those far-off unknown places were covered with a vegetation of fern[1] or flax,[2]—dwarf *kahikatoa*[3] or mangrove,—*toetoe*[4] or *raupo*,[5]—*wiwi*[6] (species) or *toetoeupokotangata*,[7]—or, if of grasses, whether *patiti*[8] or *raumoa*.[9]

A remarkable instance of their detection of a change of colour in the distant and unknown landscape, I may briefly relate,—especially as it completely bothered us all at first sight! It happened in 1845, when I first visited the South Taupo country from Hawke's Bay. On this occasion we were without a guide; we had advanced some way into the interior, and had just sighted the high open lands of Taruarau, when the strange general hue of their vegetation bearing a slightly reddish cast immediately attracted our attention. That country was then wholly unknown to all of us, and so was its vegetation; moreover, it was trackless. Among my party were some Maoris who had travelled much with me throughout the island, but we had never before noticed anything like that. Some of the party said one thing, and some another, and there was a long and earnest discussion carried on, while we were slowly journeying thither, as to what it could possibly be. Arriving there we found the reddish colour to be caused by a low red sedgy Cyperaceous plant, with long narrow grass-like leaves, a species of *Uncinia*,* which gave the prevailing reddish hue to the vegetation round about.

1. *Pteris esculenta*: 2. *Phormium*: 3. *Leptospermum scoparium*: 4. *Arundo conspicua*: 5. *Typha angustifolia*: 6. *Juncus* (sp.): 7. *Cyperus ustulatus*: 8. The commoner perennial grasses: 9. *Spinifex hirsutus*.

* In sending specimens of this plant to England, I had named it *U. rubra*; which Boott, in describing it, also adopted. I see that Dr. Sir J. Hooker (in the Hand-book of the New Zealand Flora), speaks of it as being "red," and, also, "red-brown when dry;" but it is much more red when living.

But, far above all, their fine discrimination of delicate hues and shades was correctly shown in their nice distinction of the various tints of the flesh of the several kinds of *kumara* and of *taro* when cooked ; also, of the varieties (in colour) of the *koroi* berry (fruit of the *kahikatea*—white pine tree), and of the *karaka* berry (*Corynocarpus lævigata*) in their stages of ripening ; and of the several shades and hues of their dressed flax during the drying and bleaching process ; for all of which colours, or fine shades of colour, they had distinctive names. And here I may relate a notable incident which once happened ; it pleasingly surprised me at the time, and often since on recollection. I was travelling, as usual, in 1845, on the coast, and was staying at Mataikona, near Castle Point, then a populous village. In talking with one of the oldest chiefs of the place about the *taro* plant, and its varieties, he said that he had long ago seen and cultivated the sort called *Wairuaarangi*,* but that it had long been lost to them. Now I had also known that peculiar sort when residing at the north, and I had more than once noticed the delicate and curious pinkish hue of its flesh, so different to the other sorts ; and wishing to test my old friend's knowledge, I enquired particularly of him its colour, and his answer was a beautiful one, so clearly expressive ; he replied,—"*I tu-a-kowhewhero tona kiko.*" A phrase exceedingly difficult to render as briefly into English ; but meaning, that its flesh had a pinkish appearance.†

(3.)

*Of their names for colours, and their various shades.*

Here I would first observe :—

(1.) That, according to the genius of their expressive language, many common nouns are as largely used for indicating a single species, or peculiar

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* See "Trans. N.Z. Inst.," Vol. XIII., p. 36.

† *Wairuaarangi*—the proper name of this variety of *taro* is so highly expressive (like most special names among the old Maoris) that I am tempted to give its full meaning, and to offer a few words upon it. *Wairuaarangi*, *lit.* Reflection-from-(the)-sky : meaning, the light reddish-pink tint, as sometimes thrown of an evening over the features of the eastern landscape, from a glowing sunset ; also, the more distant, faint, reddish hues of the rare ends of an *aurora australis*. This colour (as I have sometimes seen it of a summer's evening), when cast on or reflected back from white cliffs or mountain snow, or from an extensive flat filled with the dead feathery panicles and culms of the large cutting-grass (*Arundo conspicua*), is exceedingly like that of the pink flesh of that peculiar variety of *taro*; and its poetical beauty, as well as its truthfulness, is still further enhanced when we think (*as the old Maoris did*) of that beautiful colour as emanating from a Personage, (the Sky), and their great, first, and common Father.

I have before had occasion to observe that, with the old Maoris, the *name* of a thing meant a great deal—very much more, concerning its qualities, uses, etc., etc.—than we at best can possibly suppose. Hence, too, the incessant demand from them in the early days, on seeing any new thing, whether vegetable or animal, especially if *living*, of—"the name," "the name?"

individual of a family,* as they are for a stirps, family, or genus; and commonly so by way of laconism, ellipsis, abbreviation, or carelessness; always, however, perfectly well understood among themselves. Hence, owing to this common usage, appellatives and proper names become gradually dropped, and fall into abeyance; though, *as the Maoris formerly were*, never wholly forgotten.

(2.) That being a truly natural observant race, and fully acquainted with nature, they often, or generally, used her peculiar productions and appearances to express colour, or the exact hue of colour required;—there was no mistake here, among themselves. For in the highest minds a single descriptive word, or sign, is sufficient to evoke crowds of shadowy associations.

(3.) That from *the particular shade of colour of a thing*, they often gave to other and very opposite things their names,† as in the foregoing example of the pink-fleshed *taro*.

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* *Harakeke*—flax, (of which they have more than 50 sorts, or varieties, every one bearing its distinct and proper name).

*Ika*—fish, (nearly all fishes; each, however, has its own proper name).

*Kai*—food, (also, all articles of food; though each one has its own proper name).

*Kahu*—a garment, (all garments, of which they had a great and varied number, all bearing proper names).

*Kowhatu*—a stone, (all stones, etc).

*Hua*—fruit, (of plant, tree, bird (egg), fish (roe), etc).

*Rakau*—tree, (of all trees; yet each one has its own proper name, and some several names for various parts of the same tree, which are often given for the colour).

*Pipi*—a bivalve shell-fish, (and generally for all salt-water bivalves; each one, however, has it own distinct name).

*Pupu*—a univalve shell-fish, (ditto).

*Kumara*—sweet potato, (yet many sorts, all bearing proper names).

† Of which a few instances are here given by way of example:—

*Paua*, the black flesh of the *Haliotis;* also, a black sunburnt potato.

*Mangu*, *mamangu*, and *mangumangu*, black (colour); also, ink, blacking, etc.

*Tawatawa*, the mackerel, and *tamure*, the snapper fish; also, a peculiar appearance of the sky from *cirrus* and *cirro-cumulus* clouds, through which the blue appears something like the deep blue wavy marks on the back of a mackerel freshly caught (this term of *mackerel-sky*, is also given to it by Europeans); also, resembling the dark wavy lines on the flesh of a fresh snapper under its skin when cooked.

*Toroamahoe*, the white-skinned root of the *mahoe* tree (*Melicytus ramiflorus*); also, a variety of whitish skinned *kumara* of exactly the same shade of colour.

*Pokere kaahu*, a dark purple variety of *kumara*;—from *pokere*, the dark purple flesh of the fruit of the *tawa* tree (*Nesodaphne tawa*), and *ka ahu*, to proceed towards; to grow up to; to become like to.

*Parakaraka*, the orange-red colour of the fully ripe *karaka* fruit; also, a light reddish-orange variety of *kumara*. [N.B. This variety of *kumara* has ever been believed

(4.) That their principal proper terms for colours were often compounded ingeniously and beautifully, in accordance with the expression and idiom of their language:—

(*a.*) By reduplication, and by half doubling:

(*b.*) By adding qualifying adjectival terms for intensifying or lessening; the power of which was further heightened or lowered according to their position;

(*c.*) By the aid of several apt particles of different degrees:

(*d.*) By other expressions also adjoined, of admiration, or depreciation. (See *Paradigm*, Appendix I.)

5. That certain colours took their own proper intensitives, etc., which could not be used with other colours.

(4.)

*Of their great labour, patience, thoughtfulness, and skill, exhibited in their seeking after and obtaining the various shades of colours; often labouring to a nicety to procure them.*

Hence (after many trials) they had succeeded in getting their brilliant black and red dyes; the former, in particular, being often envied by their early discoverers and visitors and their several European peoples. And here (as I have formerly observed when treating on another subject), we

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by me to be the identical sort seen and obtained by Cook and his companions, and well-named by them *chrysorrhizus*.]

*Pohutukawa*, a tree (*Metrosideros tomentosa*) having reddish wood; also a variety of *kumara* with reddish flesh of just the same shade of colour.

*Whero*, red (colour); also the rectum protruding, etc.

*Kumu*, the anus; *whakakumu* a red variety of *kumara; kumukumu*, the red-backed gurnard (*Trigla kumu*).

*Waewae-kereru* (pigeons' feet), and *waewae-torea* (oyster-catchers' feet), which are always red; also given to infants when wearing red shoes or socks.

*Korau*, the white edible pith of the black fern-tree; also, the large white root of a species of *Brassica*, formerly largely eaten by the Maoris.

*Kakariki*, bright green colour; also, the small green parrots; the green lizards; water melons, etc.

*Kawakawa*, the *Piper excelsum* shrub; with glaucous green leaves; also, a particular variety of jade-stone, having just the same hue of green.

*Pounamu*, the green jade-stone (general name); also, a common green glass bottle, and (with the Ngapuhi tribe) a peculiar potato, planted in February and ripe in May: (*infra*, § 6).

*Waikura*, the reddish stagnant water of some sluggish water courses and pools, arising from a deposit of protoxide of iron; also, rust on iron tools, etc.

*Waro*, charcoal; also, mineral coals; a very dark cave; a black abyss.

*Pukapuka*, the shrub with large leaves, white underneath, (*Brachyglottis repanda*); also, a book; white paper, etc.

must never lose sight of this great, this astonishing fact, namely, that the ancient Maoris knew not of the use of iron nor of any metal, neither had they any vessel which would stand fire!

Nevertheless they knew that by a second or even a third process, as well as by the application of heat in dyeing, they should increase the depth of the colour sought. To me it was really a wonderful sight to see a woman patiently engaged in her work of this kind; (take an instance)—with nothing better at very best than a large *paua* shell (*Haliotis iris*), with its natural holes artificially stopped up, as a vessel to hold her dye-liquid (red-brown) and the article to be dyed, but only a very small quantity at a time of yarns of flax (*Phormium*) scraped and beaten and carefully prepared,—this shell with its contents was warily placed on hot embers to raise it to boiling heat, and to keep it so, and there long and carefully watched and tended, and the few yarns in it taken out and repeatedly tried, until the proper shade of colour sought was obtained! which done, the operation had to be frequently carried out until a sufficient quantity of threads were died. Such always served to remind me of what we are told by Pliny* and others, respecting the tedious process followed by the women of Tyre in obtaining the famed Tyrian purple dye from the *murex* shell-fish,—"a tiny drop from each living fish!"

(5.)

*Of their light colours.*

These were various, and were both natural and artificial.

The *natural* ones were several; namely, of pure white,—the snow, the clouds, and the surf; the large white-leaved *pukapuka* shrub (*Brachyglottis repanda*), and the peculiar white-fronded fern-tree (*Cyathea dealbata*); and, strange to say, such out-of-the-way recondite objects as the white milky sap of the plant *Euphorbia glauca*, and the white meat (flesh) of the tail of the crayfish when cooked, and, also, the whiteness of living human teeth (all these I have heard used by way of naming, or of comparison); the plumes of the white heron, and of the gannet; the small downy feathers of the albatros, and of several gulls and terns; also, of another shade of white, the very thin and delicate epidermis of the long leaves of the *tikumu* plant (*Celmisia mackaui*), and the prized long hair of the tails, and also the skins, of their little white dogs. Of yellows, the long flowering reeds, or culms (*kakaho*), of the *toetoe* plant (*Arundo conspicua*); and the harsh leaves of the gamboge-coloured *pingao* (*Demoschœnus spiralis*).

The *artificial* ones were also many, and were obtained in various ways, mostly by washing and beetling, and by bleaching; namely, their dressed flax fibre and yarns for weaving their mats, and for twisting into cords,

* Pliny, Nat. Hist., *lib.* ix., *c.* 60-63.

lines, and threads, of almost all light hues,—from that of a light fawn, and a whitish-brown, to a dirty or dull white; their selected flax strips, tassels, and fringes, with the yellow epidermis unbroken save at regular distances; the narrow bleached strips of the leaves of the *kiekie* plant (*Freycinetia banksii*); the bleached inner bark of the celebrated *aute* (paper mulberry), and, also, the inner bark of the little *autetaranga* shrub (*Pimelea arenaria*).

And so particular were they (at times), that I have known them to patiently undo their panels of laced-up reed-work, after having laboriously fixed them up in their places in the chiefs' houses, merely to take out a stained reed or two which did not harmonize in colour with the adjoining ones;—though this portion of that work (*i.e.*, the proper selection of the reeds) was usually done by going over them one by one, and by joining them telescope-fashion, before they were carried off to be fixed in their proper places. And just so the women, in the weaving of their best dress mats (one of which always took a long time, often over 2–3 years), they strove hard to have the bleached yarns of flax in the body of the fine garment, though prepared at different times and seasons, all of one hue of colour throughout; often while weaving it rejecting a yarn or strand on account of a slight difference in the colour. Indeed, so sharp were their well-trained eyes at this work, that they could distinguish a difference in the shade or hue of the flax-yarns and threads when I could not.

Two little incidents, illustrating their high powers of discerning the light shades of colours, may here be mentioned. (1.) Nearly 50 years ago, when some of the Maoris had learned to write, and paper for that purpose was in high request, they preferred the white or cream-coloured paper to the foolscap writing paper having a light cast of blue, though the Mission annual supply of writing paper was composed of this latter sort, and it was stouter and stronger and better fitted for their use. (2.) When the first canaries were introduced into New Zealand, and the few Maoris who had seen them in the Bay of Islands were describing them to their friends who had not seen them, and some said the colour of the new bird was that of the *kowhai** flowers (*Edwardsia grandiflora*), others corrected them by saying, "No; not so; rather that of the paler *whanariki*" (sulphur), with which, in its pure native state, they were well acquainted.

The beautiful natural light colours of the bellies of several living fishes —silvery, dead white, slightly iridescent, and with a faint tinge of blue,— were also much noticed and remarked on; and so were the light colours, internal and external, of several shells; insomuch that not a few of them had early passed into their proverbs and songs.† Hence, too, they were

* See "Trans. N.Z. Inst.," Vol. XII., p. 99.

† See "Trans. N.Z. Inst.," Vol. XII., p. 142.

quick at detecting any light coloured variation in the plumage of birds, (well-knowing the few genera that sometimes produced albinos), and in the foliage, and fruits, and wood of plants, as well as in shells; all such, and every variety of colour, bore its own proper name.

A little botanical incident bearing on this subject may be briefly told:— On one of Mr. A. Cunningham's visits to New Zealand, he went to the *kauri* forests botanizing. While there he heard from his intelligent Maori companions of *two* kinds of *kauri* known to them, but only by the difference in their names, arising from the variety in colour of their timber. This set him on the search after the *new Dammara* pine, No. 2! but after much toil and enquiry, and the obtaining of a quantity of foliage specimens, he gave it up, concluding that such slight difference in colour (which did exist) might arise from the soil, or situation, or from the varying specimens of timber having been cut from both the sunny and the shady sides of the same tree; this latter opinion, however, the Maoris (and the few European sawyers then at work among them) always denied. It was one of my dear friend's last bequests to me to follow that enquiry up; but, like himself, I never could make anything of it. There is, however, a difference in the colour of some of the *kauri* timber, exclusive of the prized "mottled" kind, for which the old Maoris had, as usual, their own proper distinctive names.

(6.)

*Of their dark and sombre colours, not black.*

Of natural ones, they distinguished at a distance the heavy dark-green of the clumps or thickets of some trees, such as *karaka*, *mataii*, etc., and correctly named them: also, of their dark-coloured, edible fruits, when ripening, high up on their topmost branches, as of the *mataii* pine (*Podocarpus spicata*), — so as to save themselves the trouble of a high, dangerous, and always disagreeable climbing, to examine them. The peculiar black-blue colour of the sky on certain nights, dependent on the state of the atmosphere; also its colour at various times of the night; and particularly the two dark pear-shaped spaces in the Milky Way, near Centaurus and the Southern Cross (called *Coal-sacks* by the early navigators); also of the ever-varying storm-clouds, for which they had more than 40 names; and the dark colour of the sea, in calm weather, over rocky shoals, and in deep holes off the coast; the slight shades of difference between the colours of their own dark hair; the difference between the colours of several dark-plumaged birds closely allied, as of various shags and gulls, and also of some forest birds; the difference between the varying blue-black and brown-black colours of the backs of several of the larger sea-fishes and of eels; and were particularly knowing in the matter of dark-green* coloured "sun-burnt" potatoes, some

* See note § 3, clause 3, *supra;* hence that name.

kinds or intensities of which they preferred for seed. They knew at sight the difference in the colour of blood recently and some time shed; and, also, from the hue of the rich purple juice of the fruit of the *tutu* shrub, (when hospitably set before them in open calabashes in travelling in the summer season), they perceived at a glance whether it was freshly made (when it was highly esteemed), or whether it had stood a day or two; and they accurately determined the age of severe bruises on the human body from the difference in their colour. From a great distance off they knew what was burning by the colour of its smoke, whether arising from dry or green fuel, whether from swamp, or plain, or forest vegetation; and they also knew from the colour of soot what it had been obtained from:—this last was formerly a matter of great importance to them in the business of tattooing.

Of colours of this class artificially produced were the dark-red dyes of various shades obtained from the bark of the *tanekaha* (and *toatoa*) tree (*Phyllocladus trichomanoides*), used in dyeing yarns for the decorated borders of their best flax garments, and in staining their superior furniture, walking-sticks, etc., etc.

(7.)

*Of their black colours.*

Of all their artificial colours, black was the one which they knew how to make and impart to perfection. This colour they had naturally around them,—in the mineral, the vegetable and the animal kingdoms; in the first in coal, and in the black oxide of manganese, and in many species of rocks, as in obsidian and basalt; in vegetables in the common Fungi of the forest,—as *Antennaria*, *Capnodum*, etc., which sometimes completely covers the trunk of a large tree, and gave rise to strange tales and fancies; and in the animal kingdom, in the plumage of some birds,—as of the *tuii*, the *tieke*, the *huia*, the *torea*, the *kawau*, and the back of the *pukeko;* in the flesh of the shell-fish *paua*, and of the *rori:* and in the black internal skin (lining mouth and abdomen) of several fishes,—as the mackerel, herring, mullet, etc.

In their own peculiar artificial dyes of black, of various shades of intensity, used for dyeing garments, etc., they have never been surpassed; some of their black dyes being strikingly deep, pure, brilliant, and lasting. All their earlier European visitors were astonished at the intensity of this colour used as a dye among them. For dyeing black their flax threads yarns and garments, dressed and undressed, and also their whole big garments (thick cloaks) made of the fibres of the *toii* (*Cordyline indivisa*), they generally used (as is now well-known) the barks of two closely allied trees, *hinau* and *pokaka* (*Elæocarpus dentatus*, and *E. hookerianus*), with a mordaunt composed of aluminous clay; they also used the bark of the *tutu* shrub (*Coriaria ruscifolia*) to obtain a blue-black, which was sometimes used for fancy and ornamental work,—as in weaving graceful little baskets, etc., for a first-born or beloved child,—it had a very peculiar hue; and for the purpose of body-tattooing they used various kinds of charcoal, both animal and vegetable, obtained from several peculiar sources, and manufactured in a highly curious manner with much labour and skill. For colouring black their narrow and thin wooden slips, or carefully prepared laths of totara wood,—with which they plentifully ornamented the interior panels on the walls of their chiefs' houses, in order to set off to advantage the white and yellow filagree work interlaced thereon to regular patterns, as well as the lighter yellow reeds beneath,—they passed the laths one by one repeatedly and quickly through a fire, partly charring the outside, until they had made them of the proper hue; this done the slips were well rubbed and made quite clean and glossy, and fixed in their places.

(8.)

*Of their sober neutral colours neither dark nor light.*

These, composed of various shades and of nearly all colours, they knew well, both naturally and artificially. It was in this particular portion of their discriminating knowledge of the shades of colours, that I early felt the more deeply interested, and often indeed proved their correct descriptions of them, with no small degree of astonishment; for by it I was not unfrequently led, in my early botanizing, to note down and to obtain some new plants or varieties of plants. Even while writing this, I well recollect their statements to me (40 years ago and more), concerning certain plants,—as various species of rushes and of sedges, of scented *Hepaticæ*, of river *Confervæ*, and of sea-weeds, and particularly of a *Chara*, and of a curiously-coloured species of *Conferva* (possessing a steel-blue cast of colour), which I was led to seek in out-of-the-way holes, through casually hearing from an old woman of their different shades of colour. Hence, too, they discriminated between the different sorts of *kumara*, and of *taro*, when the plants were young and growing, by the hue of their leaves (and also of the various kinds of potatoe), and that when travelling along by the plantations, outside of the fence. Also, the varieties of New Zealand flax (*Phormium*), more than fifty in number, were detected by the hue of their leaves,—all being alike green, yet all slightly differing in the shade of that colour, and only three or four of them (at most) in the shape and size of their leaves. I have sometimes been amused, when travelling, in hearing the descriptive remarks (among others) which would arise from my party, on the baskets of cooked potatoes being placed before them, kindly yet hurriedly boiled on their arrival at a village. On the top of each basket, according to custom, was placed a handful of boiled greens (of sow-thistle tops, or of wild cabbage-sprouts), of such as were at hand; and the remarks would arise simply from the difference in the colour of the greens,—some being well-done, and some (hurriedly) half-done; some freshly gathered, and some stale; the food having been quickly cooked for them by two or three different persons; the little baskets severally brought in; and, according to etiquette, none touched until all were in and placed (as, indeed, with us). It was owing to this finely-developed faculty that they knew so well, and from a distance, whether the annual summer luxuries obtained from the female flowers of the *kiekie* plant, and from the pollen of the *raupo*, were in season, and ready for collecting or not,—through the slight change in the green of the tips of their leaves,—and so saved themselves the labour of climbing, etc., purposely to ascertain.

And here I may mention another little botanical incident, which indeed not unfrequently occurred in our deep forest travelling. And to those present who may have travelled through, or even only entered into, an uncleared standing New Zealand forest in all its pristine glory, such a relation may almost seem marvellous. In those umbrageous forests the large trees are generally completely covered with all manner of plants growing thickly on their trunks and branches, as freely, or even more so, than if on the ground beneath. And there, sometimes, nestling among them, yet far away, high up, would be a rare fern or *Lycopodium*, or some small epiphytical shrub, as *Pittosporum cornifolium*, or a *Loranthus*, or a *Viscum*, or a still smaller plant of *Peperomia;* and yet all those (and many more) were severally made known to us below by their slight difference in hue; and so, through the quick and fine discernment of my Maori friends, I sometimes gained some desirable specimens. The obtaining of one such I would more particularly relate, as it is an excellent example of what I have just mentioned, and one never to be forgotten by me. It was my discovery (at the north, in 1841), of that rare pine, *manoao* (*Dacrydium colensoi*, Hook.). I had heard of it from the old Maoris, but none had seen one for several years, as they grew singly in the dense forests, and the young Maoris did not even know it! On one occasion, however, when travelling through the trackless forest near the coast between the Bay of Islands and Whangarei, we (or rather one elderly Maori then with me) kept a look-out for it. Now this "pine," in its foliage, etc., closely resembled some others of the class,—as the *kahikatea*, the *rimu*, etc.,—especially when at the distance of the top of a high tree, but the keen eye of the old Maori detected it at last (though I, and the other younger Maoris with me, could not make out any difference, owing to the distance). And then, for my pocket-knife, he undertook the ugly job of climbing the tree, and breaking off a branch for me. In this case it was more the peculiar shade of green of the foliage, though distant, than anything else that distinguished the tree in his sight; the fruit of this species being very small and concealed, and not at all showy. Specimens from that branch I subsequently sent to Sir W. J. Hooker, and they were described by him with a drawing.*

It always seemed (to me) as if the old Maoris had a peculiar natural inclination, or bias, towards what I have called neutral colours. This, I thought, was shown,—(1.) in their sometimes choosing to line their large public reception houses with the small, light-brown, narrow stalks of the common fern (*Pteris esculenta*), all cut to one length, and placed horizontally and closely, and built up, or interlaced together, in separate panels between the pilasters of the building, with a very great deal of care and trouble:—(2.) again, in their sometimes preferring to line the roofs of their dwelling-houses and *kumara*-stores (*i.e.* the first layer of thatch placed upon the white rafters), with the large green fronds of the *nikau* palm (*Areca sapida*), which were regularly placed on while fresh, and their long narrow pinnate leaflets neatly interlaced; these, which were green at first, soon became of a uniform dark-brown colour on drying, serving remarkably well to set off to advantage the light-coloured rafters of *kauri*, or of *tawa* wood. This manner of roofing, chiefly obtained at the north, among the Ngapuhi tribe, where the *totara* timber was not so common as at the south:—(3.) in their dingy-looking *kiwi*-feather cloaks, and in their common, slightly-coloured, (dyed) flaxen ones:—(4.) in the brown parrot, and dark pigeon plumes, used largely for their war-canoes:—(5.) in the women wearing around their necks little *satchets* composed of the finely-mottled neutral plumage of the *whio* duck (*Hymenolaimus malacorhynchus*), and of the elegantly flecked, or pencilled, back plumage of the male *putangitangi* or paradise duck (*Casarca variegata*):—and (6) in their, sometimes, only lightly dyeing their prepared strips of undressed flax for their fancy baskets, so as to become of a dark dove, or drab, or even a light slate-colour; and then, in weaving them, to form many kinds of regular chequered patterns, by ingeniously turning sides to the said strips in the weaving; giving the whole, when finished, somewhat of a damasked, or mosaic, appearance, owing to the difference of the reflection in the hues of the one colour, arising from the more glossy upper skin of the flax-leaf regularly interwoven contrasted with the duller appearance of the under and slightly scraped surface of the same; hence, too, it was, that the skilled old lady-weavers were always mightily pleased with the in-woven damasked pattern of a common unbleached linen table-cloth:—and, also, (7) in their pleasingly weaving together the undressed leaves of widely different fibrous plants,—as of New Zealand flax (*Phormium*), of

* *Vide*, "London Journal of Botany," Vol. I., p. 301: and, Hooker's "Icones Plantarum," Vol. VI., t. 548.

*Astelia* (sp.), of *kiekie*, and of *pingao*,—collected from opposite and distant habitats;—some from the deep forests (climbing the highest trees), some from sandy dunes and sea shores, some from cliffs, and some from marshes; and all torn into regular-sized shreds, and dried, and woven in various patterns, into one basket! often causing it to possess a very agreeable appearance from the various hues of colour; though, sometimes, the difference in the colour of some of the strands obtained from various plants was so slight as not to be readily distinguished at first sight by the eye of a stranger,—not without inclining the basket at its proper angle towards the light so as to reflect it.

(9.)

*Of their striking, contrast, and gaudy colours.*

These, though various and often contrary, yet not many in number, I have taken together; and that because they may all (as formerly used by the old Maoris) be well included under the one term of *striking; i.e.*, immediately catching the eye and arresting attention.

And here their red colour, in its various shades of richness and depth, must take a first place. In nature around them, they saw plenty of a red colour,—in the rainbow, and in the gorgeous hues of the clouds at sunset; in some of their birds,—as in the red beaks and feet of the pigeon, the oyster-catcher, and the blue swamp-hen, and in the red feathers of the large parrot, and on the heads of the two species of parrakeet; in their fish,—as the red gurnard, the snapper, and the crayfish; in many of their sea-weeds; and in the flowers and small fruits of several trees and shrubs. All those reds differed in hue, etc., from carmine to vermillion, and from bright light- to dull dark-red.

Red, as already observed, was one of their national colours; yet, its use was, in a measure, limited; and this, I think, is to be attributed to its having been originally deemed a sacred (*tapu*) colour; which, in connection with their cosmogony, very likely first arose from observing the brightest colour of the rainbow (also a personage), and of the heavens at sunset, and sometimes preceding sunrise. They used this colour in its mineral state only extensively and commonly for their war-canoes, their chiefs' private and their village big reception-houses, their *kumara* storehouses and the large carved images on the outer fences of their *pas* (towns and forts), for their grave fences and monuments, and for their boundary and other raised cut commemoration posts: all of which were more or less public and superior matters. This mineral colour was also used, both by male and female chiefs, for ornamenting or staining their persons, and also their clothing mats, especially on great public occasions and times of ceremony. To obtain this mineral red colour cost them much patient labour and no small amount of skill in its preparation; as all the several varieties of it were only found deposited in very small quantities, whether in the still and slow-running waters, or in the earth; or deposited as minute crystals and rust-like dust between small layers of shale in some dry cliffs. To relate the several long and tedious processes of collecting, roasting, or baking, etc., etc., though highly interesting, would take up many pages. And this toil was not unfrequently increased through their not at first obtaining the true shade of red they wished for, hence they patiently repeated their work. Those various hues of red colour all bore different names; the brightest and purest was very highly prized. Notwithstanding, they never adorned their hair with red flowers, or with red feathers* from their birds; these latter (obtained from the abdomen and under the wings of the big parrot), were used by them to decorate the heads of their staffs of state (*hani* and *taiaha*), for which purpose they were neatly woven into, or stitched on to, a bit of flaxen cloth woven expressly for that purpose.

And here it may be remarked, that on the early coming to New Zealand of Europeans (before the establishment of the colony), and their trading with the Maoris, they did not care to select red wares, save in the matter of red worsted cravats, and red sealing-wax; the former they generally unravelled to weave it into the borders, etc., of their best flax clothing-mats, and the latter they used as a base for the fang of the shark's white tooth which the chiefs usually wore suspended in their ears; and, also, further to ornament the four mother-of-pearl eyes of their carved staffs of state (*supra*). Subsequently, however, when red articles of clothing both woollen and cotton were brought for sale, and (for a time) became more eagerly sought after, the Maoris could not be deceived with the cheaper *common dull red* handkerchiefs, though stouter in quality, instead of the brighter Turkey-red ones.

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* This was the common custom among all the tribes; yet a legendary incident showing the very opposite, may be briefly noticed; particularly as a proverbial saying of some power and often in use is said to be founded on it. On one of their famed "canoes" from "Hawaiki" reaching the shores of New Zealand, the chiefs on board saw the littoral *pohutukawa* tree (*Metrosideros tomentosa*) bearing a profusion of red blossoms; then one of them named Tauninihi flung his own red (feather) head-ornaments into the sea, in order to re-decorate his hair with those beautiful red things before him, saying, "Those on land were far better!" but, on gathering them, they fell to pieces, and he discovered them to be only mere flowers! and was, consequently, much chagrined. After this, his cast-away red head-dress was washed on shore at a place near by, and found by another person named Mahina; who, on Tauninihi seeking to recover it from him, refused to give it up, saying, that it was a waif washed on shore and found by Mahina; which saying also settled the matter. This sentence became a proverb, and was always used by a Maori on finding anything; and through his so doing, the claim to retain it was usually allowed. No doubt there is a far deeper meaning in this ancient story than what appears on its surface.

It was owing to their quick and correct perception of the several hues of red that they often saved themselves from loss and disaster, and from much extra and dangerous labour. As, for instance, in their knowing from the *peculiar red* of the clouds and sky *before* sunrise of the coming change in the weather, and so postponed their deep-sea fishing, or voyage by sea, and sometimes their journey also by land; as they always commenced their expeditions very early in the morning: and, just so, again, at sunset, they knew by the red hue of the clouds, etc., what weather was at hand, and if stormy, then they drew up their canoes, and collected their nets, and arranged their matters accordingly. Indeed, a whole paper might be written on their descriptive powers and opinions concerning the colours of the clouds, their changes, and their portents, and the speedy alterations in the approaching wind and weather (exclusive of their many superstitious notions), of all which they had evidently made a long natural and useful study, in which their remarkably tenacious memory assisted them greatly; every variety in colour (as well as of form, though in a much less degree), was critically scanned, and bore its own proper name. For my part, I confess, I never could learn those nice differences; though I had always found the old Maoris to be correct in their weather prognostications. Also, in the climbing of the high white pine (*kahikatea*), *totara* and *rimu* trees in the forests, to obtain their fruit (a work always attended with more or less of danger), for they readily discerned from below whether the fruits were quite ripe, though very small, from their shade of red colour; and so with the *karaka*, *poroporo*, *kawakawa*, *rohutu*, *kohia*, and other fruits, which are orange-coloured when fully ripe. This last, being a high-climber, was only found bearing fruit on the tops of their highest trees; from its seeds they obtained one of their choicest anointing oils. And here, in speaking of orange-colours, I may also mention the discussions I have known among the old Maoris relative to the proper hue or colour of the wattles of some of their birds (*e.g.* the *huia*, and the *kokako*), which led me to believe that their wattles varied in the intensity of their colour owing to the season of the year, or that those of the male birds were of a different shade of orange from those of the females.

The various sorts of the red-skinned *kumara* tubers,*—light-red, dark-red, purple-red, reddish, etc.,—were also all well-known and accurately distinguished. Their experienced eye also saw, at a glance, the difference in the two shades of red exhibited in the flower and the fruit of the *puriri* tree (*Vitex littoralis*), and accurately described them. And the planet Mars

* See, "Trans. N.Z. Inst.," Vol. XIII., p. 34.

was also distinguished by the old Maoris from the other planets and stars by its redness. Hence, too, they very quickly detected the alteration in the colour of the face and of the eyes,* arising from bashfulness, apprehensiveness, or shame, or from concealed vexation or open anger; and not unfrequently plainly told the actor or sufferer of it! to his, or her, further vexation and discomfiture.

Blue was another colour which the women and young men sometimes used with striking effect for ornamenting their faces, necks, and arms; this colour they obtained from two sources, one mineral and one vegetable, but it was very scarce. The mineral, in the state of a fine clay or powder, was but rarely found at the north, and then by chance, in some cold swampy grounds having a clay subsoil, and there only occasionally, adhering in small quantities to the roots of some cyperaceous plants; when pure it was of a most beautiful hue of blue (ultramarine); the only indigenous natural productions known to me at all resembling it in colour, were the lovely blue berry of *Dianella intermedia* (when in perfection); the blue tints of a *living* Medusa (*Physalis pelagica?*—"Portuguese-man-of-war") often found on our outer sandy beaches in the summer season; and a portion of the blue plumage of the kingfisher; this colour was a still more brilliant blue than the breast of the swamp hen (*Porphyrio*). In the early summer season the youths of both sexes ornamented their faces with the light-blue pollen of the *Fuchsia* flowers,—much, indeed, as they also did with the orange pollen of the New Zealand flax, but this latter was not sought out purposely for face decoration as the former one was, but used, or accidentally smeared, in their sucking the honey-like liquid from the perianths of the flax. Of pure blue colours, however, the Maoris had but few naturally, save in the sky† and (at times) the changeable sea; in the breast plumage of the swamp

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* See, "Trans. N.Z. Inst.," Vol. XII., pp. 124, 138, etc.

† Here I would remark, that it was always my opinion—I might say, my well-grounded belief—that to the old Maoris the unclouded midnight sky did not everywhere appear to be of so dark, or so clear, a blue as it does to us,—owing to the superior strength of their far-off and piercing sight, through which they saw very many more of the smaller stars, and even nebulæ, than we did, or could. I have already mentioned, in a former paper ("Transactions," Vol. XIII., p. 63, *note*) my having *proved* their seeing with the unassisted eye Jupiter's satellites; and I have also repeatedly proved their seeing not only the "seven" stars in the cluster Pleiades (which was one more than I could ever see), but even *more!*—eight, nine, or ten. And so, again, in some parts of the Milky Way,—the nebulæ in Argo Navis, and in Orion,—the Magellanic clouds, etc., etc., all appeared to them more clearly defined, more starry (if I may so say), than to us. Still, their very expressive proper name for the intense blue sky—*kikorangi* (on which and its correlatives a chapter of interesting philological exegesis might be written) must be borne in mind. (I believe that I was the first who discovered, or unearthed, and brought into early notice this term.)

hen, the little blue penguin* (*Eudyptula*, sp.), and the kingfisher; in the mackerel, in a Medusa (common on the sandy sea-shores in summer) and in a few marine shells both uni- and bi-valve; and in two or three inconspicuous flowers of small plants, as *Wahlenbergia* and *Teucridium; Colensoa* also bears a blue flower, which is by far the largest of them all, but it is very local and scarce, being only found in a few spots between Whangaroa and the North Cape. Sometimes, though rarely, a chief would wear a portion of the blue plumage of the swamp hen dangling in his ear as an ornament.

I should also observe, that although (as I have shown) the old Maoris had but little of blue colours of their own which they could use, yet on their early becoming acquainted with Europeans—whether resident among them as missionaries, or merely as visitors in the numerous ships which visited their shores,—no colour was better known to them in all its shades than this one of *blue*. In the ships and vessels—both of the Royal Navy and merchant line—there were the blue jackets, blue shirts, blue trousers, and blue caps! while with the Mission from the beginning, blue was the common and, indeed, almost the only colour used in the female and infant schools, and in the Mission houses and premises, by the numerous female domestics,—all alike were clad in blue, both on Sundays and on week-days. "Navy-blue" cotton prints (dark blue with minute white dots) for the children, and blue linen for the women, and blue woollen shirts, and blue-striped cotton shirts (and sometimes blue caps) for the men; and afterwards (say 40–45 years ago), when the American whalers largely and frequently visited New Zealand (Bay of Islands), they brought their wares for trade, and many useful lots were from time to time purchased from them for the general use of the Mission; and among those goods were the twilled cotton shirt with a much wider blue stripe, and the famed American blue twilled cotton; this last was much stouter and stronger than the thin "navy-blue" cotton print of English manufacture (being made among the cotton-growing plantations, and, I believe, originally, for the use of the coloured slaves there), and was also much warmer than both that and the English blue *linen*, and more easily worked than this latter, apart from its being very much cheaper; therefore, this new blue article also got largely into use. Its colour, however, was very different from that of the "Navy blue" print, of the dark blue linen, and of the blue woollen shirts, being

* In 1836, while residing at Paihia, Bay of Islands, I had a living specimen of the blue penguin, which I kept alive for some time in my garden. I made it a little skin jacket, with a brass ring in the back, and to this I frequently tied a long fishing-line and let the bird go out to aea, where it dived about and enjoyed itself. One day it bit the line in two, and so got off. It was a wonderful pet with the Maoris.

much lighter, and when it was washed it became lighter still in its colour! Hence soon arose a great number of names among the Maoris for all those different shades and hues of blue. Possibly there might have been a dozen or more of Maori names to indicate these several varieties of blue colour, newly introduced. And while it was a neat sight to see all the children, and all the adult women, sitting together at school, etc., clad alike in decent garments of English blue, which stood washing well and kept its colour, it was strangely different afterwards to note the contrasts in the several colours and hues of blue; for the American twilled blue cotton after a few washings became of a dull greyish-blue colour, and was then known among the Maoris as the "*tupapaku*" (corpse) from its faded dead appearance. And so, also, the Maoris in the villages, in their visiting the several stores to sell their produce, and seeking blue cloths and garments, could not be deceived as to their shades of colour, neither as to their durability; just as I have already shown (*supra*) in the matter of the red handkerchiefs. But all those several colours of blue, each bearing a distinct name among them, were shut up by the European under the one horrid term of *puuru*—blue! which, like several other words, mispronunciations of common English terms, inevitably became fixed, and drove the pure Maori equivalents—figurative and comparative—out of the philological field! It is well known to the oldest residents, that had it not been for the many books published in generally pure Maori by the Mission Press, and extensively circulated among the Maoris at an early period,—and the determination of the missionaries generally (at least of all those who knew Maori well), never to use or to encourage the use of such mis-shapen English,—the language would have completely deteriorated, and that very rapidly, becoming a wretched unmeaning and mixed *patois*. Above I have merely remarked on the corruption of *one* word for colour—blue; but I have also (especially at the north) heard too often such words as *paraki*—black, *rari*—red, *karini*—green, *waiti*—white, etc., used among the Maoris themselves, instead of their own far better and more intelligible words for those well-known and common colours!

Another little early incident,—or series of them,—which frequently occurred before New Zealand became a colony, and which also serves further to illustrate what I have already related, as to their correct knowledge of blue and other gaudy colours, is the following:—Large coloured prints (too often mere daubs) of Scriptural and other subjects, were from time to time kindly sent out from England for the Mission Infant Schools; in the close examination of those coloured prints the Maori adults were as much interested as the children, or more so. And here, while they were often "at sea" as to many of the *forms* drawn in those pictures (the same being wholly new), they were never wrong as to the *colours* of the robes, etc., in which blues, greens, yellows, and reds, often predominated; these they always settled to a nicety of description of their peculiar hues, and mostly by exact comparison, although to do so, occasionally took them some little time.

It was mainly in this figurative manner, and by way of semblance and likeness, that the Maoris of my early days in New Zealand (following out the long-established habits and customs of their forefathers) could receive and communicate knowledge among themselves; and happy was that missionary or teacher, who could empty himself, as it were, of his foreign ideas and ways, and thus go with them after their manner in seeking to impart truth: all such always found willing hearers. Ideas must be given through something; and the old Maoris could only receive teaching in and through modes of thought that were natural to them. For it is not the mere use of terms, but the sense in which they are used and received that must be considered. It is a fallacy, though both a natural and a common one (and one into which Mr. Stack in his paper has fallen) to confuse the image with the thing signified, like mistaking the colour of a substance for its true nature; but the old Maoris always steered clear of this.

But, after all,—though they so well and so clearly distinguished the many natural hues of red and of orange, of blue and of green, and of all gaudy colours,—perhaps their really chief *forte*, their strict national taste, in this line was shown, in the using and displaying to advantage the more striking contrast colours,—the contraries of white and of black. This was everywhere among them singularly exhibited, particularly in their clothing and in their dress ornaments. In this particular I never heard or read of any uncultured nation that ever approached them. Hence, when first visited, their best dogskin garments, strongly lined with woven cloth of flax, were composed of small white and black squares of dogskin with the hair on, laboriously and firmly sewn together;* much like the regular pattern of one of our chess-boards, only on a larger scale. And so, following out the same severely chaste taste, they often trimmed and adorned their best bleached white flax dress-mats, covering them all over with black hanging strings and tassels set on at regular distances, and with a deep border of thick black fringe,—each separate cord or strand finely twisted by the hand. And just so it was in that other elegant dress-mat of theirs, the *korirangi* (large variegated shoulder-mantle, or tippet), in which the numerous larger hanging tassels with which the garment was closely

* And here it should be remembered, that while the flax-mats were manufactured only by women, the dogskin-mats were wholly made-up by men.

covered were all severally and regularly annulated, and made of alternate black and white (or black and yellow) chequer-work. Each of those dress-mats, made after the fashion above described, took a long time to manufacture.

The same taste was also observable in their smaller personal ornaments;—in the pure white natural plumes of the white heron, and in the long white semi-transparent muslin-like epidermis of the mountain *tikumu* plant, and in the artificially-scraped and bleached white inner rind of the paper mulberry, for their black hair; in the snowy-white tufts of the down of the albatros and of the gannet for their ears, to set off the more strikingly the black lines of tattooing in their cheeks. And so with their other highly prized head ornaments, namely, the long black tail-feathers of the *huia* bird tipped with white; and the skin of the dark-plumaged *tuii* (or parson-bird), with its strikingly-contrasted hanging white neck-feathers suspended in their ears; and also the shark's white tooth (*mako*), for which, as a contrast, they early sought a yard of black silk shoe-ribbon: this last addition of a black ribbon, was, of course, a more modern one; but it was entirely in keeping with their national taste before it became debased and vitiated;—and in no case did I ever once detect a Maori wearing a red or gaudy-coloured ribbon to suspend his white ear-pendant of shark's tooth.

Before, however, I quit this part of my subject (having brought prominently forward their dresses made out of their white and black dog-skins), I would also briefly remark, that although I have seen very many of their old and ancient carved and ornamented staffs of rank, they were all hung and decorated with *white* hair only, obtained from the flowing tails of their *white* dogs; and I never saw, or heard, of such a staff being so ornamented with the hair of the tails of their *black* dogs. And this could only have arisen as a matter of similar general taste; the *white* hair, when new, being a much greater contrast to the carved dark and stained wood of the staff, than the black hair could be.

I have shown how greatly the old Maoris loved a pure white colour, and to what great pains, and even dangers, they went in order to secure ornaments, etc., possessing it in its purity. Some of our early settlers will also recollect how very much the Maoris of 25–30 years back (before they generally adopted European garments) preferred pure white calico sheets as open flowing garments for summer wear, for adults as well as for children. And not a few of our colonists (possibly some of my audience here this evening), who have travelled with Maoris, or who may have fallen-in with them in travelling, will have noticed how very quickly the

Maori has descried something at a great distance,—something white, or whitish, or, at all events, of a lighter colour than its environment; whether a distant sail at sea,—or a slip of earth or spot in a far-off cliff,—or a patch of snow on the mountain's crest,—or a white-breasted pigeon high up in a tree,—or a gull flying over the sea,—or a settler's house, or even a sheep in the distance;—how readily his eye had caught the object, and that entirely owing to its light or white colour. Now this is quite in keeping with our latest scientific investigation concerning what is known as "colour-blindness;" and serves to show, to establish, *a priori*, how very free the Maoris must have been from all such infirmity. Indeed, for my part, and separate from my experience and experiments among them, I cannot perceive how the old Maoris were to live if such a failing ever existed, seeing that so very much in their daily life depended on their faculty of clear, correct and distant sight. Neither can I bring myself to believe that any such imperfection ever pertained to man in a state of nature.

I find that Mr. Brudenell Carter, F.R.C.S., has lately been giving a series of Cantor lectures at the Society of Arts on colour-blindness; and, among other things, he clearly showed and explained how "that the appearance of the world to the colour-blind must be less bright, less luminous, than to the colour-sighted; and that the appearance of whiteness, as familiar to the latter, must be unknown to the former. Whiteness is the result of the blending of the three primary colours of the spectrum in correct proportions, and the colour-blind, who perceive only two of these primaries, and can consequently only blend two, must see white surfaces as if their colour were compounded of red and violet, of green and violet, or of red and green, according to the primary which was wanting from the perception of the individual."

But I must close.

Wishing to do justice to my subject, my paper is more diffuse and anecdotical, and at the same time longer, than I had originally intended. I fear, moreover, that, in a few instances, I may at first sight seem to be a little tautological. But when I considered, on the one hand, what Mr. Stack had painfully endeavoured to establish (as against the old Maoris' superior natural faculties, and especially their knowledge of colours),—and, on the other hand, my own long and varied experience to the direct contrary, it seemed to me that I had no alternative left, if I wished the truth to be known concerning them, but to state what I knew, and to supplement the same with a few facts in support thereof; which, if I did not thus make known, would in all probability die with me.

I will conclude this paper with an excellent observation by the celebrated Professor Owen :—" Past experience of the chance aims of human fancy, unchecked and unguided by observed facts, shows how widely they have ever glanced away from the gold centre of truth."*

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Appendix.

*A Paradigm of the word* Whero, *one of the (several) Maori terms for the red colour.*

" It is said, that the New Zealander's perception of colours was defective and weak; this, however, is a mistake. Their colours were mainly divided into three distinctive classes,—white, black, and red ;—but they were never at a loss clearly to express all colours. They used them, much as an English mariner uses the four names of the principal winds and points of the compass, repeated and involved to make 32, only much more expressively; as they also used with them several adjectives, increasing or lessening the meaning; also the words themselves reduplicated as diminutives. Besides which, if a New Zealander wished to convey to another a very exact idea of any colour intended, he would mention that of some natural object which was of the same shade of colour," etc., etc. (W. C. " Essay on the Maori Races," § 33, *Vol. I., Trans. N.Z. Inst.*)

*Whero* = red.†

I. *Ascending: intensifying.*

(Indicating, pure, clear, strong, brilliant, and lasting red colours.)

Kowhero.
Tino kowhero.
Tino whero.
Tino whero rawa.
Whero nui.
Whero nui rawa.
Whero nui whakaharahara.
Tino whero nui rawa.
Tino whero nui rawa whakaharahara.
Tona whero i whero ai.
Tino whero whakawhero.
Katahi te tino whero.
Katahi te mea i tino pai tona whero.

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* *Palæontology*, p. 443; Second Edition.

† There are also several other proper names of red,—as, *kura*, *kurakura*, *ngangana*, *pakurakura*, *ura*, etc.

| | |
|---|---|
| Koia rawa<br>Koia kau<br>Ehara<br>Tena | te nui o te whero !<br>te pai o te whero !<br>te kaha o te whero !<br>te ataahua o te whero !<br>te ahua pai o tona whero !<br>te tuahua pai o tona whero ! |

Tino whero rawa, anana !
Whero kita.
Whero kitakita.
Whero whakamoe kanohi.
Whero whakakorekoreko kanohi.

II. *Descending: lessening.*

(1. Lighter, but fair reds.)

Kowherowhero.
Wherowhero.
Kowhewhero.
Whewhero.
Towhero.
Tu-a-whero.
Tu-a-kowhero.
Tu-a-kowherowhero.
Tu-a-wherowhero.
Tu-a-kowhewhero.
Tu-a-whewhero.
Wheronga-parakaraka.
Whero-kowhai.

(2. Fainter, but having more or less of red and pink hues.)

Maa-whero.
Maa-whero maa-whero.
Maa-wherowhero.
Maa-tu-a-whero.
Maa-tu-a-wherowhero.
E iti ana tona whero.
E iti ana tona wherowhero.
E itiiti ana tona whero.
Maa-wherowhero tu-a-whakamaa ake.
Maa-wherowhero ake.
Maa-wherowhero iho.
Maa-tu-a-wherowhero iho.
Maa-tu-a-whewhero iho.
Ahua whero noa iho.

Ahua whakawhero noa.
Ahua wherowhero noa iho.
Tu-ahua wherowhero noa iho haere ake ki te maa.
Tona whero, he wherowhero noa iho otira ahua whaka-whero ake.
Ata wherowhero.
Tu-a-kowhewhero.
Tona ata e ahua wherowhero ana.

(3. Dark-red, red-brown, etc.)

Whero-pakaka.
Whero-tu-a-pouri.
Whero ahua pouri.
Whero ahua whakapouri.
Whero-parauri.
Kihai / Kahore } i maarama tona whero.
* { Whero-rere-kee.
Whero-tangi-kee.
Whero-ahua-kee.
Whero-ahua-tangi-kee.
Whero-tu-ahua-kee.
Whero-tu-ahua-tangi-kee. }
Whero-pouri.
Whero-pango.

(4. Faded red colour.)

Whero haamaa.
Wherowhero haamaa.
Whero tupapaku.
Wherowhero tupapaku.
Whero kua kore.

(5. Ugly, disagreeable, bad, red colours.)

Whero kino.
Whero kinokino.
Wherowhero kino.
Wherowhero kinokino.
He whero ano ra, otira he whero tu-ahua kino.
Whero marutuna.
etc., etc.

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* These six terms are really beautiful ones, possessing great depth of meaning; A good and interesting philological chapter might be written in their exposition.

To most, if not all, of those terms and idiomatic phrases (of which many others could be readily furnished) for the various natural colours of red, would be added the thing possessing that particular hue of red in the estimation of the speaker; who would also aim to be correct, otherwise his comparison, or simile, would be sure to be ventilated and roughly handled. Such was generally given with the comparative particle *me* (like: just as) preceding the noun: as,—*tino whero, me te pua raataa*=of a deep red, like the flowers of the *raataa* tree: *whero, me he koura*=red, just as a craw-fish: *whero, me he toto pango*=red, like black (*or* old) blood. There were also several other modes of drawing the comparison.

Of those examples I have given above, I have repeatedly heard a very large number of them used.

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## Art. IV.—*Notes upon the great Floods of February,* 1868. By W. T. L. Travers, F.L.S.

[*Read before the Wellington Philosophical Society, 3rd September,* 1881.]

In February, 1868, the northern part of the South Island was visited by an extraordinary rainfall, which did a large amount of damage and left indelible marks of its occurrence wherever the waters of the main rivers rose above the height of ordinary floods. The general steepness of the mountains within this area necessarily causes a rapid superficial drainage, and, as a consequence, a rapid erosion and displacement of the materials of their surface, so that during heavy rains the channels of all the draining streams are not only quickly filled but their waters become heavily charged with silt and gravel, which is carried into the main watercourses, converting them into huge muddy torrents. Almost all the main rivers in this part of the South Island are, in effect, torrents even to their mouths, the average slope of their beds being little less than 35 feet to the mile. There was, moreover, this peculiarity in the rainfall in question, namely, that the quantity which fell within the first few hours was so great as to fill every stream bank high, and as the rain continued to fall almost as heavily for many hours after that had occurred, the main rivers not only became enormously flooded within a singularly short period, but maintained their flooded condition for an unprecedented length of time. Many causes, too, resulting from man's foolish and wanton interference with natural operations, had contributed to bring about a rapid accumulation of the rainfall in the main rivers. In the first place, the forest had been cleared by fires and otherwise, but principally by fires, from a large extent of the eastern slopes of the mountains in the very localities in which the ordinary rainfall is usually heaviest. In the next place, the surface vegetation of all those portions of the country in question, which could be used for depasturing purposes, had been systematically burnt over, year after year, in order to encourage a fresh growth for the use of the stock. And, moreover, the treading of the surface by depastured animals tended still further to harden it, and cause it to contract and crack in under the combined influence of the sun and wind. It is easy, therefore, to conceive that after any exceptionally great rainfall the main rivers which drain the districts referred to must become powerful engines for mischief, and are well calculated to make and leave indelible marks of their action, especially where their waters overspread a cultivated country.

Some years ago, I brought under the notice of the members of the New Zealand Institute (in a series of lectures) the desolating effects of torrents such as those which rise in and flow from our great mountain districts, owing to destructive changes occasioned by man's agency ; but, although the evils I pointed out have been recognized and publicly commented upon, both in and out of Parliament, no attempt has been made to check the continuance of the acts which have brought them about. It is, no doubt, true that legislation has proved ineffectual to prevent the progress of such evils in older countries, but this is chiefly owing to the facts that the entire soil is vested in private persons, and that every proprietor will, as a rule, insist upon his right to fell his woods, and otherwise deal with his property in such manner as he thinks most consistent with his pecuniary interest, and that whether the result be injurious to others or not. But in a country like this, where the State has the possession and control of nearly all the forests which clothe the mountain sides, it is its imperative duty to retain that possession and control, and to provide severe punishment for acts calculated to produce evils of the kind referred to. The revenue derived from the demise of the great tracts of beech forest, which are frequently included within the limits of depasturage areas, is as nought when compared with the enormous damage which must result to the State from its destruction, destruction, moreover, which is rarely confined to the tracts comprised within the demise itself. I have seen thousands of acres of such forest wantonly burnt, and within a very short period afterwards nearly the whole of the loose soil has been washed from the cleared surface, leaving nothing behind but bald mountain ridges, rocky declivities, and steep earthy banks, furrowed by deep ravines usually filled, during rains, with torrents of mud and gravel. In Europe and America, the desolation produced by such causes has already been very great, and, in the older continent, millions of money have been spent in the regions of the Alps, the Pyrenees, and the Apennines, in attempts to prevent a continuance of the physical deterioration already produced in tracts of country which had formerly presented the uniform aspect of luxuriant pasture grounds and abundant cornfields and vineyards.

I have digressed somewhat from the immediate subject of my paper, but a recollection of the destructive results of the great floods of February, 1868, brought vividly before me the amount of injury which has already occurred, and which is likely to follow, from continued improper interference with natural operations; and I could not resist the opportunity of once again urging the necessity for checking such interferences, before it is altogether too late to do so with effect.

To return to my immediate subject. I have added by way of Appendix to this paper, a table (compiled for me by Mr. Gore), containing the meteorological notices recorded in both Islands during the month in which they occurred, from a perusal of which, independently of what I am about to state in this paper, you would doubtless conclude that the floods in question were of an unprecedented character. From observations made by myself during two or three journeys overland between Christchurch and Nelson, and, therefore, through the heart of the country in which these floods attained their maximum intensity, I was led to the startling conclusion, not only that they were the greatest which had occurred for a very long period of time, but that that period might properly be reckoned by thousands of years. Such a statement is, I admit, easily made, and must primarily be treated as being incapable of proof; but, whether I succeed or not in establishing my proposition to your satisfaction, I feel pretty well assured of its truth, and will, in due course, state my reasons for advancing it. In order, however, that you may be able to appreciate those reasons, it is necessary that I should give a somewhat detailed description of the features of the country in which my observations were made.

My first journey took place within a fortnight after the floods had subsided, and was from Christchurch to Nelson, visiting on my way a cattle-station which I then held, in the heart of the Spenser Mountains. My route, after leaving the Canterbury Plains, lay through the Weka Pass to the Hurunui and Waiau-ua Plains; from thence through the second gorge of the Waiau-ua, to the Hanmer Plain; across that plain to Jack's Pass; and over the pass into the Valley of the Clarence; and then into my station on the Upper Waiau-ua, by Fowler's Pass. From my station to Nelson, I crossed Maling's Pass to the head of Lake Tennyson; thence over the Island Saddle to the head waters of the Wairau, and through the Wairau Gorge, and the upper valley of that river, to the Top House; and thence through the Big Bush, to Nelson.

The Hurunui and Waiau-ua Plains form together a long oval tract of practically level country, lying nearly east and west in its longest diameter, surrounded by mountains, and occupying the centre of the Amuri District, in the Province of Nelson. The eastern and larger portion of this oval is called the Hurunui Plain, and is traversed diagonally from north-west to south-east by the river of that name. The western and smaller part of the oval is called the Waiau-ua Plain, and is also traversed from north-west to south-east by the river of that name. This latter portion lies at a lower level than the Hurunui Plain, for reasons to which I will shortly refer. The whole area presents the appearance of an ancient lake basin, the bed of which had been filled with gravels brought down by its various feeders before the waters had been drawn off through the channels cut from its southern side to the sea, by the rivers which now traverse its bed. These rivers are the Hurunui and the Waiau-ua, the first of which, after debouching from the mountains at the north-western end of the oval, flows diagonally across its upper part to about the middle of its southern side, where it enters a gorge and passes on to the sea; and the second of which, debouching from its own gorge above referred to, at a point a little below the middle of the northern side of the oval, also flows across it diagonally (on a line nearly parallel to the course of the Hurunui) to the south-eastern end of the oval, where it also enters a gorge through which it flows to the sea. Each of these rivers has removed in its course from its debouchure onto the plain to the gorge which it enters on the southern side, an immense quantity of the materials of which the lake bed was originally composed, leaving that part of the latter which lies between their courses as an undisturbed level tract, some twelve miles long, standing considerably above the general level of those portions of the oval which have been acted upon by the two rivers. Moreover, each of these rivers occupies a more or less defined channel in the lower ground through which it now flows, that of the Hurunui gradually widening to about three-fourths of a mile until it reaches the point at which it enters the gorge, where it again contracts, while that of the Waiau-ua rapidly spreads until it attains a width of from one to two miles, and as rapidly contracts again towards the point at which it enters its own lower gorge at the south-eastern end of the oval.

A stream called the Pahau, which in its ordinary state is most insignificant, flows from the mountains on the northern side of the oval about midway between the debouchures of the Hurunui and Waiau-ua, running in a shallow depression across the higher ground between these two rivers, until it joins the Hurunui close to its entrance into the gorge on the south side of the plain.

The Hurunui and Waiau-ua are both, and especially the latter, very large rivers, each draining an immense area of the steep mountain masses which form the northern extension of the Southern Alps, and each is subject to heavy floods, especially during north-west summer rains. The Pahau, though ordinarily an insignificant stream, is also liable to heavy floods, not only because it drains a large mountain tract, but also because in the area which it drains the mountains are exceptionally steep, and the rainfall necessarily finds its way very rapidly into the minor water-courses which supply it. The Weka Pass road debouches on to the Hurunui Plain at a point where there is yet an undisturbed level portion of the old lake bed, from the top of which it descends into the channel of the Waikari, a small tributary of the Hurunui, which flows along the base of the mountains on the south side of the oval. This tributary has also cut its channel through the old lake bed, and has a small terrace on its northern side, between which and the channel of the Hurunui the ground rises gradually to the westward. On arrival near the latter channel we find a terrace similar to that on the north side of the Waikari, below which lies the main bed of the Hurunui river. Crossing this bed, which is here upwards of half a mile broad, we come to a high terrace, on ascending which we reach the level ground which I have referred to as lying between the two main rivers. The surface of that portion of the plain which lies between the Waikari and Hurunui rivers is, as already stated, a good deal lower than that of the original lake bed, as both rivers have been engaged, ever since the lake basin was emptied, in removing the sands and gravels of which it was composed, but this surface rises gradually towards the western end of the oval, where it lies at the same level as the upper surface of the plain between the two main rivers.

On reaching the point at which the second gorge of the Waiau-ua opens out to view, the road leads downwards over a succession of small terraces to a main one bounding the high flood-channel of the river, the whole of the gravels and sands below the original surface-level of the lake bed having been removed from this part of the oval, besides which the river, in its course through the gorge, has cut through the solid rock, underlying these gravels, to a depth of from twenty to thirty feet. The gorge itself between the Waiau-ua and Hanmer Plains is about eleven miles long, and rarely more than a quarter of a mile in width, from the foot of the hills on the one side to that of the hills on the other, the greater part of the river channel being in solid rock overlaid by gravels disposed in terraces, corresponding with those above described. The road through the gorge runs along the surface of a main terrace on its western side, the gravels of which immediately overlie the rocky walls between which the waters now flow.

A number of small valleys, lying generally at right angles to the course of the main river, occur amongst the spurs of the mountains on each side of the gorge, each of which has its own stream, whose size is proportionate to the extent of the valley in which it flows. Every one of these lateral valleys is filled with gravels to about the same height as the level of the higher part of the Hurunui Plain, and its front towards the main river, between the extremities of the spurs which bound it, is a terrace face equal in height to the difference between that of the upper surface of the Hurunui Plain and the surface of the gravels of the terrace at its foot. From this foot to the edge of the bank of the main river the width varies from fifty to three or four hundred yards, and it is along this terrace that the road runs.

Now each of the streams which occupy these lateral valleys has cut a channel, more or less deep, through the gravels with which its own valley is filled, and, in some instances, through the rock which underlies them, and debouches on to the terrace of the main river, over which it flows in a manner having special relation to its magnitude and the force of its current. In every instance, however, these lateral streams have formed, at their debouchures on to the main terrace, what are geologically termed half-cones, more or less extensive, composed of the gravel and other detritus which they have removed in their courses through their own respective valleys. In some cases, where the streams are small, they become lost after debouching from their own valleys in the gravels of these half-cones, their waters then finding their way by subterranean courses to the main river.

In flood times the waters of these smaller streams spread over the surfaces of their several half-cones, and after flowing beyond them for short distances lose themselves in the gravels of the main terrace. In other cases, where the streams are larger, each of them has cut a channel through the upper surface, but not to the full depth of its own half-cone, and after discharging its waters beyond the edge of the half-cone, also loses itself, except in flood time, in the gravels of the main terrace, whilst in flood time it finds its way by a number of shallow surface-channels to points beyond its ordinary place of disappearance, and then loses itself in the same manner.

But there are several of these lateral streams which, after having formed their half-cones, in times long past, have not only cut through the gravels of their own valleys and through the rock below them to a level below that of the surface of the main terrace, but also through their half-cones and the gravels of the main terrace and the rock below them, running into the main river in narrow ravines, varying from ten to thirty feet in depth.

In flood times streams of this class are raging torrents, bearing into the main river immense quantities of silt and gravel which are carried forward by the larger stream. As may be supposed, however, the beds of all these lateral streams contain considerable quantities of boulders and gravels which floods of ordinary magnitude are incapable of moving, the larger rocks and boulders serving as dams or buttresses for supporting smaller matter above them. But, whatever the relative size and force of these lateral streams may have been, there was one character which they all had in common before the occurrence of the great floods of 1868, namely, that they had evidently never changed their courses, at all events for some distance upwards from their debouchures onto the main terrace, since this had been left permanently above water by the cutting down of the present main river-channel. This is a point of great importance, and to be carefully borne in mind in connection with the observations referred to in the sequel. The hills and mountains on each side of the gorge are steep and hummocky, generally bare of forest, but covered with tussock grass and fern, and with the other vegetation characteristic of such localities in the South Island.

The valley of the main river rises from about 800 feet at the mouth of the gorge to about 1200 at its upper end in the Hanmer Plain, Mount Tekoa, on its western side, attaining an elevation of upwards of 5000 feet on a base of less than ten miles from the bank of the river. I am bound to be thus particular in describing the physical features of this gorge, and, indeed, of all the country in which I noticed extraordinary marks of the flood in question, because the changes effected by it in those physical features afford the chief proofs in support of my proposition. To these changes I will refer after completing my general sketch of the country affected, so far as this is necessary for the purposes of this paper. The gorge I have been describing terminates at the Hanmer Plain, which, like that of the Hurunui, lies nearly east and west, and is also surrounded by mountains. The main river flows into the plain from a gorge at its western end, and after flowing along its southern side to about the middle of the plain, turns abruptly into the one which I have lately described. At the point where this occurs it is met by two small rivers, one called the Percival, flowing directly across the plain from the northward, and the other called the Hanmer, flowing from the westward in a course directly opposite to that of the main river.

These rivers are very insignificant in size compared to the Waiau-ua, but in times of flood each of them brings down to the latter a large quantity of silt and gravel, partly derived from the shingle of the plain and partly carried into it by the innumerable rivulets which drain the surrounding mountain slopes. When, however, the whole of the rivers are in flood, the waters of the Percival and Hanmer are banked up at the confluence, and form a large expanse of practically still water, the effect being that, as in the case of the Pahau and the Hurunui hereafter referred to, a considerable quantity of silt is precipitated, which, upon the subsidence of the waters, presents the appearance of a bed of soft sandy mud. The Hanmer Plain appears also to be the bed of a former lake which had been gradually emptied by reason of the erosion of the rock in the gorge below it.

Crossing this plain the road leads up a long spur to Jack's Pass, a depression in the mountain ridge on the north side of the plain, through which the valley of the Clarence is reached. I need scarcely say, that the scenery in the gorge, and upon the lines of road over the passes into the Clarence and the Upper Waiau-ua, is very beautiful, but I am compelled to omit any notice of it in this paper as foreign to the subject in hand, although I should like to dwell upon it. It is a curious circumstance that the valley of the Clarence lies but little below the upper level of Jack's Pass, and that from the outlet of Lake Tennyson, for upwards of sixty miles of its course, it lies at an average altitude of 1,400 feet above, though parallel with the valley of the Waiau-ua, the level of Jack's Pass being little less than 3,000 feet above that of the sea. Fowler's Pass, through which the Upper Waiau-ua is reached from the Clarence, is about twenty miles up the valley from Jack's Pass, the saddle being from seven to eight hundred feet above the level of the valley, making the summit of the pass nearly 4,400 feet above sea-level. It is in these localities that the remarkable Alpine vegetation of New Zealand is found in its greatest luxuriance and in its most quaint and striking forms, whilst the air is not only delicious from its mere purity, but is always filled, and especially so in midsummer, with the perfume of many exquisitely scented mountain plants.

The descent from Fowler's Pass to Lake Guyon is extremely rapid, the track leading through broken rocky gorges, above which the mountains, rugged and bare, rise to an additional height of several thousand feet, the more sheltered spots in their northern aspect being rarely free from snow. The valley of the upper Waiau-ua lies below Lake Guyon, and was formerly filled by a huge glacier, formed and fed from the snows of the Spenser Mountains, the highest points of which, the Faery Queen, Mount Una, and the Pyramid, attain to the elevation of nearly 10,000 feet above sea-level. Maling's Pass is about eight miles above the outlet of Lake Guyon, and leads to Lake Tennyson, a very beautiful sheet of water now occupying the bed of a great glacier, which formerly descended from the skirts of the Princess Mountain. This lake receives the head waters of the Clarence River. From the eastern side of the lake the track lies over a low saddle to the head of the Wairau, the river which, after passing close to the town of Blenheim, flows into Cloudy Bay. Between the northern side of the saddle and the Rainbow River, the Wairau runs for several miles through a narrow rocky gorge, on each side of which the mountains rise in steep and rugged masses to the height of three or four thousand feet; numerous torrents flow into it from lateral gorges and ravines, helping to swell the volume of the main river, and they bring down, even in ordinary floods, great quantities of angular detritus. But the beds of these lateral streams were, as a rule, prior to the floods of February, 1868, much encumbered with loose rock and other material not liable to be removed even by the heaviest ordinary floods. The bed of the main river, in its course through the gorge, was filled with huge smooth boulders, which made it difficult to ford it even when low, and dangerous even when moderately swollen, its waters then rushing over their rough bed with great force and impetuosity. In this gorge, also, the marks left by the great flood of 1868 were most singular and instructive, and I will now proceed to mention such of those marks along the line of country which I have described as appear to me to afford evidence of the unprecedented character of that flood.

The first thing which struck me was the enormous quantity of water-borne timber which was lodged upon the surface of the Hurunui Plain, every part of it which had been reached by the flood-waters being strewed with such timber in the most extraordinary manner. The waters of the various rivers which ran through it appeared to have risen to an incredible height, so much so indeed that a very large part of it must, when the waters were at their highest, have presented the appearance of a vast lake. I was told, moreover, by a person who stood on the terrace above the Hurunui, so as to command a view of the line of the ordinary channel of the river, that the waters in that line appeared to run at a height of from three to four feet greater than the general level of the water spread over the plain, and that the roar of the shingle which was being carried down was like that of distant thunder. As the waters subsided enormous quantities of timber were left upon the level ground over which they had spread, and it was curious to see the singular regularity with which the drifted logs were piled up, often to the height of several feet, giving to the whole an absolutely artificial appearance. The Pahau, which in its ordinary flow is scarcely more than a brook, and which even in ordinary floods is rarely more than two or three hundred yards broad, must, during the flood in question, have been upwards of two miles wide. Like the Hurunui, and upon a scarcely less scale, it deposited upon the surface of the upper plain immense quantities of timber built up in precisely the same manner. I was informed by shepherds and stockmen well acquainted with the forest tracts on the surrounding mountains, that every atom of fallen timber had been washed out of the innumerable gullies and ravines by which their slopes are furrowed, and that the beds of all the streams which flowed in them appeared to have been cleaned out to the very rock, few of them retaining even the slightest trace of the shingle and other materials which had previously lain in them. It is impossible to convey an idea of the extraordinary quantity of timber piled upon the surface of the plains, and that, too, in positions which had not, before this flood, presented any trace of having been covered with water since that of the lake had been drained from it. It must be borne in mind, moreover, that the timber thus left on the surface of the plain could only have been a mere fraction of the total quantity brought down by the rivers, the greater proportion having been carried out to sea.

At the point where the waters of the Pahau joined those of the Hurunui, they were banked up to the height of upwards of thirty-five feet, and a bed of silt was deposited varying in depth from a few inches to upwards of ten or twelve feet (according, of course, to the depth of the banked-up water), and covering an area of several hundred acres. This silt-bed remained so soft for many months after the subsidence of the waters, immediately below the dry crust which formed on its surface, that cattle which got on to it from the bank above, attracted by the young grass which soon grew upon it, sank into it and were smothered. A similar but smaller bed of silt was formed at the confluence of the Hanmer with the Waiau-ua, and several months after it had been uncovered, a pack-horse, which I was driving, was very nearly bogged in attempting to cross it. The larger part of the great bed of silt, formed at the confluence of the Pahau and the Hurunui, remains to this day, and is not exposed to removal by the ordinary action of those rivers, but no such bed existed prior to the occurrence of the flood of February, 1868.

The next striking result of this flood was one which especially affected the surfaces of the hills in the Waiau-ua Gorge, and was indeed noticeable, though in a less remarkable degree, all over the surrounding country. These hills were scarred by innumerable small isolated slips, evidently caused by the sudden bursting from points on their sides of accumulations of water which had suddenly found its way between the surface-soil and the solid ground below. An occasional scar of the same kind is seen on the mountain sides all over New Zealand, but the extent to which this process had taken place as the result of the great flood in question, was such as to create a marked and by no means agreeable feature in the landscape. I believe I am not exaggerating when I say that, to the eye at all events, not less than one-twentieth part of the surface of a large proportion of the hills had been rendered useless by these peculiar slips, for as the surfaces exposed by them consist almost exclusively of the underlying rock, they are, and are likely to remain for ages to come, completely destitute of vegetation.

A still more remarkable result of the flood was presented in connection with the lateral valleys which opened on to the terrace of the main river. You will remember that I described the front line of each of these valleys, drawn from the extremities of the bounding spurs, as presenting the appearance of an ordinary river terrace, more or less deeply cut through by its own particular stream, and I mentioned that each of these streams had formed, at its debouchure on to the surface of the main terrace, a half-cone of detritus over which it continued to flow, or through which it had cut a channel more or less deep as the case might be. Now, before the flood of 1868, there was not, *in any instance,* more than one such half-cone in connection with any one valley, the stream from each valley having unquestionably debouched from the same channel on to the main terrace ever since the waters of the main river had ceased to run at the level of the upper surface of that terrace. But in the case of several of these larger lateral valleys, the channels of their streams, though wide and deep, had proved to be entirely insufficient to carry off the enormous quantity of water which had suddenly poured into them during this flood, the consequence being that the surplus water overflowed the valley and found its way along one or more lower lines on its surface over the edge of its frontal-terrace on to the main terrace below. These valley-terraces are, as I think I have before observed, composed of loose gravels and silt. Now the quantity of surplus water was so great in some instances, that wide fresh channels were cut through the fronts of the valley-terraces, and fresh half-cones deposited on the main terrace below, some of them being actually larger than the old half-cones which had accumulated in front of the original debouchures during the immense time which had elapsed since they began to be deposited. There could be no mistake about this operation. There were the large open gaps freshly cut through the front terraces, in some instances extending in depth to the solid rock below. There were the great new half-cones, some of them covering several acres of the previously level surface of the main terrace, and formed out of the materials which had filled these gaps. But no water has ever since flowed through these new gaps. The streams of the lateral valleys are again flowing in their old channels, and the latter have, in almost every instance, been emptied of every atom of the loose material which had previously lain in their beds, thus giving largely increased room for the flow of the water. Chasms along the line of these streams, in their course across the main terrace, in some instances ten and twelve feet deep, the bottoms and sides of which are clean solid rock, have taken the place of beds of shingle which had formerly filled them up to the general level of the ground, the consequence being that a considerable number of bridges have had to be constructed on the line of road along the main terrace, in order to permit the wool-drays to pass over across the beds of these streams in places which had previously been forded without the slightest trouble. In several places, moreover, where the old channels had proved insufficient to carry the enormous quantity of flood-waters suddenly poured into them, these had burst over their banks and cut subsidiary channels through the gravels of the main terrace down to the solid rock on which they rest, and had then fallen in cascades into the great river below. Now I submit, that if any such flood as that of February, 1868, had occurred in this locality since these several gravel terraces had been formed, it must have left marks similar to those which I have described, marks which, looked upon from a geological point of view, are practically indelible; and the non-existence of such marks in any part of the gorge prior to the occurrence of the flood in question, is sufficient to indicate that no such flood had taken place since the river had flowed at the foot of the terraces fronting the lateral valleys.

It is not necessary that I should specially notice the effects of the flood in the valley of the Clarence on the Upper Waiau-ua. Though palpable enough, they were not of a class to afford strong evidence of its being unprecedented in extent, for both these localities are high above sea-level, are very rugged and bare, and the marks left were not sufficiently distinctive to require special notice.

In the gorge of the Wairau the case was different. There, as before observed, the river flowed for miles over a bed filled with huge boulders, but the immediate effect of the tremendous rainfall referred to had been, that all the loose angular detritus previously lying in the beds of the lateral torrents was washed out of them, forming, in some instances, enormous mounds, the bases of which were cut away by the waters of the main river, the effect being that the interstices between the boulders in its bed were filled up, for many miles of its course, changing the surface of this bed from one of great ruggedness to the smoothness of a macadamized road, and giving to the river the appearance of a beautiful purling stream instead of that of an impetuous brawling torrent. In process of time the major portion of the small stuff thus distributed over the bed of the river will be removed, but when I last passed through the gorge, eight years after the occurrence of the flood in question, the places where I forded the river still retained the even smoothness which had followed from the great flood.

Such are the principal grounds upon which I have based the opinion expressed in the earlier part of this paper, and I have little doubt that, had I been able to devote time to a more extended examination of the district in which my observations were made, I should have found abundant additional evidence in support of it. I am aware of the danger of drawing general conclusions from isolated facts, but instances sometimes occur—footprints on the sand—so pregnant as to justify such a course, and I still believe, after long thought, that the remarkable results of the flood in question, which I had the opportunity of observing in the gorge of the Waiau-ua, are of that character. It must be remembered that whilst all the great observers of physical phenomena have rightly concluded that the changes which have taken place upon the surface of the earth have not been suddenly brought about, but result from the slow though continuous operation of natural causes, none of them can or do deny that there are, or have been, catastrophes or cataclysms, though these are usually limited in extent at any one period, when compared with the whole terrestrial surface. The downfall of nearly thirteen inches of rain, in the course of three days, over an area of thousands of square miles of steep mountain country, was unquestionably calculated to produce a catastrophe in the level areas through which their drainage passed to sea, for even the water which would thus be carried into the river of a valley whose drainage area did not much exceed eight square miles (which is about that of the Kaiwarra stream), would reach the astounding quantity of sixteen hundred millions of gallons, a quantity equal to the entire measured ordinary flow of that stream for a period of three years, or to the estimated ordinary flow of the river from which the city of Wellington is about to derive its new supply of eight millions of gallons a day, for a period of nearly eight months. Whilst I have not hesitated in setting forth the views contained in this paper, I feel that they may not deserve acceptance; but, even then, I trust that the observations I have brought under your notice will not be without their use to those who take an interest in the history of remarkable physical occurrences.

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Extracts from the official Meteorological Reports for February, 1868.

The rainfall, especially in the earlier part of the month, was excessive in some districts. A storm, which commenced *on the 3rd*, appears to have backed round from north, through east, when the rainfall from this unusual quarter *was productive of the most disastrous floods which have been recorded in the colony, and which devastated the eastern districts of the South Island.*

*Taranaki*—On 2nd, barometer 29·628, wind S.E.; but scud coming from E. and N.E., threatening rain and wind; at 3 p.m. barometer falling, wind S.E. and rising, evening wild looking, with heavy rain; at 10 p.m. barometer 28·80. *On 3rd, gale from S.E., with thunder and lightning; about two inches of rain fell during night; wind changed to S.W., and violent gale blew, breaking the anemometer; a maximum pressure of 18 lbs. to square foot was registered; barometer commenced to rise;* at 4 p.m. gale continued, but veered back to N.W., at 9 p.m. barometer 29·20. On 4th gale continued, with heavy squalls of rain, hail, thunder, and lightning, but moderated towards morning. It continued stormy up to 8th.

*Wellington*—On 3rd, very low barometer, strong wind from E.; at 3 p.m. barometer 28·754; at 4.15 p.m. rose rapidly, wind shifting round to S., through E.; no rain to speak of at this period.

*Nelson—A storm commenced on 3rd,* wind S.E.; on 4th, wind N.E.; and on 5th, N.; *the rainfall on the 5th, for 24 hours previous, was 7·03 inches;* from 3rd to 5th the rainfall was 12·88 inches; barometer down to 28·83 inches.

*Christchurch—Disastrous and unparalleled floods occurred throughout the eastern portion of the Province of Canterbury on 2nd, 3rd, and 4th. The rainfall at Mount Peel was 8·08 inches in 24 hours, ending at 12 p.m. on the 3rd.* In Christchurch the rain was heavy, but not so severe as the above.

*Hokitika*—On the 3rd a heavy S.E. gale experienced, but no great rain.

*Dunedin*—On 3rd, a storm from S.E.; 1·37 inches rain, recorded on 4th, for previous 24 hours. *There were great floods all over the Province, doing much damage.*

*Southland*—Gale occurred on 3rd and 4th from E.S.E., but no rain.

Total rain for Month of February, 1868, compared with averages for same month previous years.

| | Feb., 1868. | Same Month Previous Years. | |
|---|---|---|---|
| Taranaki .. .. .. | 6·07 | 3·67 | inches. |
| Wellington .. .. .. | 8·76 | 3·28 | „ |
| Nelson .. .. .. | 19·95 | 6·43 | „ |
| Christchurch .. .. | 5·66 | 1·25 | „ |
| Dunedin .. .. .. | 5·07 | 2·35 | „ |

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## ART V.—*Remarks on the Sand Dunes of the West Coast of the Provincial District of Wellington.* By W. T. L. TRAVERS, F.L.S.

[*Read before the Wellington Philosophical Society, 20th August,* 1881.]

EVERY person who has travelled from Wellington to Wanganui by the present coach road, must have been struck by the large extent of the dunes which lie inside the shore line from Paikakariki northward. These dunes, as will have been observed, consist of sand washed up by the waves, and then heaped up above the tide line by the action of the prevailing westerly winds. The depressions which occur amongst them are often of considerable extent, and where these lower areas continue moist throughout the year, they support a comparatively dense vegetation, whilst such of them as usually remain dry are mere arid wastes of shifting sand, without any vestige of plant life. The sand of which the dunes are usually composed is not exclusively silicious matter, but contains a proportion of calcareous and other mineral substances, and of animal and vegetable remains, which help to give it a capacity under certain conditions for sustaining vegetable growth, and accordingly we find that where the surface remains undisturbed, and the sand is so placed as to be capable of retaining moisture, it is generally covered with vegetation (more or less luxuriant according to the degree of moisture present), of the special character which affects this description of habitat. I give at the foot of this paper a list of the most conspicuous dune plants indigenous to New Zealand, many of which would be found valuable in other countries.

Now this vegetation confines the sand, and would, if undisturbed by man, or by grazing or burrowing animals, entirely prevent its motion under the influence of the wind, whilst, wherever the surface is not confined by plant growth or by a crust of vegetable matter, the sand is constantly rolled forward in the direction of the prevailing winds. Instances, indeed, are abundant in other countries, of populous and fertile districts having by this means been converted into barren wastes. A recent example of this was observed in connection with the dunes which lie between the Adour and the estuary of the Gironde, on the west coast of France, the sands of which were found, where not fixed by vegetable growth, to advance eastward at a mean rate of about sixteen and a half feet a year, the result being that a large extent of fertile land was destroyed before effectual measures could be taken to arrest the evil. Other instances of the mischief which results from disturbing the vegetation upon the surfaces of sand dunes will be given in the sequel, whilst, to bring the matter home, I may mention that Mr. Hadfield (who occupies a tract of land between the rivers Otaki and Ohau, on the west coast of this Provincial District) informs me that the sands of the dunes between those rivers are advancing inland at a rapid rate and threaten great injury, unless effectual steps be taken to prevent it. I have observed the same thing occurring on the shores of Pegasus Bay, but in less degree owing to the fact that the strong westerly winds which are frequent there, blow off shore, and prevent any rapid inland extension of the sand under the influence of the easterly winds which prevail on that coast.

It has been a question of interest in Europe, whether, and to what extent, the generally bare condition of coast dunes is to be attributed to the improvidence and indiscretion of man, and recent investigations seem to have shown that, in almost every case, the inland advance of dune sands may be traced to man's interference with natural operations. A patent instance of this is given in connection with the dunes of the Frische Nebrung, on the coast of Prussia. It is related by Willibald Alexis (as quoted by Mr. Marsh, in his interesting and valuable work on Physical Geography), "that the dunes of the Nebrung were formerly covered with a great pine forest, which extended to the water's edge, and bound, with its roots, the dune sand and the heath uninterruptedly from Dantzig to Pillau.

King Frederick William the First, however, wanted money, and a certain Herr Von Korff promised to provide it for him without loan or taxes, if he could be allowed to remove something quite useless. He thinned out the forests of Prussia, which then, indeed, possessed little pecuniary value, but he felled the entire woods of the Frische Nebrung, so far as they lay within the Prussian territory. The financial operation was a success. The king had money, but, in the elementary operation which resulted from it, the State received irreparable injury. The sea winds rush over the bared hills; the Frische Haff is half choked with sand; the channel between Elbing, the sea, and Königsborg is endangered, and the fisheries in the Haff injured. The operation of Herr von Korff brought the king 200,000 thalers. The State would now willingly expend millions to restore the forests again."

It has been proved, however, that where man and cattle and burrowing animals have been excluded from the surfaces of dunes, these have gradually become clothed with various species of plants and finally covered with trees, leading to the assumption, that wherever dunes are found in a bare condition, it is to be attributed to man's interference, either direct or indirect, with the natural operations under which they would become and remain covered. It has been found, moreover, that dunes begin to protect themselves very soon after human trespassers and grazing animals have been excluded from them, herbaceous and arborescent plants (of which upwards of three hundred species are known to flourish in such habitats) speedily fixing themselves in the depressions and thence extending to the surfaces of the sandhills. To quote the words of an author on this subject: "Every seed that sprouts binds a little of the sand, and gives shelter and food for the growth of others, and a few favourable seasons suffice to cover the greater portion of the surface with a net-work of vegetation which almost effectually prevents the motion of the sand." Those who have observed the rapid spread of the toi (*Arundo conspicua*), amongst the sand dunes on our West Coast (especially where they are not occupied for depasturing purposes), will have seen an example of this natural operation, and one, too, which points to a ready and simple means for preventing the further inland motion of these sands. This plant by the large amount of shade which it makes, and the protection it affords to the surface from the drying action of the wind, would materially assist in promoting the growth of more useful plants whenever it may be deemed advisable to adopt any system of artificial reclamation.

In the latter part of the last century, simultaneous active steps were taken in Denmark, in Prussia, in the Netherlands, and on the west coast of France, for the protection of the surfaces of the dunes in those countries, and for rendering them in some degree valuable, and most satisfactory results have followed these efforts in each instance. In France, especially, operations were carried on upon a large scale, under the direction of Bremontier, the system which he used being very much the same as one independently adopted in Denmark at about the same time. Bremontier's efforts were crowned with special success, owing in some measure to the nature of the climate, but chiefly to the liberal assistance which he received from Government, which placed large sums at his command in aid of the work. The area of dunes which has been secured from drifting and converted into valuable plantations by his method, exceeds 100,000 acres, now yielding a large annual revenue in turpentine and resin, independently of the value of the timber from which these are produced, whilst, as a further and more important result of his labours, the fixture of these sands has saved a much larger area of valuable country from the destruction with which it was threatened.

In the neighbourhood of Cape Breton, another process is successfully employed, both for preventing the drifting of the sand and for rendering the surface directly productive. The method there adopted consists of planting vineyards upon the dunes, the vines being protected by hedges of *Erica scoparia*, so disposed as to divide the vineyard into rectangular spaces of forty or fifty feet square. The same heath would grow luxuriantly on our West Coast dunes, and there are extensive areas amongst them, especially to the north of the Rangitikei River, which appear to me to be admirably adapted for the cultivation of the vine in the manner used at Cape Breton. The vines there are said to thrive admirably, and the grapes to be amongst the best grown in France. Dunes are, it must be remembered, favourable for the growth of vines, fresh sea-sand being regularly employed, in the west of France, as a manure for the vine, alternately with ordinary manure, with the advantage that, as the surface of the vineyard is by this means constantiy raised, the vines as constantly throw out fresh roots and thus promote a vigorous upper growth.

Coming back to our West Coast dunes, it seems clear that if the observations made by Mr. Hadfield be accurate, as applied to the district between the Otaki and the Ohau, there can be little doubt that similar results are taking place further to the northward, where nearly the whole of the coast dunes are included in sheep and cattle runs. The revenue derived from the occupation of such tracts of country by pastoral tenants, cannot possibly compensate for the injury which will be done by the inland advance of the sand, and although it may not be expedient that Government should as yet engage in such operations as those which have been carried on in France, it is in the highest degree important that it should put a stop to further interference with the surface of the dunes, and thus allow them a chance of again becoming clothed with a protective growth. The subject is not one to be treated lightly, seeing that the area of dunes on the West Coast of this Provincial District alone cannot be less than 150,000 acres, and that the prevalent winds are generally westerly, and, therefore, exactly those which are likely to do serious mischief.

As enquiries are frequently made on the subject, I think it well to add a few words as to the mode in which forest trees are cultivated on dunes. The principal tree so cultivated on the French dunes is the *Pinus maritima*, which, besides being valuable for timber, yields a considerable annual revenue from turpentine and resin. It is always grown from seed on the spot which it is intended to occupy, the young shoots being protected for several seasons by the branches of other trees either planted in rows, or formed into wattled hedges, or staked down over the surface of the sand. The sand grasses too are used for the purpose of shelter, and as the pine does not thrive well close to the sea, these grasses (especially *Ammophila arundinacea* and *Elymus arenarius*) are planted along the beach and for some distance inland, and these when grown effectually prevent the sand from overwhelming the young trees.

It is found that under the shade of the pine, while still young, deciduous trees and a great variety of herbaceous and shrubby plants thrive well, and contribute to the rapid formation of a coating of vegetable mould. In fact, so soon as the pine has become well established, the reclamation of the sand waste may be looked upon as an accomplished fact. Turpentine is extracted from these trees for several years before they are cut for timber, and although this has a tendency to check the growth of the tree, it is found to improve the quality of the timber. The trees commence yielding turpentine at the age of about eighteen or twenty years, and have been found to yield from that age, up to the age of eighty or a hundred years, an annual return, independently of the value of the timber itself, of about £1 an acre. It may interest you to know that *Ammophila arundinacea* and *Elymus arenarius*, as well as other foreign sand grasses, have been introduced and successfully cultivated by Mr. Coutts Crawford at Miramar Peninsula, where they have already been of great service in preventing the spread of the sand over valuable pasture ground.

The following is a list of the principal plants found upon the sand dunes of New Zealand:—

*Of primary value for fixing the sands:*

Coprosma acerosa, *A. Cunn.*
Convolvulus soldanella, *Linn.*
Pimelea arenaria, *A. Cunn.*
Leptocarpus simplex, *A. Rich.*
Carex pumila, *Thunb.*

Hierochloe redolens, *Labill.*
Spinifex hirsutus, *Labill.*
Arundo conspicua, *Forst.*
Desmoschœnus spiralis.
Scedonorus littoralis, *Palisot.*
Gahnia arenaria, *Hook. fil.*

*Of secondary value:*

Hymenanthera crassifolia, *Hook. fil.*
Plagianthus divaricatus, *Forst.*
Haloragis alata, *Jacq.*
Tetragonia expansa, *Murray.*
Aciphylla squarrosa, *Forst.*
Coprosma baueriana, *Endl.*
Cyathodes acerosa, *Br.*
Chenopodium glaucum, *Linn.* var. *ambiguum.*
Atriplex cincea, *Poiret.*
Atriplex billardieri.
Salicornia indica, *Willd.*
Muhlenbeckia adpressa, *Lab.*
,, complexa, *Meisn.*
Phormium tenax, *Forst.*
,, colensoi, *Hook. fil.*
Juncus maritimus, *Lam.*
Cyperus ustulatus, *A. Rich.*
Scirpus maritimus, *Linn.*
Carex virgata, *Sol.*
Zoysia pungens, *Willd.*
Dichelachne stipoides, *Hook. fil.*
Agrostis pilosa, *A. Rich.*
Glyceria stricta.
Festuca scoparia.

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## Art. VI.—*On the Taieri River Floods and their Prevention.*

By W. Arthur, C.E.

[*Read before the Otago Institute, 22nd November,* 1881.]

Plate XI.

Immunity from destructive floods during the last few years, together with the extension of the Taieri River embankments, appear to have induced a sense of security amongst the settlers on the Lower Taieri Plain, which may at any time be somewhat roughly disturbed. And I think, therefore, that the conservators of the river should not remain satisfied with what they have already done, but should take steps to determine accurately and finally the practicability of utilizing such natural sites as exist for the storage of flood waters, but which have not yet been surveyed and reported on. A tolerably intimate knowledge of the basin of the Taieri River above Outram, and of that of the Waipori River, has satisfied me that certain flats on the banks of these rivers offer very excellent facilities for the construction of dams capable of impounding the most of the flood waters, and that at much less cost than is usually supposed. The expenditure of about £200 on a survey would settle definitely this question, and the money would be well spent.

Floods on the Taieri River have been reported on, or written about, by Mr. J. T. Thomson, C.E., Mr. G. M. Barr, C.E., Messrs. Blair, Bell, and Higginson, M.I.C.E. (Flood Commissioners), and Mr. E. B. Cargill. Their estimated discharges of the river and its tributaries differ somewhat, as well as the remedies propounded; and as to the scheme of the Flood Commissioners, its cost has been fatal, apparently, to its early realization. I propose, therefore, to give you a few facts in support of my statement that the Taieri floods are capable of being checked, if not entirely reduced to manageable limits, by reservoirs, and that at a very moderate expenditure.

*Rain Storms.*

The opinion that the Taieri floods are due to the sudden melting of snow, caused by warm north-west winds, with or without rain, is erroneous. For, first, in the case of the gathering ground of the snow-fed rivers of Otago—the Waitaki, Clutha, Oreti, and Waiau rivers—the greater part of the snow lies above the 4000 feet level, while the mountains which discharge the greatest amount of water into the Taieri—viz., the Rough Ridge, Lammerlaw, and Rock and Pillar Ranges—do not exceed 3800 feet in altitude (in round numbers), with the exception of about 3000 acres on the Rock and Pillar. The snow is generally off the latter mountains by the middle of November, and this season, while I write (October), there is little or none; and the Taieri floods, particularly the most destructive, do not generally occur while snow is on the highest catchment ground, that is, in winter. The worst flood of all, that of 1868, occurred in the beginning of February. Lastly, the heaviest floods have been consequent on rain-storms from east to south-west. This range of direction does not bring warm rain; that comes from north-west; but the storms blow well home, and as they reach the Upper Taieri Plains keep pretty steady at south-east. My own notes on the weather, made while living on these plains during 1867-68, and 1869, show this to be correct. It is corroborated by the experience of settlers living there, and the meteorological observations taken at Dunedin for the same period are confirmatory. That is the first circumstance to be kept in view in ascertaining the distribution and effects of the rainfall.

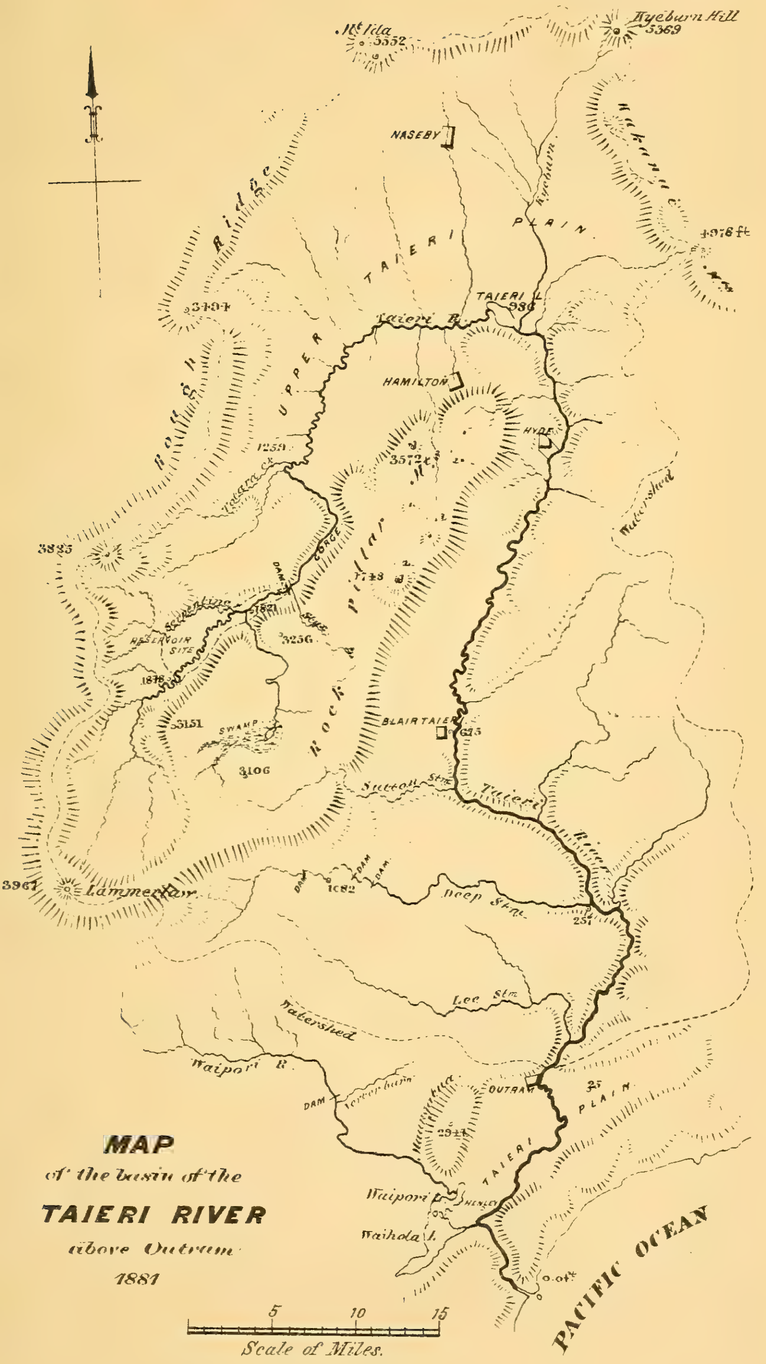
Next, the configuration of the catchment area in its main features is of great importance. This consists of the Mount Ida range and the Kakanuis on the north; the Rock and Pillar, Lammerlaw, and Rough Ridge on east, south, and west; and the Upper Taieri or Maniototo Plains in the centre, which latter average about 1400 feet above sea-level. And, lastly, the soil generally over the whole area is dry, in many places shingly, and, as a whole, has become so baked on the surface by grass fires and stocking that the rainfalls run off with great rapidity—greater, it is thought by many, than was the case before the interior was settled. But there is one remarkable exception to this general character of the soil. The plateau, or elevated plain which forms the top of the Lammerlaw and Rock and Pillar Mountains, contains a large morass of 3000 acres in extent, besides numerous smaller swamps, with bogs and lagoons. This sponge-like and porous soil, with lagoons, is more or less characteristic of the whole catchment area of the Taieri, above the Styx Stream, including the Serpentine Flat, 1800 feet above sea-level.

*Effects.*

Bearing in mind, then, these facts—the direction of the rainstorms which, at their worst, come from S.E. to S.W., the exposure and resistance offered by the faces of the mountains to these storms, and the nature of the soil on the mountain tops and on the plains, with the relative heights of these localities—what should we expect? We should expect the rain-clouds, which come up in a storm from the Southern Ocean, on reaching our coast, and losing the contents of their lower strata among the coast hills, would pass on until caught by the higher ranges which surround the sources of the Taieri River. There, rolling up the slopes of the Lammerlaw and Rock and Pillar Mountains, and forming an eddy on the flat summits, they would become piled up, and their rate of travelling or velocity being thus reduced, they would naturally deposit the greater portion of their contents on and around the tops of these ranges. The remainder of the rain-clouds would pass on and become gradually dispersed by the higher temperature of the interior plains. The more northerly columns of the rain-clouds would draw along the Horse Range to the highest peaks of the Kakanui Mountains and Kyeburn Hill, and lose the greater amount of their contents among these peaks. At the same time the Maniototo Plain itself, lying immediately west of these ranges, together with its western boundaries, the Mount Ida Range and northern part of the Rough Ridge, would have but a reduced balance of rainfall to receive, reduced still further by the superior warmth of the plain itself.

*Evidences of Distribution of Rainfall.*

And what do we find to be the case? The experience of the oldest settlers on the Upper Taieri Plains goes to show that the above




**MAP**
*of the basin of the*
**TAIERI RIVER**
*above Outram*
*1881*

theory is correct. For instance, Mr. James Murison, who first took up country there as a runholder in 1857, has assured me that, while the southerly storms rage around the Lammerlaw and Rock and Pillar, the basin of the Upper Taieri River itself escapes these to a great extent. From the Kyeburn, all round the north and west side of the plain to the Totara, that is over an area of 280 square miles, or 180,000 acres, there is not a single stream but such as a man may easily jump across. The Kyeburn stream has a rapid descent, and in floods rises to a considerable height, but falls quickly. This I saw during the big flood of 1868, when camped on its banks. The streams then round to the Totara discharge very little rainfall into the Taieri; and the most received by Mount Ida flows into the Waitaki; while on the east side, round to Hyde, there is but a small quantity runs down the Sowburn and Pigburn.* But the Deep Stream and Lee Stream rise rapidly and carry off as swiftly a large amount of rainfall. After the flood of February, 1877, I examined parts of the gorge of the Lee Stream, where the flood marks were visible 40 feet above the ordinary water-level on a width of about two to three chains. This gorge has a descent of 900 feet in 11½ miles, while that of the Deep Stream falls 825 feet in 20 miles, or thereby. Then it is well known the main body of the Taieri above the Styx comes away slowly—owing partly, no doubt, to the sponge-like and retentive nature of its catchment ground, and continues high long after the Kyeburn, Deep Stream, and Lee Stream have run off their flood waters. These latter streams are sudden and violent in their action, especially the Deep Stream, which should be checked; but most danger appears to me to lie in the accumulation of rainfall at the sources of the Taieri itself, after the ground there has become saturated and the river has risen to its full capacity. Here, then, the main reservoir should be.

Stated shortly, the above remarks come to this,—That an excess above the average rainfall on the basin of the Taieri River takes place on and around the Lammerlaw Mountains; that the Sutton, Deep Stream, Lee Stream, and Waipori River, carry off the first of this rainfall, while the Upper Taieri River itself brings away the main flood comparatively slowly afterwards; and that on these streams the necessary sites for impounding reservoirs must be looked for.

### *Sites for Reservoirs, the Styx Dam.*

From a consideration of the above conditions, it seems to me that the drainage of the plain from the Kyeburn round to near the Styx may be disregarded, and that a reservoir at the Styx would catch nearly as much flood

* I find from measurements recently made by Mr. D. Barron, that the average discharge at Hamilton Bridge exceeds that at Pateroa Ford by only 8,000,000 cubic feet daily.

water as one at the Taieri Lake. It is at this place, then, the Styx, that the natural advantages which exist should be utilized by the forming of a main reservoir. Here a large plain, 1800 feet above sea-level, and nearly flat, is narrowed in to a few chains width by the surrounding ridges, which thus offer a natural dam, only requiring man's work to complete it. There is a choice of two sites one mile apart. For nine miles up this plain the total fall on the river does not exceed 40 feet, while the first six miles of this distance, I estimate, has not a greater fall than 10 feet. There is a great width on this plain, which naturally divides itself into two parts, 920 acres in the lower, and 5,344 acres in the upper, or 6,272 acres of water-space for the reservoir all over. The average depth of water, deduced by me from a few levels taken during the triangulation of the Serpentine Flat, are, for the lower area, 27·5 feet, and for the upper area 14 feet, taking the height of the embankment, or dam, at 30 or 33 feet. The capacity of this reservoir will thus be 4,370,636,160 cubic feet, assuming the above figures as correct; and the cost of the dam, 5 chains long, if of masonry, £6390. Now, from the Flood Commissioners' report, I find they calculate on having to impound above the township of Outram, 1,506,400,000 cubic feet daily, while Mr. G. M. Barr's paper gives 4,608,000,000 cubic feet; and a rainfall of 1·5 inches run off over 1700 square miles gives 4,233,968,640 cubic feet daily. The mean of these quantities, or 3,449,456,213 cubic feet, I take as the amount required to be impounded above Outram in one day, and as the duration of flood is found to be from seventeen and a half hours to three days the proposed reservoir has the necessary capacity. For, as the drainage area above the Taieri Lake, compared with that above Outram, is as 850 square miles to 1700, the quantity of water to be retained at the Styx, taking it as the same with that at Taieri Lake, will only amount to 1,725,000,000 cubic feet. So that the Styx reservoir will be far more than equal to the work of retaining this quantity—or it will hold two and a half days' accumulation at the rate of 1725 millions of cubic feet per diem.

The only doubtful element in the above is, does the catchment area above the proposed Styx reservoir run off daily this quantity—1,725 millions of cubic feet of water during flood? This can be ascertained approximately by experiment, and, should it be somewhat less, still the quantity would be large enough when retained by the reservoir, to afford an immense relief to the Lower Taieri Plain.

*Deep Stream Reservoir.*

Supplementary to that at the Styx, a reservoir or reservoirs on the Deep Stream would be very useful. A good site exists for a dam to one of these, about a mile and a half below Walsh's accommodation house, where an embankment, 6 chains in length and 15 feet high, would retain 217,800,000 cubic feet over an area of 500 acres. The catchment area above this point is 59 square miles, which, with a rainfall run-off of 1·5 inches, gives a daily discharge of 205,603,200 cubic feet. The cost of this dam, if of masonry, I estimate at £3,115. There are other good sites on this river, but none on the Kyeburn, Sutton, or Lee Stream.

*Waipori Reservoir.*

The valley of the Waipori also offers facilities for impounding flood waters above the junction of the Verterburn, and near the outfall of the sludge-channel. I am not so familiar with this spot as with those sites above described, nor do I think it so good. Still, here also there is an area which I estimate at 900 acres suitable for a reservoir. An embankment or dam, 10 chains in length and 33 feet high, would impound about 588,060,000 cubic feet of water, the inclination of the flat being 7 feet per mile. If of masonry, its cost would be £12,000; but probably a careful survey would show that the dam need not be so long, and, consequently, not so costly. This Waipori reservoir would not, of course, be a check on the floods of the Taieri itself, and may therefore be left out of consideration until the money required for its construction is available. At the same time, it would benefit the Henley estate and others of the low-lying lands in that quarter, while indirectly it would relieve the outflow of the Taieri by the lower gorge into the sea.

In each of the above dams, self-acting sluices, openings or culverts, would be necessary, the particular form being a detail which need not here be gone into.

Neither have I particularly referred to the embankment of the Taieri River on the Lower Taieri Plain, from Outram seawards. I would only remark that, while I think it probable the money spent on this might have been expended more profitably in the construction of dams further up the river in the interior, there can be no question as to the benefit the embankment has been to the lands on the right or west bank of the river. This, however, is secured at the expense of the lands on the east side of the river, of the channel of the river, and of the bridges on the river.

In concluding this paper, I would say that the facts I have given go to prove that nearly all the flood-water which could be impounded at the Taieri Lake, may be confined above the Styx River at much less cost, and that an exhaustive survey should be initiated without loss of time, first to determine where the greatest rainfall occurs on the catchment area, and next the precise capabilities of the various reservoir sites which I have indicated, my own calculations of the latter being only approximate.

I append a table of Taieri River floods, data from Dunedin Meteorological Observatory; also a map of the Taieri Basin (pl. XI.)

| Date. | Direction of Storm Average. | Total Rainfall in Inches. |
|---|---|---|
| 1867—November 19th to December 1st.. | N.W. to N.E. | 4·002 |
| 1868—January 29th to February 8th .. | N.E. to S.W. | 5·246 |
| 1876—January 22nd to 24th .. .. | S. to S.W. | 4·960 |
| 1877—February 2nd to 9th .. .. | N.E. to S.W. | 6·200 |
| 1879—March 24th to April 1st .. .. | N.E. to W. | 4·728 |
| ,, June 28th to 30th .. .. .. | S.E. to S. | 4·560 |

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## Art. VII.—*On the Reclamation of Waste River Beds.*
## By A. D. Dobson, F.G.S.

[*Read before the Philosophical Institute of Canterbury, 2nd June,* 1881.]

One of the most striking features of the Canterbury Plains is the great area of ground occupied by the shingle beds of the rivers, an area quite out of proportion to the size of the rivers were they confined so as to flow in one deep channel instead of spreading as they now do in numerous shallow streams over their wide shingle beds.

From the Waipara to the Rangitata the area of the shingle beds is at least 100,000 acres, one half of which would be amply sufficient for the water-way were the rivers properly regulated. Not only do the rivers occupy a much greater area than is at all necessary for the water-way, but in the lower part of their courses they are continually filling up their beds with the shingle brought down from the mountains, and cutting fresh channels in the adjoining lands, thus destroying valuable property, and being a continual source of expense and anxiety to those who live on their banks.

The Waimakariri in Canterbury, and the Wairau in Marlborough, are well-known illustrations of this statement.

All rivers have a tendency to raise their beds in the lower part of their courses, this action being slowest when fine silt only is brought down, such as that deposited by the Nile and Mississippi, and most rapid in shingle-bearing torrents, such as our own rivers.

Even in the case of large rivers with long courses and little fall, the rise of the river bed, and often the adjoining overflowed country, is more rapid than would be expected by a casual observer. From long before the historical period, the Nile has been steadily raising its bed, but as its flood-waters were the source of the fertility of lower Egypt, river works were undertaken with a view to obtain the advantage of the overflow on the greatest possible area, and the flooded lands were raised annually by this process, as well as the river bed itself.

This cannot happen in the case of torrents carrying large quantities of shingle and sand, which are brought down in times of flood and left in the channels as the velocity of the stream decreases, and although much may be done towards raising the adjoining lands by inducing an overflow of flood water upon them, the floods will always bring down from the upper levels masses of material that it has no power to move along the lower course.

This is the problem the Italian Engineers have had to deal with in the management of the Po and its tributaries.

The general system in Europe for conservation seems to be to wall in the river between embankments with the endeavour to make it carry its silt as far forward as possible, making traps for catching shingle; where possible raising adjoining lands by ponding up flood-water upon them; and many other expedients for keeping the rivers from changing their courses and wandering about their fans into new courses. The great drawback to this treatment is, that however much (within certain limits) the river may be embanked, it continually raises its bed, and the banks must be raised in proportion.

To such an extent has this been done that some of the Italian rivers are now far above the level of the adjoining lands, so that the surface drainage of the country has to be carried in other channels, involving all kinds of complications in the drainage; and should the embankments fail, immense volumes of water may be dammed up on the low-lying land by the banks which were built for their protection, entailing great loss of life and property. Such a disaster occurred not long since in Hungary, at Szegedin, on the River Theis.

When we consider the enormous cost that would be incurred in attempting to control our great torrents by any system of solid embankments, it becomes apparent that we must either invent some plan which can be carried out on a much cheaper scale, or else let matters take their course.

Doubtless weak places may be defended by groins and spurs; and the more chance will there be of success so long as only one side of a river is being worked upon. But so soon as works are undertaken on both sides of a river, they will have to be more or less continuous embankments, which must be made of permanent materials, involving immense expense.

On the Canterbury Plains the conditions are most favourable for the formation of broad shingle beds, the loose shingle banks offering no resistance to the action of the floods. In a bush country, in its natural state, quite other conditions obtain; the vegetation along the river, so long as it is uninjured by stock or fires, affords great protection to the banks. Flood-water overflowing the banks is checked, and the silt deposited, whilst all scouring action is stopped by the roots and vegetation covering the surface of the ground; and when in the course of time the banks wash away, the vegetation at once takes possession of all the shingle-spits, so that in the end the forest recovers the ground lost, and the mean area of shingle remains the same; and also the silt brought down during floods settling amongst the shrubs and trees on the banks, raises them as well as the river bed. This is the way in which nature utilizes the shingle beds in bush countries; and it appears to me that by following the same mode a vast area of profitless shingle bed could be turned to account, and the rivers kept within bounds at the same time.

I consider planting would be within the means of the country; and, if properly carried out, would eventually turn valueless shingle beds into valuable forest.

I would plant a belt of willows along the river in the first instance, and, as these grew, the planting should be carried out on all the higher spits and islands. The willow-planting would be done very cheaply, a stout willow-stick being put down in a hole made with an iron bar. As soon as the willows grew, they would rapidly collect silt, and, on the ground thus formed, trees of useful varieties suited to the locality should be planted. Many flats which are only flooded slightly, on very rare occasions, could be planted at once; and in a few years the present shingle deserts would be turned into a wide expanse of young forests, with the river meandering through them. In addition to the planting, it would be necessary to erect protective works in some cases, where there was danger of the river destroying the plantations before they were strong enough to protect themselves.

In a few years the willows would provide ample material on the spot for the construction of brushwood groins, and a vast amount of live protective works could be constructed at a small cost.

It is to be expected that the plantations would suffer from time to time by the floods; but, as the banks got well covered with vegetation, the destruction of the river banks would be very slow, and the trees washed away would lodge on shingle banks and commence recovering land without further help.

By utilizing the shingle beds in the manner just described, I consider two advantages would be gained,—the formation of a useful forest, and the regulation of the river so planted,—as the forest itself would form one of the best protective works that could be made. By no other system could protective works be made a source of profit, and the money expended must be considered as so much capital sunk, the yearly interest on which represents the price the country pays for the privilege of occupying the endangered land.

The next question is that of cost, which can only be arrived at approximately, as no planting has ever been undertaken in New Zealand on such a scale as that now proposed under similar conditions; but, probably, £15 per acre would be sufficient, including the cost of fencing. At the end of ten years the thinning-out should be worth at least £1 per acre (for fence stakes and firing), clear of expenses for management and renewals; and at the end of twenty years, the timber would be large enough for posts and rails, scaffold poles, and mining timber.

Assuming that 40,000 acres could be easily utilized, the cost would be approximately, as follows:—40,000 acres, at £15 per acre, £600,000; to this add, say, £100,000, for groins, wing-dams, etc.: making a total of £700,000.

For ten years the interest on this sum will be lost; but, at the end of that time, the returns should be at the rate of £1 per acre per annum, which equals £40,000, or a trifle over 5½ per cent. on the £700,000, and the profits would increase as the trees grew larger.

The presence of the forests would, doubtless, exercise a very beneficial influence upon the climate of the plains, checking the north-west winds and inducing a greater rainfall.

There are many difficulties at present in the way of carrying out such a scheme as the foregoing, but not such as would offer any insurmountable obstacle, if the matter was taken seriously in hand.

It would be necessary to have one Board of Conservators for each river, possessing full power to fence, take land, and carry out everything necessary for the work.

There has been a great deal of planting done in Europe during the last fifty years,—the greatest achievement being the planting of 150,000 acres in the south-west of France. The whole of this area was planted in twenty-five years, at the end of which time a quantity of mining timber was being exported to England, and factories were being erected for the manufacture of paper and distillation of turpentine.

By following such an example as this, we may reclaim our barren shingle beds, control the rivers through a considerable portion of their course, and lay the foundations of extensive and profitable local industries.

Art. VIII.—*A few Remarks on the Carved Stone Bird, named Korotangi by the Maoris, now in the possession of Major Wilson.* By Prof. Julius von Haast, Ph.D., F.R.S.

[*Read before the Philosophical Institute of Canterbury, 13th October*, 1881.]

Through the kind offices of Dr. Buller, F.R.S., Major Wilson has sent to the Canterbury Museum a remarkable carving in stone, which he obtained from a native tribe in the North Island, by whom it was much prized; in order that I might have a careful cast prepared from it. Having done so, and before returning it, I have thought that it might not be without interest to the Philosophical Institute to have it exhibited at to night's meeting, and to allow me at the same time to make a few observations on its character.

It is carved out of a very dark green serpentine, according to a calculation made by Mr. G. Gray, of a specific gravity of 2·531, at 60° F., which is about the mean of a series of this mineral, of which the specific gravity has been ascertained by other mineralogists.

The bird, carved in a bold and careful way, and in a natural position, seems to represent, at a first glance, a species of *Prion*, the beak being so very much depressed, but, on closer examination, it will be seen that it does not possess the united nasal tubes placed on the top of the bill, but has the nostrils lateral, near the base of the beak, as in the ducks, but it is very possible that it might be only a conventional form.

It is not my intention to anticipate, in any way, the forthcoming paper of Major Wilson, who is going to give us in our "Transactions" a doubtless very interesting account of the history of this remarkable specimen of eastern art, said to have been brought over to New Zealand in one of the original canoes from Hawaiki, but simply to show it to you, and to note its mineralogical character by which it might perhaps be traced to the locality where it was manufactured.

I exhibit, at the same time, from the museum, an ancient Japanese bronze, without doubt a vessel for burning incense, representing also a bird, the character of which is, in many respects, not unlike the specimen carved from stone.

In both, the feathers on the back are rounded, with a central line, from which smaller lines slope down on both sides, while the wing-feathers are more pointed, and have a similar ornamentation.

To my mind there is no doubt that both have a somewhat similar origin, and come either from the same eastern country, or, if from two different countries, that the latter are nearly related to each other, and where, for many centuries, if not thousands of years, industrial art has been practised.

I wish also to draw your attention to the fact that the stone bird has been carved with a sharp implement, either of iron or bronze, of which, as we know, the Maoris had no knowledge; the lines are all cut so evenly that it could not have been done with a stone implement.

To show in what respect this specimen is held by the natives of the North Island, I add an extract from a letter of Dr. Buller's, received a few days ago:—

"Mr. Sheehan tells me that Rewi Maniapoto was greatly pleased to see the Korotangi on his visit to Waikato, and kept it on the table near his bed, waking up at intervals to *tangi* over it."

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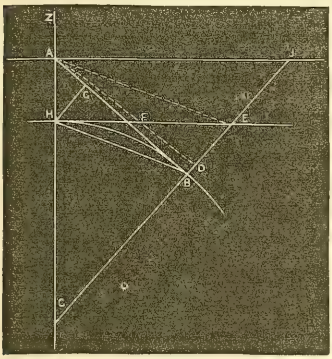
## ART. IX.—*On Vertical Triangulation.* By C. W. ADAMS.

[*Read before the Philosophical Institute of Canterbury, 13th October,* 1881.]

THE object of this paper is the investigation of a formula for the determination of the distance between two points, their difference of altitude being known, and also the angle of depression from the higher to the lower.

This problem frequently occurs in topographical surveying in the following form:—

Given the height of a station above the surface of a lake, bay, or arm of the sea; and the zenith distance, or angle of depression, to a point on the shore; to determine the distance thereto.




Let $A$ be the elevated station, $B$ the point on the shore, and $C$ the centre of the earth. Refraction will cause the point $B$ to appear at $D$, and the observed zenith distance will be the angle $ZAD$, the true zenith distance being $ZAB$. Draw $HE$ perpendicular to $AH$, and $HG$ perpendicular to $AB$. Subtracting the observed zenith distance from 180°, or the observed angle of depression from 90°, we get the angle $DAH$, which we will call the observed Nadir distance, and subtracting the refraction from this, we get the true Nadir distance $= BAH = GHF$.

Then the distance $HB = HG$ sec. $GHB = AH$ sin. $BAH$ sec. $GHB$.

Let $N$ be the observed angle from the Nadir $= DAH$.

Let $K =$ the distance $HB$.

Let $m =$ co-efficient of refraction.

Let $C =$ the contained arc.

Let $h$ = height of the station $A$ above the surface of the lake.

Then $K = h \sin.(N-mC) \sec.(N-mC+\frac{1}{2}C)$.

$$= \frac{h \sin.(N-mC)}{\cos.(N-mC+\frac{1}{2}C)} \qquad (1)$$

If $Z$ = the observed zenith distance, then the following will be the formula:—

$$K = \frac{h \sin.(Z+mC)}{\cos.(Z+m\,C-\frac{1}{2}C)} \qquad (2)$$

If $D$ = the observed angle of depression; then

$$K = h \cos.(D+mC) \operatorname{cosec.}(D+mC-\frac{1}{2}C)$$

$$= \frac{h \cos.(D+mC)}{\sin.(D+mC-\frac{1}{2}C)} \qquad (3)$$

These 3 formulas require the angle $C$ (or contained arc) to be known, but as this is measured by the distance $HB$, some method of approximation must be employed in order to get this distance. This may be done graphically by making $AH$ = the height in links, then draw $HE$ perpendicular thereto, and draw $AF$ making the angle $HAF = N$, then $HF$ will be the distance required in links nearly, but always less than the true distance. The same thing may be done by calculation, by multiplying $AH$ by tan $N$.

A more accurate method may be investigated as follows:—

To investigate a method of finding the distance $HB$ approximately.

Draw $HE$ perpendicular to $AH$, then the distance $HE$ (to a point vertically over $B$) will not differ much from the distance $HB$. Draw the line $AE$, then the angle $BAE$ will be nearly = the angle $BHE$, which is $= \frac{1}{2} C$.

Assuming the angle $BAE = \frac{1}{2} C$ and the angle $BAD = \frac{1}{14} C$, then the angle $DAE = \frac{1}{2} C - \frac{1}{14} C = \frac{3}{7}C$, therefore

Multiply $AH$ by tan $(N + \frac{3}{7} C)$ and the result will be $HE$ nearly (4)

Or if $D$ be the observed angle of depression, then

$AH \cot (D-\frac{3}{7}C) = HE$ nearly (5)

Or if $Z$ be the observed zenith distance, then

$AH \tan (Z-\frac{3}{7}C) = HE$ nearly (6).

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## Art. X.—*Notes on the Height of Mount Cook.* By C. W. Adams.

[*Read before the Philosophical Institute of Canterbury, 1st September*, 1881.]

The height of Mount Cook has been calculated in August, 1881, by Mr. George John Roberts, assistant geodesical surveyor of the Westland Survey Department, as 12,349 feet above the mean level of the sea.

This altitude is a mean result deduced from observations at twenty-two stations, and may be considered as final.

Fourteen of these results are within 5 feet of the mean mentioned above.

In my "Notes on the Height of Mount Cook," read at this Institute on the 7th of August, 1879, I stated the height to be, from my own observations, 12,375 feet, but as my observations were made under unfavourable circumstances, I consider Mr. Roberts' determination as the most reliable.

I took observations at six stations only, the nearest being 34 miles from Mount Cook, and the other five varied from 71 miles to 130 miles.

Mr. Roberts took observations from twenty-two stations, averaging only 16 miles from Mount Cook, so he would have much better opportunities of getting accurate results than I had.

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## ART XI.—*Remarks on Mr. Frankland's Paper on "Mind-Stuff."*

By J. TURNBULL THOMSON, F.R.G.S., F.R.S.S.A., etc.

[*Read before the Southland Institute, 26th March,* 1881.]

MR. FRANKLAND'S paper on "Mind-Stuff"* excited considerable attention amongst the ethical world of Wellington; and, as it is a subject in which interest is ever reviving, I hope I shall be held excused for bringing it before the notice of the members of the Southland Institute. On hearing the paper read, I found my opinions at variance with the author, and had noted my objections at the time, but any desire of stating these publicly and immediately lapsed in my listening to the reply by Mr. Justice Richmond. However, on reperusing the paper as printed in the "Transactions," it struck me that there was yet room for observations, and they are as follows:—

Mr. Frankland, at the commencement, states the object of his paper as being "to describe briefly a theory or doctrine of existence, expounded by the late Professor Clifford, in an article 'On the Nature of Things in Themselves,'" and, at the end, he sums up in the following manner: "That there is nothing in the doctrine of Mind-Stuff to negative the belief either of the spiritualist or the theologian;" but, "there is equally little in it to encourage or lend assistance to theological belief." Again, "In regard to theology, the doctrine of Mind-Stuff," he says, "is neutral." "It affirms that there is only one Existence, and that the supposed dualism of matter and spirit is an illusion."

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* Trans. N.Z. Inst., Vol. XII., p. 205.

The above summation is founded on the following main precepts, which I reproduce as succinctly as I can:—

1. That all the properties of material objects are capable of being analysed into possibilities of feeling, or relations among possibilities of feeling.

2. That the only concrete realities — *i.e.*, things in themselves — are feelings. All the real existences we know of being mental states.

3. That the external world is an "eject"—*i.e.*, the minds of my readers are "ejects" of me, and my mind is an "eject" to them.

4. Acccording to the doctrine of Mind-Stuff, feelings or thoughts are *noumena*, the "things-in-themselves" which underlie the changes in the grey matter of the brain.

5. The universe is a stupendous web of Mind-Stuff from eternity to eternity, and the universe of matter is a complex of possibilities of feeling.

6. Motion is Mind-Stuff, volume of feeling is mass, intensity of feeling velocity.

7. The relations of synchronism among elements of feeling will have their counterparts among motions of matter, etc.

Of this theory of existence, the author informs us that he arrived at it independently of Professor Clifford, as far back as the year 1870, which, stating it in my own way, makes reality into nullity, and the things of this universe into mere possibilities of feeling.

It struck me at the time the paper was read, that, though accepted as discoveries, these doctrines were not new. Turning, then, to Wilson's Religion of the Hindoos, and coming to the Satnami Sect, we find that to them worldly existence is an illusion, or the work of Maia, the primitive character of Bhavani, the wife of Siva. However, they recognize the whole Hindoo pantheon (and "hence there is nothing in their doctrines to negative the belief either of the spiritualists or theologians of their nation"), but although they profess to worship only one God, they pay reverence to what they consider manifestations of his nature visible in the Avatars particularly Rama and Krishna.

Next the Sunyavadis have an atheistical creed. They say what we behold is vanity. Theism and Atheism, Maia and Brahma, all is false, all is error—the globe itself, the egg of Brahma, the seven Dwipas and nine Khandas, heaven and earth, the sun and moon, etc., etc. Speech, hearing, and discussion, are emptiness, and substance itself no more (than this). Let every one meditate on himself ("perform self-analysis with perfect precision and faithfulness" as Mr. Frankland expresses himself) nor make self-communion known to another; let him be the worshipper and the worship. There is no other but myself, and I talk of another from ignorance. In the same way as I see myself in a glass, I see myself in others; but it is an error to think that what I see is not my face but that of another. Father and mother are non-entities; I am the infant and the old man, the wise man and the fool, the male and female, etc.

Thus we have the old adage exemplified, that there is nothing new under the sun, however unexpected be the quarter in which we find it. But we have nothing to do with the peculiar persuasions of the Cliffords, Franklands, Satnamis, and Sunyavadis in their religious aspect, it is only in their scientific phase that this society, by its constitution, permits discussion. I shall, therefore, address myself to this portion.

According to Mr. Frankland, "the universe of matter" is "a complex of possibilities of feeling," and again "feelings or mental states, comprising comparatively *vivid ones* known as sensations and emotions, the *fainter copies* of these, sometimes called 'ideas,' constitute the material of which thought is woven, and certain unique states of mind which form integral parts of volition and belief—states of mind which assimilate most nearly to emotions, but which may be described as somewhat too colourless, if the term be allowable, to be fairly classed with these."

Here almost at the commencement of his paper I find myself at issue with the author, my view going only so far as to say that the universe of matter *may be* a complex of possibilities of feeling, but to which I must add that these same feelings are either no guide or doubtful and very erring indicators in comprehending such matter of the universe.

Thus we stand on the surface of this world, and feel that the sun, moon, and stars traverse the heavens above us. Our feelings lead us to the belief that we stand stable, and the universe revolves round us. But a higher faculty informs us to the contrary. This faculty we call reason, and which is seldom at one with our feelings, but more often at variance; further, sometimes in diametrical opposition, such as in the case above recited. How frequently do not our feelings impel us to do that which is wrong, and how often would we do wrong had we not reason to stay us? Indeed, our feelings are astray in almost every direction, that it is a wonder to me to see men with enquiring minds building up a theory of empty existence on them. Thus, in the physical world, our feelings tell us that the sun has risen; our educated reason tells us it has not, for it only appears to have risen; the truth being that it has not, atmospheric refraction creating the deception. Many such illustrations might be entered into, but this would be tedious.

Again, in the moral world, how often our feelings would deceive us by impelling us to retort the angry word, and how well it is when reason comes to our aid and directs the opposite course, which is the true one.

Thus I am unconvinced when the author describes "feelings or mental states" as being divided into "vivid" and "faint," the former being "emotions," the other "ideas." On the contrary, my study of the subject has led me to conclude that these attributes are not similar, and only differing by degree of power, but opponent, though essential. And to the ideal part of man's nature I give incomparably the higher place. It is by his ideal or ethereal nature that man weighs the sun as it were in a balance; that he predicts by many years the positions of the stars in the heavens; that he anticipates eclipses and other astronomical phenomena; that he scientifically navigates the great ocean, and that he by his designs overcomes space and time by the railway and electric telegraph. Thus man is gifted with an attribute far outside of gross narrow feeling, as truthful and transcendent in its comprehensiveness as the latter is misleading and misguiding. Hence there is objectiveness and idealization or mental conception attached to man's life, the former being that function of the feelings which makes us accept as actual what is only apparent and inaccurate, while the latter is that function of the mind which enables us to comprehend what we arrive at by processes of abstract study, thought, deliberation, or consideration, entirely apart from feeling. This gift of mental conception places man in his pre-eminent position in nature, and is that ethereal part of his being which being truthful is undying and immortal.

Mr. Frankland describes man as believing his fellow-creatures to be conscious beings, while that the higher animals are sentient. It is difficult for me to guess the particular import he gives to these words, but I may suggest that he takes the former as being the power of reflection, the latter the power of perception. If so, to my mind these terms are not so appropriate as the orthodox ones—*i.e.*, reason and instinct. It is true that reason and instinct approach at times so closely that we cannot know where the one begins and the other ends, for some of the higher animals show a sagacity which makes it hardly possible to deny them some of the attributes, however small, of reason. Yet that the higher animals are only sentient I think is not consistent with correct observation, for even the lowest creatures must be admitted to have perceptions of a kind due to their varied wants and habits. In this manner even the worms have perception, and hence are sentient. To my mind, therefore, the orthodox and approved terms are yet the best—*i.e.*, reason and instinct. The material difference between man and beast is that the former stands erect on two feet; the ethereal difference is that having reason man can restrain himself, and in so restraining himself he can record and bear to record his actions, and in recording his actions he can take praise or blame, and in praising and blaming he reasons. And his reason, an ethereal attribute, carries him yet further; it gives him knowledge of letters, and he writes down events; thus the history of 4,000 years is unlocked to him. By the knowledge of figures he explores the heights of the heavens and the depths of the earth, and beholds with wonder and enjoyment the works of creation. To neither the sentient faculty of the beasts, nor the mere sensualism of humanity, could these be made obvious. They are beyond the "possibilities of feeling."

Then as to Mr. Frankland's doctrine regarding the relations of synchronism among elements of feeling having their counterparts among motions of matter, we are again at issue. Our conclusion being that among motions of matter and elements of feeling there is the contrary. Let us by way of illustration take an event, such as the firing of a cannon, wherein there is "motion of matter." By "self-analysis with perfect precision and faithfulness," what would be the relations of an observer's feelings in regard to this?

Let, for example, the observer be at 12 miles distance. First he would see the flash, next he would hear the report, then he might smell the fumes were his olfactory nerves peculiarly sensitive and the wind favourable. Now, by these elements of feeling, would there be synchronism in relation to the event? By precise and scientific analysis not so. For with the knowledge of the speed of light which reason has enabled us to measure, the event would be impressed on the feeling of sight, not synchronously, but $\frac{6}{100,000}$th of a second after it. By sound it would come to the feeling of hearing one minute after, and carried by the wind it might be smelt in feeling a quarter or half an hour afterwards. Thus among the elements of feeling the relations of events are not in synchronism, but in complete discordance.

Hence in regard to a single event or events there is no synchronism "between a man's own feelings" and things as they appear to him, one sense leading him $\frac{6}{100,000}$th part of a second astray from scientific truth, another one minute, and another a quarter to half an hour. "Feelings," therefore, give no rigid or scientific basis on which to found a "theory of existence;" and if this is to be attained it must be by and through the higher phase of man's nature—viz., the ethereal one, reason, which gives him the power of accurate and truthful mental conception, and ultimately stable faith and belief.

And it may be mentioned in passing, though it has no necessary connection with the argument, that neither do separate men's feelings admit of synchronism as with each other. This fact is well-known to astronomers, when observing by time, wherein it is a fact that one person does not hear or see concurrently. Thus, in time observations: one person hears before the other, sometimes to the extent of half a second; while in instrumental reading, one often reads a minute or two different from the other, and in order to overcome the inexactitude or deficiency of sense or feeling in this respect, the mental power of men,—*i.e.*, reason,—has again to be had recourse to; wherein minute calculations, abstract of feeling, are made to reconcile the observations of different persons,—in other words personal equation has to be ascertained by man's ethereal or mental attributes, and allowed for, in all investigations which approach higher science or rigid truthfulness.

As synchronism between feelings and events is a radical element of Mr. Frankland's theory of Existence, I will be excused in dilating on it somewhat prolixly; and, in doing so, may bring to notice the very unequal manners and different times in which separate men's feelings are affected by influences and objects. Thus rhetoric makes one laugh, another cry, another sorrowful, and another angry; and, while the feelings of none are affected exactly alike, neither is the time of affection one and the same. Some being notoriously slow and obtuse in impression, others easily and rapidly moved. Some are case-hardened to any appeal; others, the contrary. Hence, as between one man and another, feelings and events are anything but in synchronism. Now as on this doctrine Mr. Frankland founds his ultimate theory,—to wit, that there is only one Existence, therefore, to his showing, non-synchronism indicates two more, or many existences; this is obvious as between man and man, or as between multitudes of men.

Again, in each individual we have seen that neither is there synchronism in regard to "motions of matter," or events "among elements of feeling," hence, by the same rule we are bound to conclude, that in each individual there is more than one Existence.

And when we consider the widely-distinct essentials appertaining to man's position in creation,—that is in the lower attribute, "feeling," always erring or inaccurate, and, as between the several senses, discordant; in the higher attribute, "reason," capable of accuracy, truth, and concordance; the one feeding on the apparent, the other on the intangible; the one on the objective, the other on the invisible; the one on the relative, the other on the abstract; the one on the material, the other on the ethereal; the one contracted, the other boundless; we are led up to the doctrine of two Existences,—the one fleshly, revealed through our feelings, the other mental, revealed through our reason: the one Existence of matter finite, the other Existence of spirit Eternal.

Art. XII.—*On the Production of Inflammatory Action in detached Portions of dead Animal Bodies.* By Robert Hall Bakewell, M.D., Fellow of the Royal Medical and Chirurgical Society of London; formerly President of the Medical Board of Trinidad, etc., etc.

[*Read before the Westland Institute*, 1st *November*, 1881.]

The question, "What is death?" is one not so easily answered as might be supposed. The popular idea that death in animals is a sudden and instantaneous change, is of couurse not held by physiologists, who have long recognized the distinction between *somatic death*, or that of the animal body as a whole, and *molecular death*, or that of the elementary structures of which it is built up. It is difficult to find a good and terse definition of death. In the following article, *somatic death* may be defined as *the permanent arrest of all the functions and powers of the body*. The only certain proof of death, as thus defined, is the commencement of chemical decomposition in the whole of the body.

It will be at once apparent that this definition of death leaves a considerable interval between that cessation of respiration and circulation, accompanied by entire unconsciousness, which is the popular idea of death, and the commencement of chemical decomposition. During this interval the only vital actions* generally supposed to continue, are that peculiar state of muscular action called the *rigor mortis*, and the growth of the hair. Some writers consider even the latter as not a true growth, but only an appearance produced by the shrinking of the skin.

It is the purpose of this paper to give a very brief epitome of a series of experiments which have been performed during the last ten years, showing that, in so far as inflammation may be considered as an evidence of life, molecular life exists with a vigour and for a length of time hitherto unsuspected, after somatic death has taken place.

It may just be mentioned that, when in medical charge of a smallpox hospital some ten years ago, in the West Indies, I was engaged in microscopical investigations into the growth and development of the variolous vesicle, which were published at the time in the "Medical Times and Gazette," 1871–2, in a series of papers on the Pathology and Treatment of Smallpox. I then observed that in my quarters, a small wooden building of inch planks, where the temperature in the middle of the day was often 100° F., changes took place in the variolous matter, kept in the ordinary capillary glass tubes. I was thus induced to try the cultivation of variolous

* I use this term for convenience' sake.

matter, and subsequently of vaccine lymph. These experiments were only partially successful for reasons which are now obvious; but they led on to other experiments.

Mainly these were on the growth and development of the red corpuscles in birds. The results of these experiments were published in the Transactions of the New Zealand Institute for 1874. It was shown that by the use of a suitable nutrient fluid—egg-albumen mixed with water—the nucleated red corpuscles could be made to grow and throw off their nuclei, which became developed into round coloured non-nucleated corpuscles, exactly resembling those of mammalia. The same experiments, with a like result, were made with the blood of fishes, particularly with sharks and rays, and subsequently with the blood of reptilia.

During the investigations upon the blood of reptilia, (frogs being selected for convenience), I naturally took the opportunity of observing the phenomena of inflammation, as seen in the web of the frog's foot and the tail of tadpoles. Having for some time entertained grave doubts, on *à priori* grounds, as to the possibility of Cohnheim's so-called wandering corpuscles really passing through the walls of the capillaries, I was induced to make some experiments with a view of testing the matter.

For this purpose I took advantage of a few months' residence in New South Wales, not only carefully and repeatedly to examine with the microscope, the phenomena of inflammation in the tails of tadpoles, but also to show, beyond the possibility of doubt, that leucocytes do not, in these animals, wander from the blood vessels, but are formed from pre-existing germs in the solid tissues, either from connective tissue corpuscles or from some other source. A very simple experiment showed this. A small portion of the transparent extremity of a tadpole's tail was cut off, and immersed in a nutrient fluid, (half egg-albumen and half water was found the most useful), and kept at the ordinary temperature of the air, which at that place and season varied from 70° to 90° F., in the house. Control experiments were made by immersing other portions of tails in water, in water impregnated with carbolic acid, and in various other media. The tails immersed in pure water were in a few hours in a state of decomposition, sulphuretted hydrogen was evolved, bacteria and multitudes of animalcules (monads) were formed in the water, the portion of tail was shrivelled, and dead to all intents and purposes. With carbolic acid the tails underwent no change.

The following description, taken from the notes of one experiment, will show the changes that ensue in a few hours:

"March 13th, 1878, 2.30 p.m.—Snipped off four tadpoles' tails, placed them in a mixture of egg-albumen and water. Tails sank in mixture.

5 p.m. temp. 90° F. The cut extremity of each piece was cloudy and whitish, as viewed through a lens of 1½ inch focus; vessels looked more marked and prominent than when put in; outline of pieces not so sharp and well marked as those in the water.

"Under the microscope, round nucleated cells were seen projecting from the cut surface; a few of such cells were floating in the nutrient fluid; several dark-coloured cells round, containing numerous nuclei, were seen.

"At 5.30, these were obscured by a cloud of white cells with granular contents.

"14th, 9 a.m.: The little phials in which the tails had been placed showed a white cloudy precipitate, about ¼ inch deep. On microscopical examination, this proved to be granular protoplasm in amorphous masses, but showing faintly a commencement of segregation into cells. In the fluid were floating about (A) innumerable altered red corpuscles; (B) many round cells of a yellowish or fawn colour, containing two or three nuclei; (C) innumerable leucocytes; (D) columnar and other epithetial cells.

"The tails themselves showed the following changes:—1st, all the red corpuscles were gone; none were to be seen in the most transparent parts; 2nd, all the pigment cells were broken up into small portions, irregular in outline, but much rounder and less angular than the normal pigment cells of the tadpole; 3rd, the striped muscular tissue was in a state of incipient fatty degeneration; 4th, over the whole of the skin were crowds of leucocytes covering it, and easily detached."

This is a fair sample of scores of similar experiments. They proved that leucocytes originated in an inflamed part, and were not brought to it from the blood.

I then tried what could be done with warm-blooded animals, but was for a long time only partially successful, owing to not using a proper nutrient fluid at a sufficiently high temperature. The following experiment with egg-albumen and water is interesting, as showing that even with this the commencement of inflammation could be produced in a warm-blooded animal.

December 23rd, 1878.—Placed portions of the liver, the peritonœum from the mesentery, and voluntary muscle of a duck, in a mixture of egg-albumen and water, kept in contact with my own body. The peritonœum was in a separate bottle. Between two and three hours afterwards, there was evident (naked eye) turbidity of the albumen in which the peritonœum was placed; the membrane appeared swollen and milky. The turbidity of the bottle in which the muscle and liver were placed was not so marked. Both appeared paler.

December 24th, 8 a.m.—Increased turbidity. Peritonœum much swollen and milk-white; the muscle nearly milk-white; the liver a pale yellowish grey.

Peritonœum bottle; under microscope, multitudes of young cells and granules were floating about in the fluid;* peritonœum granular, with many young, round, nucleated cells sticking all over it. (Bad light; very wet day.)

Liver very friable; quantities of young cells with well marked edges and nuclei, mostly one, some two, a few three. The usual liver cells were dark, with many dark spots, not removable by acetic acid.

Muscle: no cells except a few adherent to it. No trace of striation, but very opaque fine granules (commencing fatty degeneration).

At length it occurred to me that defibrinated blood would be the best nutrient fluid for mammalian tissues. After numerous experiments, many of which were failures owing to the want of suitable apparatus, and the extreme difficulty of keeping the blood at the temperature desired, ranging from 100° to 105° F., the following were found to be the conditions under which inflammation in detached portions of the body could be carried as far as the production of pus.

The blood should be obtained from an animal rapidly killed by violence, not poison. It should be defibrinated by whipping, and the agitation of the blood should be continued until the whole has become bright scarlet, and thoroughly oxyginated.† The parts to be operated on, which should if possible be from an animal of the same species as that from which the blood is taken, are then to be placed in a glass vessel containing a quantity of the blood—the more blood the better; for instance, 4 fluid oz. of blood would be a fair allowance for a sheep's eye. The vessel must be closed to prevent evaporation of the watery parts of the blood. Open vessels are found not to answer, the blood gets thick very soon. This glass vessel must be placed in a water bath, which must be kept at a temperature of 100° to 105° F. This is the most difficult part of the process. Until one has watched a thermometer for some hours, it will hardly be believed, how, with the same degree of applied heat, the temperature of the water bath will vary. As the temperature of the room falls or rises, so the applied heat has to be adjusted, and a few minutes neglect will suffice for the whole

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* Subsequent researches made it probable that these were not derived from the peritonœum itself but from the lymphatic vessels and their contents, contained within the folds of the mesentery.

† The blood always becomes of a dark venous hue after being exposed to the temperature indicated for a few hours.

experiment to be spoiled. *E.g.*—One night after watching from 8 p.m. until 1 a.m. I turned away for a few minutes to get a cup of coffee. When I had finished I found the thermometer marked 113° F. ; half an hour afterwards the blood was black and smelling most offensively. It may be observed that when once molecular death has occurred in the blood and tissues, chemical decomposition proceeds with very great rapidity.

The only absolutely safe plan to prevent the temperature rising too high, is to place a very small tube or bottle in contact with the body of a warm-blooded animal. The warm-blooded animal I found most convenient was myself, but on one or two occasions I used a fowl, tying the tube or bottle under its wing when at roost. I also tried a cat, but cats and fowls are both objectionable—the former have claws, and the latter claws and beaks. The objection to the healthy human body is the low temperature ; you can get cell-growth abundantly ; you can get fatty degeneration of muscle, but I have not yet succeeded in getting pus, except at a temperature over 100° F. (38 Cent.) Having only produced pus in the chambers of the eye, I have not yet been able to do so except at a higher temperature than the healthy human body affords. I have tried every tissue of the mammalian body, except bone, repeatedly, but the most striking results were with eyes, and as the globe of the eye roughly removed with muscles attached, contains nearly all kinds of tissue except bone and cartilage, it is very convenient. I will briefly describe the changes that follow immersion for from 4 to 12 hours in defibrinated blood of the temperature 100° to 105° F.

I sent an account of these experiments more than a year ago to Professor Flower, F.R.S., and to Mr. R. Brudenell Carter, with specimens put up in carbolized glycerine, of portions of the retinæ and conjunctivæ, and I think other structures of the eye. Since that time I have several times repeated the experiments with the same results. I am now about to try what changing the blood frequently, so as to give fresh supplies of oxygen, will do.

It may be well to mention that the immersion of an eye in defibrinated blood at a temperature of 50° to 60° F., will in about half a hour restore the transparency to the cornea, making it quite bright like the living eye, so as to make out all the structures with an ophthalmoscope.*

Within a period varying from one to two hours, according to the temperature, a fresh mammalian eye will undergo the following changes when immersed in defibrinated blood of a temperature of 100° to 105°. First, the dull opalescent tint of the cornea will disappear and it will become bright and transparent. Then it loses this brightness again, and becomes of a

* This might be utilized for the purpose of taking photographs after death.

dull milky tinge; not the appearance presented after death, but more opaque. It is difficult to describe the difference, but it will be immediately appreciated when seen. Second, after two hours, or thereabouts, some one point near the centre of the cornea becomes obviously whiter and more opaque than the remainder, and looks rougher and more granular; in fact, looks like a recent ulcer in the first stage. Third, during the course of six or eight hours the cornea becomes quite opaque, so that no portion of the pupil or iris can be seen; the epithetial layer peels off in large pieces with great ease; the whole globe becomes flaccid; the sclerotic much softened; the crystalline is slightly less transparent in sheeps' and pigs' eyes, but small eyes may be semi-opaque; the aqueous humour is turbid; the vitreous reddened but transparent; the retina, except round the optic nerve, converted into dirty-looking pus, mixed with the *débris* of the pigment layer of the choroid. The recti and other muscles are pale; the cut extremity of the optic is reddened. When portions of the epithetial layer of the cornea are detached, they appear the colour of whitey-brown paper when wetted, but are more opaque. Under the microscope, to quote from the notes, "The shreds of fibrinous exudation in the anterior chamber are composed of granular masses faintly marked out into cell-like portions. The epithetial layer of the cornea is a mass of proliferating cells, the nuclei of the flat epithetial being much enlarged and quite round; immense numbers of cells, four or five times the size of a human red corpuscle, and exactly resembling these enlarged nuclei, were floating about in the immediate neighbourhood of these shreds of epithetium. The columnar and spherical cells were all enlarged, and in many the nucleus was showing a tendency to divide." The deeper layers of the cornea are full of young cells, and the normal structure is often quite obstructed by their number. In addition to the shreds of fibrinous exudation in the aqueous, "it contains numbers of detached leucocytes."

The crystalline shows, without any staining or preparation, its fibrous structure; the nuclei of the fibres are much enlarged and very distinct. When the crystalline is detached from the eye and immersed directly in blood it assumes a sort of opalescent tint.

The smaller vessels of the choroid have disappeared, the pigment cells are almost all broken up, and in the most advanced stages nothing but pigment granules can be seen.

The retina, except just round the optic, is, as has been said, dissolved into pus and *débris;* all traces of rods, cones, and nerve cells, have disappeared. The portion adherent to the optic is of a dirty drab colour, and loaded with leucocytes.

In the vitreous itself, numerous leucocytes appear to exist, but I am not sure that they are formed in the substance of the vitreous, as they may be merely adherent to the portions examined. In the centre of the vitreous a vein may be observed by the naked eye, "it is gorged with red corpuscles, but there were no leucocytes within it, nor surrounding it in greater numbers than were to be found elsewhere."

The muscles show commencing fatty degeneration of the fibres.

This is a very brief account of some of the changes that occur. Briefly the whole globe may be said to be in the first stage of acute inflammation.

Portions of lung, treated in the same way, show swelling of the pleura; the air cells gorged with leucocytes, and the lung no longer crepitant.

If in any parts of the body subject to this process there are veins filled with blood, and visible to the naked eye, the corpuscles within them become shrunken, and much smaller. All the red corpuscles in the capillaries and smaller vessels disappear. My opinion, derived from hundreds of observations, is that they dissolve when in vessels which contain only one or two rows, furnishing the material for the formation and growth of leucocytes.*

The following experiment was a little variation from the plan usually adopted:—

November 5th, 1880.—A kitten was killed by wringing its neck; its abdomen was opened, and about half an ounce of blood from another kitten, not defibrinated, placed in the cavity of the peritonœum, together with two eyes, a portion of liver, and a portion of lung from the other kitten. The animal was then wrapped in a warm cloth, placed in a Norwegian refrigerator previously heated, together with a bottle of hot water. It was then kept in a warm room for twenty-eight hours, the bottle being refilled with hot water three times.

November 6th, evening.—It was evident from the smell that decomposition had commenced. The kitten was therefore taken out and exposed during a cold night.

November 7th, morning.—The abdomen was opened. It was first noticed that every particle of the blood put in had disappeared from the peritonœum. The bowels near that part which had been opened were rough and of a bright red colour; particles of what appeared like lymph were attached to the peritonœum in flakes; they were of a drab colour, and under the microscope were seen to consist of minute granular particles, bacteria and fatty matter; not a trace of red or white corpuscles.

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* This is not the place for the indication of this opinion, but I have numerous notes of microscopical examinations, which may at some future time be published in support of the view here maintained.

The piece of liver was soft, of a pale fawn colour. It was not examined microscopically.

The eyes were in the condition described above.

The pericardium was distended with serum, tinged bright red with blood; the wall of the left ventricle contained a black clot.

In a similar experiment performed with puppies, I find it noted that "striped muscular tissue shows nuclei very distinctly; no blood corpuscles amongst the muscular fibres; blood in capillaries has all disappeared." This is invariably the case. [See note ante.]

In one puppy, when a portion of pericardium had been removed immediately after cessation of respiration, during a condition of entire unconsciousness, but the heart having beat a few times, I find it noted "the chest and membranes wounded appear inflamed; pericardium found clouded with leucocytes." In this case the puppy was poisoned with hydrocyanic acid.

To conclude. The experiments, of which I have given a very brief account, and which have been carried on with intervals for several years, extend to hundreds of observations. They show that in parts of the body separated from the trunk after somatic death, the phenomena of inflammation as far as the production of pus may be produced by immersion for some hours in defibrinated blood, at a temperature of 100° to 105° F., or in albuminous fluids of the same temperature capable of supplying them for a short time with nourishment. It will be observed that true nutrition does not occur; there is no evidence that the structures grow; they do not assimilate to themselves the elements necessary for their growth or reproduction; they degenerate; they take on a lower form of life, but still it is life after a kind. The highest forms of tissue, like muscular fibre, simply undergo fatty degeneration; cell structures take on a lower form of cell structure without differentiation.

I have given an epitome of some of the observations made without attempting to theorize on them. Should this paper receive any attention, I may pursue the subject, but in this remote corner of the world, without access to libraries, without personal communication with men engaged in similar pursuits, and with most imperfect apparatus, there is not much encouragement to persevere.

Art. XIII.—*On a Source of Water Supply for Invercargill.*

By John R. Cuthbertson.

[*Read before the Southland Institute, 4th May,* 1881.]

[abstract.]

It seems certain that the whole of the country between Invercargill and the Hokonuis consists of a comparatively level deposit of silts and clays, resting on a bed of sandstone sloping gently to the south. This deposit of gravel, etc., lying on the impervious subjacent rock, has been proved by actual experiment to be absolutely saturated with water; and that, as soon as we pass the first bed of clay, at a very considerable pressure indeed. Here then is what we want; an inexhaustible supply of well-filtered water, close at hand. Why go thirty miles for what can be had within less than thirty yards? Supposing for a moment that artesian springs will never be discovered strong enough to reach the surface, and that even the supply from a series of tube wells might not prove sufficient, why not sink an ordinary shaft, protected by suitable casing (say a bridge cylinder), as far as such a shaft could be sunk, and kept dry with a good pump and a ten horse-power engine? When the engine can no longer keep down the water, then you have got all you want, namely, a water supply which will suffice for many a year to come, and that at a very moderate cost. From what I have seen I should be much surprised if such a shaft ever reached the depth of 100 feet, the quantity of water is so great. Then as to the permanence of the supply. There seems no reason to suppose that the vast subterranean stream which it is proposed to tap should be less permanent than any river flowing on the surface. Of the existence of this immense supply of water, all who witnessed the progress of the borings are firmly convinced; and it seems reasonable that others should accept their testimony. The water was in fact the one difficulty, and an ever-present difficulty, in the way of the boring. A recent bore put down at Clinton to a depth of 102 feet, presented precisely the same features, so far as the constant inrush of water was concerned. There is really no question as to the quantity. Then as to quality: the water from all the lower levels tasted perfectly pure and free from any mineral solution. As to its freedom from organic matter, twenty miles of natural gravel filter, from the base of the Hokonuis to Invercargill, is a sufficient guarantee for that. This is an advantage which no water collected from surface gathering-grounds can possibly possess; for where the water, or any considerable portion of it, passes over ground covered with herbage and the droppings of animals, organic matter in various stages of decomposition is always present; and where that is found, living

organic forms, chiefly of a low type of animal life, are found also. The most careful artificial filtering fails to free the water entirely from these organisms, some of which are now regarded as the probable source of many diseases. Filtering certainly fails to eliminate the germs; that is to say, such artificial filtering as is possible on a large scale, such as that of a water supply. But what art cannot do, nature does with unerring certainty, for microscopic examination shows that the water from deep strata is perfectly free from every form of organic life. It must be remembered also that the vast natural filter-beds which lie between Invercargill and the Hokonuis do their work without trouble or interference, and while perfect in their action, are not a source of expense. I therefore claim for the subterranean supply the double advantage of abundant quantity and perfect purity.

The quantity and purity being taken for granted, it has still been objected to this proposal that the expense of pumping, and the difficulty of obtaining a sufficient pressure for extinguishing fires, render it inferior to a gravitation scheme. Without now going into details, I may remark that the question of expense is one which can easily be settled by calculation; and I fearlessly assert that the expense of pumping will be but a mere fraction of the interest on cost and the maintenance of thirty miles of iron mains.

It should be noticed that the pumping scheme has the advantage of being capable of expansion, at no great expense, exactly as the wants of the town increase. When one shaft is no longer sufficient, another at a small distance can be added, and the supply doubled, and so on as required. Or should it ultimately be decided to adopt a gravitation scheme, this would not stand in the way; for, with the single exception of the pumping machinery and shaft, everything else in the town service is exactly the same as that required for the gravitation scheme, and could be utilized without the slightest loss or additional expense.

On all these grounds it appears that the subterranean sources of supply are worthy not only of more attention than has hitherto been bestowed upon them, but of a serious practical trial. The expense of a trial-shaft would not exceed £200, including hire of engine and pumps. The question of quantity would then be for ever settled.

ART XIV.—*On the Conversion and Civilization of the Maoris in the South of New Zealand.* By the Rev. J. F. H. WOHLERS, Ruapuke, Southland.

[*Read before the Southland Institute, 20th September,* 1881.]

FOVEAUX STRAITS, between Stewart Island and the south coast of the South Island, was but imperfectly known in civilized parts when I arrived here in May, 1844. Going to an unknown region, it was thought not advisable to be encumbered with much luggage: so I landed on the island of Ruapuke with a carpet-bag and a pair of blankets. I was now alone among the Maoris, and had a good opportunity of learning their language and their ways of thinking. There were then about two hundred living on the island, and about four hundred more were living in small villages on the coasts and islands in the straits. The island of Ruapuke, where the principal chiefs resided, was the centreing place for all, and was frequently visited by the dispersed population in the straits; it was, therefore, a suitable place for commencing mission work.

Some years before my arrival the straits had been frequented by whaling and sealing vessels, and some forty of the sailors had remained here among the Maoris. This was of importance, for through them a little trade was coming up: and they could make boats, which were of far more use to the Maoris than their former canoes. But a movement of greater importance had now come from the north.

To understand this movement, we must first look into the then condition of the Maoris. Through the increasing importance laid on the *tapu*, during several generations, they had lost their hold on the poetical and sublime ideas of their ancient religion. Their ancient gods had now merely historical significance, and these were known only by a very few wise old men. Their poetical ideas had no longer any influence on the minds of the Maoris. They had sunk deeper and deeper in savage barbarism and cannibalism. This is unnatural to the idea of humanity, and must lead to destruction of the race. So their bodily constitution lost its vitality. If any one became sick, he had no hope of recovery. The *tapu*—sacred to ghosts and favourable to the higher classes living—had grown to a fearful extent. Anything *tapu* dared not be touched or even approached by people of the lower classes. Offenders were generally killed for such sacrilege; and, even if they were not detected, the ghosts always killed them through inward fear. The higher classes had the power to lay the *tapu* on any thing, by solemnly naming it with deceased members of the chiefs' families. Though they were not affected by all *tapus*, yet all, high and low, had to dread them. Especially dreaded were old forsaken houses, old fences, or anything which had once been occupied by families of the higher chiefs now dead.

In former times, while they lived and moved in the feelings of their ancient religion; while the poetical ideas of their gods occupied their minds, and they felt themselves above grovelling animalism: they could be healthy, live and thrive as other heathens do, though their morals and civilization do not come up by far to that of the Christians. But when those higher ideas did no longer occupy their mind, when they were in constant dread of offending against the *tapu*, when their physical constitutions were no longer healthy, when they saw but few children were born and many of the young people died: then they lost heart, and felt themselves sinking.

Yet there is something in the human mind, also in the mind of the miserable savage, which, through all the dulness, inward and outward, longs for something higher, for something heavenly, divine. When, therefore, the Maoris in the north of New Zealand at last comprehended the teaching of the missionaries, when the spirit of Christianity was brought near their heart, then they felt that that was the very thing which gave them relief in their inward groaning. Some were converted; others followed. They were sincere. They became cleanly, enlightened, good, and loving. Others saw it,—it infected them. Then Christianity spread from place to place—a most powerful spiritual movement vibrated through the race.

With Christianity the missionaries in the north had also introduced the arts of reading and writing. This was a marvel to the Maoris, who, by nature, are endowed with a fair intellect. That the new things, called books, could talk to them; yea, that they could put their talk on paper and send it to distant friends, there to be understood: that was to them a miracle, which confirmed their faith in Christianity. They felt at once their minds lifted high above the old dulness, and that explains the great spiritual movement which vibrated through the whole race. Yet it was not the mechanical art of reading and writing which changed their minds from wolves to lambs, but the spiritual ideas in Christianity. Murder, cannibalism, and other sins, as far as they had light and understanding, were at once abolished. Also wars ceased, so long as the spirit of gentleness and forbearance of Christianity dwelt in their simple minds. That there should come some reactions, that the inherited wildness in a generation grown up since then should have broken out here and there, was no more than might be expected.

Now, that great spiritual movement from the north had already reached this far south, chiefly through native agencies, when I arrived here. It was, therefore, quite safe for me to live among the Maoris. The New

Testament had been translated into Maori, and some copies had found their way hither. Some of the young people were learning to read and to write; yet none were so far as to understand the meaning. It was as much as they could do, like children just learning to read, to spell out the words. It will be seen, therefore, that I found a "field here white for the harvest."

When landing at Ruapuke I was taken to the house of the principal chief, named Tuhawaiki, commonly called Bloody Jack. The chief himself was absent northward—I had met him at Banks Peninsula—but the house was full of his relatives. A sort of bedstead was provided for me to sleep on, but several persons slept on the floor close by. This did well enough for a few days, but it could not go on so for long, or I should lose my civilization. I wanted a house for myself alone, and the Maoris were kind enough to put up one for me. It was fourteen feet by nine. The walls were four feet high. The whole structure, walls and roof, was thatched with grass and looked like a heap of hay. Herein, then, I lived like a hermit; but I had always visitors from morning till evening. By and by I found that I could not keep up cleanliness in the house as it was. First I had to make a chimney to let the smoke out. I cut a hole through the roof, put up a frame of wood and sticks and plastered that over with prepared clay. When that was done I made a fire and went out to see, and lo! the smoke curled up out of my chimney as in a civilized place. Then, little by little, I took away grass from the walls, put more wood and sticks in and made clay walls. I also plastered over the insides of the roof. My visitors all the time looked and wondered, none offered to help. I had brought with me a small parcel of very small panes of window glass, not much larger than cardpaper, for convenient carrying. Now I made a window frame with my pocket knife, and so got a window. In order to keep the house free from fleas, which my visitors brought me in great abundance, I procured some planks and made a floor. I also partitioned off a sleeping place, to keep the visitors with their fleas away from my bed. The house being now a little refined, visitors were no longer allowed to go to sleep in it, nor to stay over long. When a set of them left I took the broom and swept the fleas out after them.

I must needs speak a little of myself, because I am so mixed up with the recent history of these southern Maoris, and my actions, trifling as they may seem, were not without influence. By the time the spring season came round I had fenced in a potatoe garden, and in it, just before my window, I planted a flower garden. My visitors always liked to look through the glass of my window, and by and by when the flowers were in bloom it raised their admiration.

These flowers were sermons. Among a people sunken so low in the scale of humanity, all such little improvements help to lift up their minds a little higher. Among other faculties of their minds, the Maoris here had lost altogether the sense of the beautiful. Some of the very old Maoris were much tattooed, and there was art in the designs. I do not mean to say that it improved the beauty of their faces, far from it, but art and beauty was in the design. The same can be said of some pieces of clothing, which sadly distort the beautiful human form in highly refined society—there is art in it. Only the old Maoris carried out the art of beauty in their tattoo; in that of the younger there was none. The young women had not the least taste for beauty, only by instinct they painted, or rather besmeared, their faces with the red juice of a wild berry.

They were altogether a dejected people. I found, as I kept a register of births and deaths on the island, that, year by year, for every child born, from three to four persons died. No wonder that they had lost heart and felt as if there were no spirit of life left in them. Now, when Christianity was brought near their hearts, they began to feel as if some help were coming. I cannot yet say it gave them hope, for they had not even a word for that in their language. They liked to read in the New Testament, as they began to understand the meaning, that Jesus was so good and helped poor suffering people without asking if they were good. But then they would learn to love Jesus and that would make them good. It went to their hearts that Jesus had died for the badness of mankind. There is an affinity between it and a deep yearning in the human heart, and when they come near each other then there is a contact, and happiness is the result. Theological arguments, and dogmatical statements, are too poor to explain it. There was a belief in the old Maori religion, that the goddess of death was dwelling in the world of night (their Hades), and drawing her children (she having before been the original mother of mankind) down to her. That gave them no comfort. But it comforted them to learn that Jesus died upon the cross, that he rose again and went to his Father in heaven—and that he will draw all men unto him.

By the foregoing I have simply indicated the way the Maoris have been converted, and science need not ignore that.

By and by some earnest simple souls wished to be baptized. These were instructed more fully, and then solemnly baptized before the whole community. They felt that they were taking upon themselves a great responsibility, that all the others would watch them to detect flaws in their lives. This made them careful to be good and to walk circumspectly. Then others followed, who were likewise instructed and baptized. Soon the news of this spread over all the straits, and boats after boats, with anxious inquirers, came to Ruapuke to see the new things and to ask for baptism. They had to stay here for a week or longer to be instructed and to see if they were sincere, and were then baptized. After that they sailed back to their homes, to be there a light among their neighbours. So it came to pass that in a short time there were earnest Christians in all the villages of the district.

It was natural that, by and by, I should feel constrained to go and visit my spiritual children. I made, therefore, frequent voyages with Maoris in their boats. When I came to a village I stayed there for about a week to strengthen the faithful, to help up again the fallen, and to instruct fresh candidates for baptism. Then, when all was done, I went to another place to perform similar works. I mention this and the following to show the state of the Maoris at that time, both mental and bodily.

The Maoris in most of the dispersed villages were very poor; their houses were not good. They were improvident with their food. It would happen during bad weather, when the sea was too rough to go out fishing, that for a whole week we had nothing to eat but potatoes, and nothing to drink but cold water. Add to this, that the hovels were overcrowded, for where I went others went. We had to sleep rather close on the hard clay floor. The smell of such sleeping company was not pleasant.

A man in the strength of his life, and whose mind is in his work, can bear such hardship. Yet I was always glad when, after a poor Maori hospitality, I came to a place where Europeans lived, namely, some of the before-mentioned former whalers and sealers, who had remained here and taken Maori wives. In their houses I found a clean seat, not perhaps on a chair—chairs and tables were rare articles at that time in this part of the world—but on a seaman's chest, drawn for me to the fire. Here also I was treated to pork and damper (unleavened bread baked in hot ashes).

Cleanliness and better living were not the only pleasures I found in the houses of the Pakeha Maori families. (I prefer to use the term *Pakeha*, for that includes Americans, and these might object to being termed Europeans.) The Maoris had few children, and these had a dirty and dull look about them. On the other hand, in the Pakeha Maori families, I found plenty of clean, lively, and healthy-looking half-caste children. Surely a friend of flowers wandering through a waste country, where only a few stunted plants were growing, and thinking to himself, there might be green leaves and bright flowers here, but there were none, and who then found a rosebush full of buds and roses just opening to the light of the sun, could feel no greater joy than a loving heart must feel at the sight of those lovely children. The houses were clean, and the parents and children were clean. They were all very simply but neatly dressed. May be this was not always so. There may have been washing and cleaning because I was expected. Be that so, it was a step in the right direction. The Maoris had not yet caught the idea that it would be comely to wash and clean themselves for the visit of a stranger whom they respected. The baptized, of course, had to appear a little cleanly, but the mass comprehended that not yet.

Here some one may ask: Why not civilize the Maoris first and afterward christianize them? To that I would reply: That cannot be done. No savage will take to civilized habits before a higher idea is instilled into his mind and is working there. Always washing and combing—too much work. Let now the leaven be mixed with the unsightly lump of flour, and by and by, when it is working, we shall see the uprising of a civilization.

I have said the Maoris had but few children, and these had a dull and unhealthy look about them. What was the cause? Let us look into their family management. Strictly speaking, there were no families—there were parties—large ones and small ones. Most of the food was procured and eaten by each party in common, and as there was no organization for economy, there could be no saving. When after a time of hunger there came a time of plenty, then the craving was so great, that they ate overmuch. At another time they had to starve again. Their eating, clothing, housing, were unwholesome. For a time such a way of living might go on; but in the end, generation after generation, it must weaken their health, at least in these latitudes. Besides the above, it was a settled custom among them, that parents must not correct their children—and there was a reason for it. They did not understand that children were to be made better by correction. If they would beat their children, it would be done in a brutal way, while in a great rage. Then others of the party would get angry and interfere. This would lead to a fight, and perhaps to manslaughter. To avoid such disturbances it had come to be a settled habit, that children must be left to have their own way, and the children knew that they need not obey. If a child objected to be weaned, the mother must go on giving it suck. I have known children four or five years old still sucking. It was a common sight to see a mother coming into the house and sit down, then a big boy, or a big girl, would run up to her and stand bolt upright by her side and suck, like a big calf. No wonder they had but few children, and one can think that children growing up in such a way must make bad parents. They could not always have been so, else they would have died out long before.

On the other hand, Maori women, though grown up in the same way, when joined to a Pakeha husband, had plenty of healthy children. How can we account for that? It was because the families were provided for and ruled over by Christian fathers. I do not say that these fathers were regenerated Christians ; but they were born and had grown up in Christian countries, had got used to civilized habits, and, as sailors, had learned discipline. The mothers in such families, had, therefore, better food, better clothing, better dwellings, than the other women of their race who had Maori husbands. This raised their minds to a higher level of humanity. They got self-respect. This made them willing to fall in with the discipline of their husband. They became healthier and had more children.

Such chaste, soul-ennobling love, as exists in refined Christian societies, was at that time unknown among the Maoris. All marriages were treated as political affairs. The tribal divisions were subdivided again and again, to mere parties. Such parties had many things in common. Now marriages among the young people, if left to themselves, might be to the advantage of one party and the disadvantage of another. There were rights to be considered. Therefore the councils of the parties, in which all free men and women had voices, decided how people should marry. On the same wise were some of the girls given away to become wives of the Pakehas among them—not without a consideration.

The minds of the Pakeha Maori wives were affected by the agitation of the conversion among the Maoris ; the half-caste children were so lovely as "to turn the hearts of the fathers to the children, and the disobedient to the wisdom of the just, to make ready a people prepared for the Lord." When a mother with her children had been baptized, and the blessings of a Christian marriage pronounced over father and mother, then all felt so happy that now they formed a Christian family.

It was a time of revival here then, and as such a happy time, but it was a poor time in temporal affairs. It was as if we had been left and forgotten in this out-of-the-way corner of the world. The whales and the seals had been exterminated, and it did not pay any longer for ships to come this way. Wellington, at Cook Strait, was the nearest civilized settlement, and that was far away. The communication was by Maori boats from place to place along the coast. It took about two years before my clothes and books, which I had left at Nelson, found their way to Ruapuke, and it was a marvel that they arrived at all. Correspondence here was not so easily carried on then as it is now. When I wrote home to Germany, it took two years and a half before I could receive an answer. I lived, when not travelling, like a hermit, cultivated my food and cooked it myself ; did also my washing. When I could get no flour, then cooked peas were a good substitute for bread. I also tried to introduce the cultivation of peas among the Maoris, who needed such nutritious food, but could not succeed ; the time for industry had not yet come.

As the conversions went on, there came gradually a change over the minds of the Maoris. They saw that the low dirty way of life they were leading did not agree with their new Christian feeling. They became desirous for a better way of living and were willing to work for it, for civilization requires a great deal of fresh work. I felt the same for them; but what could I do? Their civilization must commence in the families, as will have been seen in the foregoing, and there I could not help. There was one way of helping—I must get a wife, one that is "cumbered about much serving" the Lord Jesus in "the least of his brethren." Such women there are in civilized Christian communities, but there were none of that sort in this obscure corner of the world. Yet there was a chance.

When I had been five years here, it became necessary for me to go to Wellington and Nelson to make arrangement with some merchant or banker to draw some money from home. In 1849, I set out on that journey. Coming to Otago I found that a few settlers had arrived there; but what is now the city of Dunedin, was then an insignificant place with a few small houses. Five years before I had seen that place when it was an uninhabited wilderness. However, I could find a passage on a schooner direct from here to Wellington.

When I had arranged my money affairs, I looked out for a wife, and in Wellington I found a young lady who had a willing mind to carry civilized habits into the families of the Maoris in the far south. If these statements do not concern science, they concern learning—I mean learning the history of civilizing the Maoris in the south.

The Maoris had already got into the way, of their own accord, of calling themselves my children, old and young; and now, when I came back to them and brought a wife, she was received at once as the head mother of the community; and she had the talent to establish her authority as such, and to be obeyed. She went into the work with her mind in it, and with excellent results. When she went to a place and was observed on the road, then the children shouted, "Mother is coming!" Quickly the women began to sweep and to put things tidy, so as to pass muster at the inspection. Gradually each family was taught to manage its own affairs.

The children could no longer be allowed to have their own perverse ways; but as the parents did not know how to correct them, I had to take the chastisement in hand. If children were under a sentence of whipping, they knew that it would be carried out, and that made them feel unhappy. So a conscience was cultivated in them, for which the heathen Maoris had not even a word in their language. When those children felt the guilty weight getting too heavy on their minds, they came to me of their own accord, and begged to have the whipping over, so that they might feel good again. The chastisement was then performed under loving admonitions, and that made them love me and helped them to be good.

To the civilization of the Maoris also belongs the introduction of the English language. So long as they cannot read the colonial newspapers, they must remain an inferior race in the colony. This cannot be accomplished in one generation—the Maori language being so simple and the English so complicated, especially in spelling and pronouncing—but it can in two or three. I commenced a school for that purpose. Of course the scholars did not learn much English, but they learned some, and that did them good; for when they grew up and became parents, by the time the Government had established English schools among them they were very anxious that their children should attend regularly, while parents who had not been at the former school were not.

The work towards civilization began at Ruapuke, but it spread also to other parts of the Strait. Let us look at their dresses, when, in the time of transition, they came into the church in their Sunday clothes. Some wore native mats, some woollen blankets, though cleanly, in most cases old and much worn. Some few also wore parts of European clothes, but seldom complete. It caused not the least surprise when a man came in dressed in a European man's shirt and a short waistcoat and nothing else. Some years later such an appearance would not have been tolerated by the congregation. In a few years more, as improvement went on, all wore simple and decent European clothes. Though they were much patched, it was neatly done. The head mother of the community had instructed them. It also did not look amiss when the patches were of different colours. I rather liked that under the circumstances.

By this time the Maoris had turned very industrious, their minds having been raised by Christian ideas. They raised now large crops of potatoes for export. At first they had to take them in their boats to Dunedin; but by and by trading schooners came this way who bought the potatoes and sold wearing apparel and other things necessary for housekeeping. Cows were imported, and the girls learned to milk and to make butter. The cultivation of wheat was introduced. We got a cart, ploughs, and hand-mills. I broke in young bullocks for working. However, most of the cultivation was done by spade husbandry, owing partly to the rocky soil of the island, and partly to the men, being proud of their skill in managing boats on a boisterous sea, disliking the working with bullocks. However, large crops of wheat were grown, both for home use and for export. The health of the Maoris improved; the births began to exceed the deaths.

The circumstances of our mission work here in the south were remarkably favourable. First, when I began my work here, the great movement of the conversions in the north had reached this way. Secondly, when civilization began, the Otago settlement commenced, so that our Maoris found a market to sell their produce and to buy things necessary for a civilized life. But no civilization among such low sunken savages could have succeeded if conversion to Christianity had not gone before. The savage heathen is used to filth and vermin and occasional starvation; they do not inconvenience him. If nice things of civilized people come within his reach, and he can get them by begging or stealing, he will take them; but to work constantly, which a civilized life requires, that he cannot and will not. Looking from his standpoint at the toil of civilized men, he must be a fool to undertake these in exchange for his careless ways. But when conversion comes in, and his mind is occupied with Christian, humanizing ideas, then that is all changed. He becomes willing to work out his civilization, his mind is in his work, and the advances he makes please him.

It is a wonderful power that works so mightily in the human mind and changes it for the better. It may be "hid from the wise and prudent and revealed unto babes," figuratively. Missionaries understand that power, for they have it, else they could not and would not undergo such long hardship as to live among savage heathen for the purpose of helping them up, by precept and by example, to a Christian humanity. Savage heathen are not pleasant company; they are rude and offensive; they are full of vermin, they stink. But the wonderful spiritual power within overcomes all that. There was a time, before they became missionaries, when they groaned and travailed, may be in a dry orthodoxy, may be in an honest scepticism, till they listened to the voice of Jesus: "Come unto me all ye that labour and are heavy laden." They came and found rest for their souls. There came into them the mind which was also in Christ Jesus, namely to seek and to save such as are lost, though it may be under hardship and sufferings.

I have stated the above to show the moving power of mission work, because science works to bring to light hidden forces which produce visible effects.

Some people think that no good is done by converting the heathen; but such people do not know the heathen in their places of heathenish living, nor the converted in their civilized homes. The Maoris here in the south had, in their heathen state, such weak constitutions, brought on by their miserable way of living, that anyone who became sick had no hope of recovering—(they had no word for hope in their language). The sick were taken out of the houses to some distance, so that their sickness and dying might not offend the living. A rude shelter was made over the sick person. Sometimes someone might sit with him, but more often he was left quite alone, with some cooked cold potatoes and some cold water within his reach. So he was left to die without comfort, without consolation. Now, since the Maoris have been converted to Christianity, the sick ones are nursed in their houses by their loved ones, they are supplied with bodily comforts and die with Christian consolation.

The wheat culture, which flourished under the excitement of the conversion and the commencement of civilization, did not last many years. This was not due so much to a reaction in industry, as to trade finding its level. The Maoris here could catch and preserve in airtight kelp bags a great quantity of a kind of young fat seabirds, commonly called mutton-birds. They abound in the south, but not further north than Foveaux Straits. All the Maoris are very fond of them, and if our Maoris could have sent the preserved birds to the north, they would have received good value in return. But it was too dangerous to sail with heavily loaded boats. This was changed when settlers came to Otago and Southland, and shipping came with them. Then our Maoris found that if they took their preserved birds to a merchant in their neighbourhood, they could depend upon their being forwarded to a port near which those Maories resided to whom they were addressed. They then received flour and sugar in return. Thus they found that this was an easier way and better to their liking, than to grow the wheat in the field and to grind it in hand-mills.

I have said before, that with civilization, through cleanliness, better food, better clothing and housing, the health of our Maoris improved. This was as if a person in decline is patched up for a while through some change. The inherent sickness of the Maoris, consumption, brought on and intensified by their unhealthy ways of living, could not be entirely cured. When the old Maoris dropped off, they left but few children and young persons behind them, and these had more or less the old disease in them, which some overcame through the new spirit of life and civilization. A small remnant of the Maoris would have been left here, but for the half-caste children, of whom I have spoken before. These grew up and intermarried with the remnant of the real Maoris. Therefore, the present Maori population here, has strong European features, and one sees only a very few real Maoris among them.

The Island of Ruapuke, which, lying between two coasts, was formerly, in the time of Maori dominion, an important centreing-place, is now, since colonial shipping has superseded the canoe and boat voyages, an insignificant spot, with a small population. The Maori young men grown up here, were very fond of the sea. They went away as sailors, then came back, married the girls, and procured for themselves cutters for oystering, fishing, sealing, etc. But there being no good harbour at Ruapuke, they left and settled at Stewart Island. The remnant of the families of the old Maori nobility is still here. They have some sheep on the island, the profit of which gives them a living.

It will have been seen, that the common saying, "When a superior race comes in contact with an inferior one, the latter must die out," does not apply to the dying-out of the Maoris in New Zealand. I have lived thirty-seven years among these Southern Maoris, and am not unmindful of observing the signs of the times around me. I can positively say that the coming of the Europeans has nothing to do with the dying-out of the Maoris. They would have died out, only faster, if none of the stronger race had ever come to New Zealand. They were dying-off very fast when I came among them, thirty-seven years ago, and the few pakehas, who had come only a few years before my arrival, could not have had the slightest influence among them to that effect. On the contrary, by keeping discipline in their families, and inspiring their Maori wives with higher ideas than grovelling animalism, their half-caste children were lively and healthy. The Maoris, as a race, had outlived their time. Still, a remnant will be saved; but it will be melted into the European settlers.

Still I think there is, in a higher sense, a connection between the dying-out Maoris and the coming-in of a superior race to take their place and to make a better use of it. I believe that God takes a great interest in the ways people and races have to work out their destinies under his, mostly unseen, guidance; and that when the Maori race was going to die he caused a race, best fitted for his purpose of mercy, to come and smooth the bed of the dying Maoris with Christian consolation and bodily comfort. "Blessed are the merciful, for they shall obtain mercy."

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## Art. XV.—*Fallacies in the Theory of Circular Motion.*

By T. Wakelin, B.A.

[*Read before the Wellington Philosophical Society, 21st January,* 1882.]

If a body be set in motion in empty space it would move on in a straight line for ever, if not subject to any action outside itself. If the body be deflected out of a straight course some force outside itself must have acted upon it. When a body is deflected from a straight course continuously, so as to move in a circular orbit, of course round a central point, a certain force must have acted on this body. Mr. Todhunter says: (1.) "If a body of mass $m$ describes a circle of radius $r$ with uniform velocity $v$, then whatever be the forces acting on the body their resultant tends to the centre of the circle and is equal to $\frac{m v^2}{r}$. No single fact in the whole range of dynamics is of greater importance than this." It will be advisable to illustrate this measure of circular force by an example. A slinger whirls round a stone in a sling. "The stone pulls at the string one way, the controlling hand at the centre of its circle, the other (2). Were the string too weak it would break, and the stone prematurely released would fly off in a tangential direction. If a mechanist were told the weight of the stone (say a pound), the length of the string (say a yard, including the motion of the hand), and the number of turns made by the stone in a certain time (say sixty in a minute or one in a second), he would be able to tell precisely what ought to be the strength of the string so as just not to break: that is to say, what weight it ought at least to be able to lift without breaking. In the case I have mentioned it ought to be capable of sustaining 3 lbs. 10 oz. 386 grs. If it be weaker it will break. And this is the force or effort which the hand must steadily exert to draw the stone in towards itself, out of the direction in which it would naturally proceed if let go, and to keep it revolving in a circle at that distance." The result of the foregoing example is obtained from the preceding formula in this way. The formula stated that the acceleration, that is the pull on the hand of the slinger, is equal to the mass (one pound) multiplied by the square of the velocity divided by the radius. As the radius was three feet, the circumference of the circle would be equal to 18·8496 feet nearly, and as the mass made one revolution in a second, this is the velocity. The square of this velocity is equal to 355·30742016 feet, and on dividing this by the radius, three feet, the acceleration is found to be equal to 118·43580672 feet. The acceleration of the force of gravity at the surface of the earth is very nearly equal to 32·2 feet, and it is thus seen that the force with which the stone has to be pulled into the hand greatly exceeds the force with which a pound weight is pulled to the earth by gravity. On dividing 118· etc., by 32·2 the answer is 3·6781306, which is the ratio of the greater acceleration to the less—that is, the force said to be pulling the stone (a pound mass) into the hand is 3·67, etc., times the force with which gravity pulls a pound mass towards the earth. Now the force of gravity pulling at the stone gave it a weight equal to one pound, and consequently the central force pulling at the stone would give it a weight of 3·6781306 pounds, meaning that the hand has to bear this weight to keep the stone from breaking away. This reduced is equal to 3 lbs. 10 oz. 371·9142 grains, and more exact figures would have given a closer result.

Reference to the formula will show that the centripetal force varies as the square of the velocity. It will be well to see very clearly what this means. Taking the particular example already given, if the velocity be doubled the acceleration is quadrupled; that is, the acceleration would be 474 feet, nearly. This means that the force necessary to retain the stone in its revolution round the hand, if it constantly acted on a mass in the same way that the force of gravity does, would add to the velocity of the mass moving freely, 474 feet per second, which is nearly fifteen times the effect produced by gravity, and the hand would experience a pull equal to that which it would feel in supporting fifteen pounds weight (nearly). If the velocity had been trebled, the acceleration would be nine times 118 feet, and the weight nine times 3 lbs. 11 oz. (nearly). If the velocity were increased nearly twenty-five times,—that is, if the pound mass made twenty-five revolutions per second (471 feet per second),—the pull exerted by the stone would be equal to the pull which would be exerted by a ton weight suspended from, say, a stout beam. If the pound mass revolved one hundred times per second, it would exert a pull equal to that which would be exerted by a weight of 16 tons. This velocity, 1885 feet per second, is about 300 feet faster than a fast cannon ball, and the weight, 16 tons, is almost sufficient to break, by stretching, ordinary bar iron one inch square. These figures are remarkable, but science teaches remarkable things, and we are not much surprised at them. The principle itself will have to be looked at closely.

Momentum is the measure of force. It is the measure of the force of gravity. The acceleration produced by gravity, namely, 32 feet per second, really means the momentum generated in a mass by gravity. Let us use the word momentum instead of acceleration, meaning, when applied to the effect produeed by the force of gravity, the velocity with which the mass was moving at the end of the time. This can easily be done by taking a one pound mass. If the revolving pound mass have its velocity successively increased by blows, its momentum may be represented by $v$, $av$, $bv$, $cv$, $nv$, and in this case the corresponding accelerations may be represented by $v^1$, $a^2 v^1$, $b^2 v^1$, $c^2 v^1$, $n^2 v^1$ when $v^1$ stands for acceleration, ordinarily represented by $f$, and in the special case of gravity by $g$. Both these sets of measures are *momentum* measures of force. Does it not seem strange, that if the momentum of the revolving pound mass be increased $n$ times, the momentum to be generated by the centripetal force will be increased the *square* of $n$ times. It may be conceived possible to make $n$ indefinitely great, and still it is asserted that the momentum generated by the centripetal force will be as the *square* of $n$. Does not this seem very much like *creating* force out of nothing. It may be urged against this, that a blow is of the nature of an infinite force, while it might be said that the centripetal force is infinitesimal, it being the force of a pressure. In such statements as these, however, the phrase "of the nature of an infinite force," is itself a vague and indefinite expression.

The clearest objection that can be raised against the common measure of centripetal force, is that which can be urged against the assertion that a mass revolving in a circle with uniform velocity, is every instant trying to fly off at a tangent to its orbit. The words "instant" and "tangent" here have their mathematical meanings. If the string holding the revolving mass in its circular orbit is *inextensible* in a mathematical sense, then it is difficult to conceive how the stone can possibly be doing otherwise than trying to go off at a tangent to its orbit. But this will only make it less necessary for the centripetal force to be great in amount, even when the velocity is considerable. If the stone is *every* "*instant*" trying to fly off at a "tangent" in a strictly mathematical sense, then every "instant" the stone is going in a direction at *right-angles to the string;* how then can it possibly exert a pull *along* the string? Of course practically no string is inextensible, but theoretically, the more the string is made inextensible, the less should be the force necessary to retain the stone in its orbit. And yet for all that, *some* force *is* necessary, for how could a stone be deflected from a straight line unless a force acted upon it. Let a ball strike a smooth surface very obliquely, in a direction almost parallel with the surface, and it will be deflected from its straight course; but how small relatively to that of the striking ball would be the force that deflected the ball in the least degree only out of its course. Is not this *effect* similar to the *effect* of a centripetal force? If so, can the force possibly be so great as shown in a previous paragraph it would be if the formula is correct?

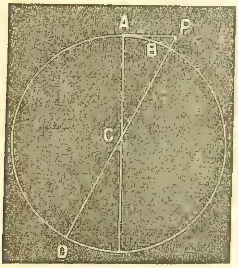
Perhaps the foregoing reasons may be considered a sufficient cause for a reconsideration of the formula giving the measure of centripetal force. Let us examine with great care, and step by step, the process by which this formula has been obtained. A large number of treatises on astronomy and mechanics, including the best and most commonly used, deduce the formula from one of the two following propositions:—

Theorem.—If two straight lines cut one another within a circle, the rectangle contained by the segments of one of them, shall be equal to the rectangle contained by the segments of the other. (*Euclid*, *Third Book*, *Prop.* 35.) The case is taken where the diameter bisects a chord.

Theorem.—If from any point without a circle two straight lines be drawn, one of which cuts the circle, and the other touches it, the rectangle contained by the whole line which cuts the circle and the part of it without the circle, shall be equal to the square on the line which touches it.

(*Euclid, Third Book, Prop.* 36.) The particular case taken is where the point outside the circle is the extremity of the tangent, and a diameter produced to meet the point. Mr. Todhunter deduces the formula apparently from the parallelogram of velocities.

The method of deriving the formula for the measure of centripetal force is very clearly and precisely given by Mr. (I think now Professor) Goodeve in his "Principles of Mechanics." He takes the thirty-sixth Proposition of the Third Book of Euclid, where it is proved that the square of the tangent is equal to the rectangle contained by the diameter produced to meet the tangent and the part produced. Accordingly, in the annexed figure, the square on the line AP will be equal to the rectangle DP, PB. In the




work referred to, the explanation given is nearly as follows:—The rectangle DP, PB is equal to DB, PB together with the square on PB. When the angle is made very small, the square on PB may be neglected, and then the square on the tangent AP is equal to the rectangle DB, BP. Now DB is the diameter of the circle; then $(AP)^2 = 2r \cdot PB$. (1.) In the limit this is mathematically exact. Let the body revolving with uniform motion be supposed passing through the point B by the end of the time *t*. If no force had deflected the body it would have pursued a straight course along the tangent, and would have reached the point P at the end of the time *t*, or to speak more exactly it would very nearly have reached that point, because AP the tangent is greater than AB the arc. When the arc, however, is extremely small, the difference between the arc of the angle and its tangent is inappreciable—in the limit they coincide. The body was deflected from its course the length PB. It is pulled through the distance PB, that is it falls through that distance. From this geometrical construction we can now derive an algebraical equation. The line AP is equal to $tv$, and the distance fallen through, namely PB, is equal to $\frac{1}{2} ft^2$. Here $v$ of course is the velocity of the body, and $f$ stands as usual for the acceleration. The time that would have been taken by the body to move from A to P is, of course, the same that it took to fall from P to B, that is, if the angle represented by the arc, or tangent, be very small. In the figure the angle is very much exaggerated for the sake of clearness, but the arc taken should not be greater than a degree when the error will be very small. Bearing these considerations in mind, we can proceed to evolve from the equation we have obtained the measure of centripetal force. The equation before given may be conveniently put distinctly. Thus:—

$$AP = tv \quad (2)$$
$$PB = \tfrac{1}{2} ft^2 \quad (3)$$

These two equations may be put in the form of a ratio, as follows :—

$$\text{As AP : PB :: } tv : \tfrac{1}{2}ft^2$$

or in a better form:

$$\frac{\text{AP}}{\text{PB}} = \frac{tv}{\frac{1}{2}ft^2} \quad (4)$$

Both sides of this equation are really identical, the capital letters forming one side of the equation being lines, and the small letters forming the other side of the equation being the algebraical,—that is the numerical,—value of those lines. The square of the tangent AP is equal to the square of *tv*. See equation (2). Equation (4) can now be put as follows :—

$$\frac{(\text{AP})^2}{\text{PB}} = \frac{(tv)^2}{\frac{1}{2}ft^2} \quad (5)$$

On referring back to equation (1), it will be seen that $(\text{AP})^2$ is equal to $2r \cdot \text{PB}$. Substituting this value of $(\text{AP})^2$ in equation (5), we have now :

$$\frac{2r \cdot \text{PB}}{\text{PB}} = \frac{t^2v^2}{\frac{1}{2}ft^2} \quad (6)$$

or, as PB cancels out, the simple form will be :

$$2r = \frac{t^2v^2}{\frac{1}{2}ft^2} \quad (7)$$

It will be necessary to pause here. A careful study of these three last equations, namely (5) (6) and (7), shows us that $t^2v^2$ is the *square of the tangent*, and that $\frac{1}{2}ft^2$ is the *distance fallen through*. The last equation then reads thus, if the numerical value of the square of the tangent be divided by the numerical value of the distance fallen through, the quotient will be equal to $2r$. Here $2r$ is, of course, the diameter of the circle. In the last three equations the quantity $t^2$ could have been cancelled out, but, by retaining this quantity, the whole algebraical expression on the right-hand side of the equation can be directly transformed into its geometrical equivalent. The term $\frac{1}{2}ft^2$ is certainly the distance fallen through represented by the line PP, and is it not equally true that *tv* is the length of the tangent represented by the line AP, $t^2v^2$ being the value of the square on the tangent, which is equal to $(\text{AP})^2$. The fraction in the denominator of the fraction on the right-hand side of equation (7) is got rid of, and the equation will then stand thus :

$$r = \frac{t^2v^2}{ft^2} \quad (8)$$

It may be read thus : If the value of the square of the tangent be divided by the value of *twice* the distance fallen through, the quotient will give the value of the radius of the circle. Cancelling out the time equation (8) becomes

$$r = \frac{v^2}{f} \quad (9)$$

and from this equation the formula for the measure of centripetal force is obtained, that is the value of $f$ is found to be as follows :

$$f = \frac{v^2}{r} \quad (10)$$

Equation (7) will be the best to take for a special consideration. The equation is

$$2r = \frac{t^2v^2}{\frac{1}{2}ft^2}$$

This may be read,—The diameter is equal to the square of the tangent divided by the distance fallen through. Let us double the velocity and the body would traverse the tangent AP in half the time, and it would have to fall the distance PB also in half the time. The velocity would be represented by $2v$. The equation would then stand

$$2r = \frac{(2\,v)^2\,(\frac{1}{2}\,t)^2}{\frac{1}{2}f\,(\frac{1}{2}\,t)^2}$$

Here the two numeral factors, 2 and $\frac{1}{2}$, cancel one another, and the tangent is unaltered. It will be seen, also, that to give the same quotient, $2\,r$, $f$ must be increased four-fold; that is, the velocity being doubled, the acceleration had to be increased in the ratio of the square of the velocity. Other cases can be made up in the same way. In all of them the acceleration would have to increase as the square of the velocity.

Mr. Proctor observes, in effect, of the radius vector sweeping over equal areas in equal times, as follows: "Because a line, which is attached to a fixed point at one end and at the other to a body in motion, sweeps over equal areas in equal times, it does not therefore follow that the body is going in any orbit. For if the body moved in a straight line, the line joining the body to the fixed point would still move over equal areas in equal times. Let there be any fixed point A, and another B at some distance from it, and join AB. Let now a body be projected from B along a straight line BZ, at right angles to the line AB. It will move with uniform velocity in this direction, and of course will move over equal distances in equal times. Let it move from from B to C in one second. Mark off on the line AZ a number of spaces CD, DE, EF, etc., each equal to BC. Join AC, AD, AE, AF, etc. The body passes through the points C, D, E, F, etc., in successive seconds. The triangles constructed on these bases, BC, etc., are all equal to one another, because they have equal bases and are between the same parallels. The line joining the fixed point with the body moving in the straight line AZ, will therefore sweep over equal areas in equal times. It is not necessary, therefore, for the body to move in any orbit, because the line joining it to a fixed point passes over equal areas in equal times.

Let a body be held at rest at the point A and let a uniform constant force act in the direction AZ. This line AZ may be conceived as being vertical to the surface of the earth, or any other planet, or the sun. Let the body at the point A be set free to the action of the accelerating force, and let it be drawn, or fall through, the points B, C, D, at the end of the first, second, and third seconds respectively. The formula

$$s = \frac{1}{2}\,ft^2$$

is perfectly general. If the accelerating force be equal to the force of gravity at the surface of the earth, the point B will be 16 feet from A, the point C 64 feet, and the point D 144 feet. Let it now be required to make the body pass through these several points in half the time. What must be the acceleration?

At B, $s = 16 = \frac{1}{2} f \left(\frac{1}{2}\right)^2 = \frac{1}{8} f$ and $f = 128$
" C, $s = 64 = \frac{1}{2} f \, 1^2 = \frac{1}{2} f$ and $f = 128$
" D, $s = 144 = \frac{1}{2} f \left(\frac{3}{2}\right)^2 = \frac{9}{8} f$ and $f = 128$

From this we gather that when the body falls through the same spaces in half the times the acceleration must be four-fold, for 128 is four times 32. Let the body be now drawn by an accelerating force through the points B, C, D, in one third of the times it was drawn through those points in the first case. What must now be the acceleration?

At B, $s = 16 = \frac{1}{2} f \left(\frac{1}{3}\right)^2 = \frac{1}{18} f$ and $f = 288$
" C, $s = 64 = \frac{1}{2} f \left(\frac{2}{3}\right)^2 = \frac{4}{18} f$ and $f = 288$
" D, $s = 144 = \frac{1}{2} f \, 1^2 = \frac{1}{2} f$ and $f = 288$

We see from this that when the body is drawn through the same spaces in one-third the times that the acceleration must be increased ninefold. Reverting now to the geometrical figure already given (see page 138), if the velocity of the revolving body be increased to twice or thrice the velocity it had at first, it will have to be drawn from P to B in half or one-third the time. But if the body had not been revolving at all, but had been at rest at P, the acceleration would have had to be increased fourfold or ninefold. It is not necessary, therefore, for a body to be revolving in any orbit to satisfy the condition, that if it be required to draw the body through the same space in one-half or one-third the time, the acceleration must be increased fourfold or ninefold. That the acceleration should increase directly as the square of the velocity, or *inversely* as the square of the times, it is not necessary, therefore, that the body acted upon by an accelerating force should be moving in any orbit.

Let a circle be drawn, and let a polygon of $n$ sides be inscribed in the circle. Produce each of the sides to a distance equal to itself. This lengthened side is divided equally by the circumference—the side of the polygon is one-half, and the part produced outside the circle is the other half. From the end of the *produced* side draw a line to meet the angular point of the polygon opposite to it. This line will not coincide with the radius—it will not form part of the radius produced through the angular point of the polygon. Let a particle B be moving with any velocity along one of the sides of the polygon, and when it comes to the angular point let it be struck by another particle H *so as* to cause it to move along the next side of the polygon. When the particle B comes to the next angular point of the polygon, let it be struck by another particle (of course equal to H), *so as* to cause it to move along the next side of the polygon. And so on in the same direction along the other sides without loss of motion. Let the length of each side be represented by $b$, and let the length of line passed over by particle H, during the time particle B traverses a side, be represented by $h$. Then $h$ will be the length of the line drawn from the end of a produced side to the angular point opposite. When B has traversed all the sides of the polygon, it has passed over a distance equal to $n \times b$ and the sum of the distances passed over by the other particles (which are the same as H, and have the same velocity) is equal to $n \times h$. The ratio of the distance passed over by the striking or deflecting particles to the distance passed over by the revolving (struck or deflected) particle is constant. Whether the velocity be augmented or diminished the ratio is the same. The force necessary to deflect by successive impulses a particle along the sides of a polygon does not therefore have to vary in strength as the square of the velocity of the deflected particle. It is only reasonable, therefore, to suppose that the force necessary to deflect a particle *so as* to cause it to move in a circle does not vary as the square of the velocity.

# II.—ZOOLOGY.

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## Art. XVI.—*On the New Zealand* Hydrobiinæ.

By Professor F. W. Hutton.

[*Read before the Philosophical Institute of Canterbury, 3rd November,* 1881.]

Plate I.

In the "Smithsonian Miscellaneous Collection," vol. vii., and also in the "American Journal of Conchology," vol. i., 1865, Dr. Stimpson founded a new genus—*Potamopyrgus*—on *Melania corolla* of Gould, from Banks' Peninsula, and in my "Manual of the New Zealand Mollusca," (Wellington, 1880,) I followed Dr. v. Martens in considering this species to be the same as *Melania corolla* (Reeve), and *Paludestrina cumingiana* (Fischer). I also followed Mr. Tenison Woods in putting all our other *Hydrobiinæ* into Moquin-Tandon's genus *Bythinella.* But an examination of these shells during the last year has convinced me that Gould's species is not the same as *Paludestrina cumingiana*, and that all our species belong to the genus *Potamopyrgus.* I have not seen the "Mollusca of the United States Exploring Expedition," but I found my identification on the fact that *P. cumingiana* is not found in Banks' Peninsula, and that its dentition does not correspond with the description given by Dr. Stimpson of the dentition of *P. corolla*, while that description does agree with the dentition of *P. fischeri* (Dunker), which is common in Banks' Peninsula. The dentition of all the species is so much alike that all must be included in one genus, but it is necessary to alter Dr. Stimpson's diagnosis in order to include the slight differences that are found among them.

The absence of books prevents me feeling certain that all the synonyms I have given are correct, and as three out of the four species vary very much, it is possible that other naturalists may consider some of the forms to be distinct which I consider only as varieties.

### Potamopyrgus, Stimpson.

*Shell*, ovato-conic or oval, imperforate; body whorl more than half the length of the shell; aperture ovate, the outer lip acute; peritreme continuous or discontinuous. *Operculum* horny, subspiral, without any internal process. *Animal* with the foot rather short, broadest, and slightly expanded, in front. Tentacles very long, slender, tapering and pointed. Eyes on very prominent tubercles. *Dentition.* Median tooth trapezoidal, the inferior margin more or less trilobate. First lateral broad and excavated in the middle, contracted into a long peduncle, the denticles nearly equal. Second lateral pointed at the inner extremity; the shank broad, and thickened on its outer margin. Third lateral with the inner extremity broad and rounded, constricted at its junction with the very broad shank, which is thickened on its outer margin. Number of transverse rows of teeth, 55 to 69.

Formula of the denticles, $\frac{7 \text{ or } 9}{3 \text{ or } 4 - 3 \text{ or } 4}$; 9 or 11; 20 to 23; 30 to 40.

The formula of the denticles differs widely from that of *Bythinella*, and approaches more nearly those of *Stomatogyrus* and *Amnicola;* but *Potamopyrgus* is readily distinguished from both these genera by the shape of the third lateral tooth.

*P. cumingiana* and *P. antipodum* are both ovo-viviparous, and probably the other species are the same. The species inhabit both fresh and brackish water. They are very variable in form, and the only reliable character is the dentition.

Key to the Species.

Shell with spines, whorls more or less carinated.

Spines long; first lateral tooth with 9 denticles .. .. *P. cumingiana.*

Spines short; first lateral tooth with 11 denticles .. .. *P. corolla.*

Shell without spines, whorls rounded.

Whorls 5 or 6; basal denticles 3-3 .. .. .. .. *P. antipodum.*

Whorls 4; basal denticles 4-4 .. .. .. .. *P. pupoides.*

### P. cumingiana.

Plate I., figs. A and E.

*Paludestrina cumingiana*, Fischer. Jour. de Conch. viii., 1860, p. 208.

*Paludestrina salleana*, Fischer, l.c. 1860, p. 209 (?).

*Melania corolla*, Reeve. Conch. Icon. fig. 366; not of Gould.

Shell ovate, thin, olive-brown; whorls $5\frac{1}{2}$ to $6\frac{1}{2}$, angulated; a row of distant curved spines on the last two or three whorls, 10 to 17 spines on the body whorl.

Formula of denticles, $\frac{9}{3-4}$; 9; 23 to 25; 26 to 30.

Axis, ·2 to ·23 inch; breadth, ·12 to ·1.

*Habitat:* The northern part of the North Island and the valley of the Waikato. I have not seen it from Wellington, nor from any part of the South Island. Fresh-water only.

The shell is very variable in shape, especially in the angle of the whorls, which is sometimes sharp, sometimes rounded, and sometimes absent altogether on the body whorl. The peritreme is usually continuous, but occasionally it is discontinuous in apparently adult shells. The lower side of the median tooth is trilobate, but the middle lobe is not conspicuously developed, and is sometimes slight.

The specimens figured were sent me from Lake Pupake, Auckland, by Mr. T. F. Cheeseman.

P. COROLLA.

Plate I, figs. B and F.

*Melania corolla*, Gould. Pro. Bost. Jour. ii., 1847, p.

*Amnicola badia*, Gould. Pro. Bost. Jour. iii., 1848, p. 75.

*Hydrobia fischeri*, Dunker. Mal. Blatt. viii., 1861, p. 152.

*Hydrobia reevei*, Frauenfeld. Abh. Zool. Bot. Ges. Wien, 1862, p. 1024.

Shell ovato-conic, reddish-brown or brown, rather solid; whorls 5 to 6, angulated; a row of close short spines on the last 2 or 2½ whorls; usually from 26 to 32 spines on the body whorl. Peritreme continuous or discontinuous.

Formula of denticles, $\frac{9}{3 \text{ or } 4 - 3 \text{ or } 4}$; 11; 23; 35 to 40.

Axis, ·15 to ·22 inch; breadth, ·13 to ·08.

*Habitat:* South Island; abundant in fresh water, Wellington.

This is a very variable shell in shape, but the whorls are always angulated. The spines are always short, but very variable in number; sometimes several are united together, and then the number on the body whorl may not be more than 8 or 10; but their compound nature is indicated by their broad flattened base, while in *P. cumingiana* they are always round and long. This form may be *P. salleana*, Fischer. The specimens figured are from the Heathcote River, near Christchurch.

The animal is white, sparingly speckled with black on the foot, body, and tentacles; more thickly speckled on the head and rostrum; a paler transverse band near the end of the rostrum.

The animal does not glide, but moves along by jerks, dragging its shell after.

Dr. Dunker agrees with Dr. v. Martens that his *H. fischeri* is only *P. corolla* with the spines rubbed off, which is no doubt true. *A. badia*, Gould, and *H. reevei*, Frauenfeld, are certainly the same as *H. fischeri*.

P. ANTIPODUM.

Plate I., figs. C and G.

*Amnicola antipodum*, Gray. Dieffenbach's New Zealand, 1843, p. 241.

*Amnicola zealandiæ*, Gray, l.c., p. 241.

*Amnicola egena*, Gould. Pro. Bost. Jour. iii., 1848, p. 75.

*Amnicola gracilis*, Gould. Un. States Ex. Exp., p. 126, fig. 150.

*Hydrobia spelæa*, Frauenfeld. Abh. Zool. Bot. Ges. Wien, 1862, p. 1022.

Shell ovate, blackish-brown to olive-green, rather solid; whorls 5 to 6½, rounded, smooth; aperture ovate, peritreme continuous or discontinuous.

Formula of the denticles, $\frac{7 \text{ or } 9}{3-3}$; 9; 23; 35 to 40.

Axis, ·24 to ·16; breadth, ·12 to ·09.

*Habitat:* Throughout the whole of New Zealand; abundant in fresh water, extending into brackish water.

A very variable shell, but easily recognized by its smooth rounded whorls. The aperture varies from nearly a half to a third of the length of the shell. The narrow, turreted, form is *P. zealandiæ*, but I do not think it is distinct, as there are many intermediate varieties.

The animal is in all respects like *P. corolla*. The central lobe of the median tooth is considerably produced.

Our species appears to be quite distinct from the Tasmanian *Paludina nigra* (Q & G), the whorls in that shell, judging from the figure, being much more oblique, and the aperture nearly parallel to the axis. *Hydrobia spelæa* is, I think, only a small form of *P. antipodum*. It was found, along with *H. reevei*, with moa bones in the Collingwood caves near Nelson.

P. PUPOIDES.

Plate I., figs. D and H.

Shell minute, oval, olive-green, or brownish; whorls 4, smooth, rounded; aperture ovate, two-fifths the length of the shell, peritreme continuous.

Formula of the denticles, $\frac{9}{4-4}$; 9; 20; 30 to 35.

Axis, ·06 to ·07; breadth, ·035.

*Habitat:* Estuary of the Avon and Heathcote rivers, in brackish water. Not found in fresh water.

This shell is very constant in its form, and very unlike the other species of the genus, but the animal and dentition at once indicate its relationship. No doubt it will be found in many other localities. The central lobe of the median tooth is considerably produced; the central denticle of the first lateral is rather larger than the others. The inner surface of the operculum has some small granules at its anterior end; these are not calcareous.

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EXPLANATION OF PLATE I., FIGS. A TO H.

A 1. *Potamopyrgus cumingiana*, × 5 times.
2. „ „ embryonic shells × 25 times.

B 1. *Potamopyrgus corolla*, × 5 times.
2. „ „ animal × 5 times.

C 1. *Potamopyrgus antipodum*, three varieties × 5 times.
2. „ „ operculum × 8 times.

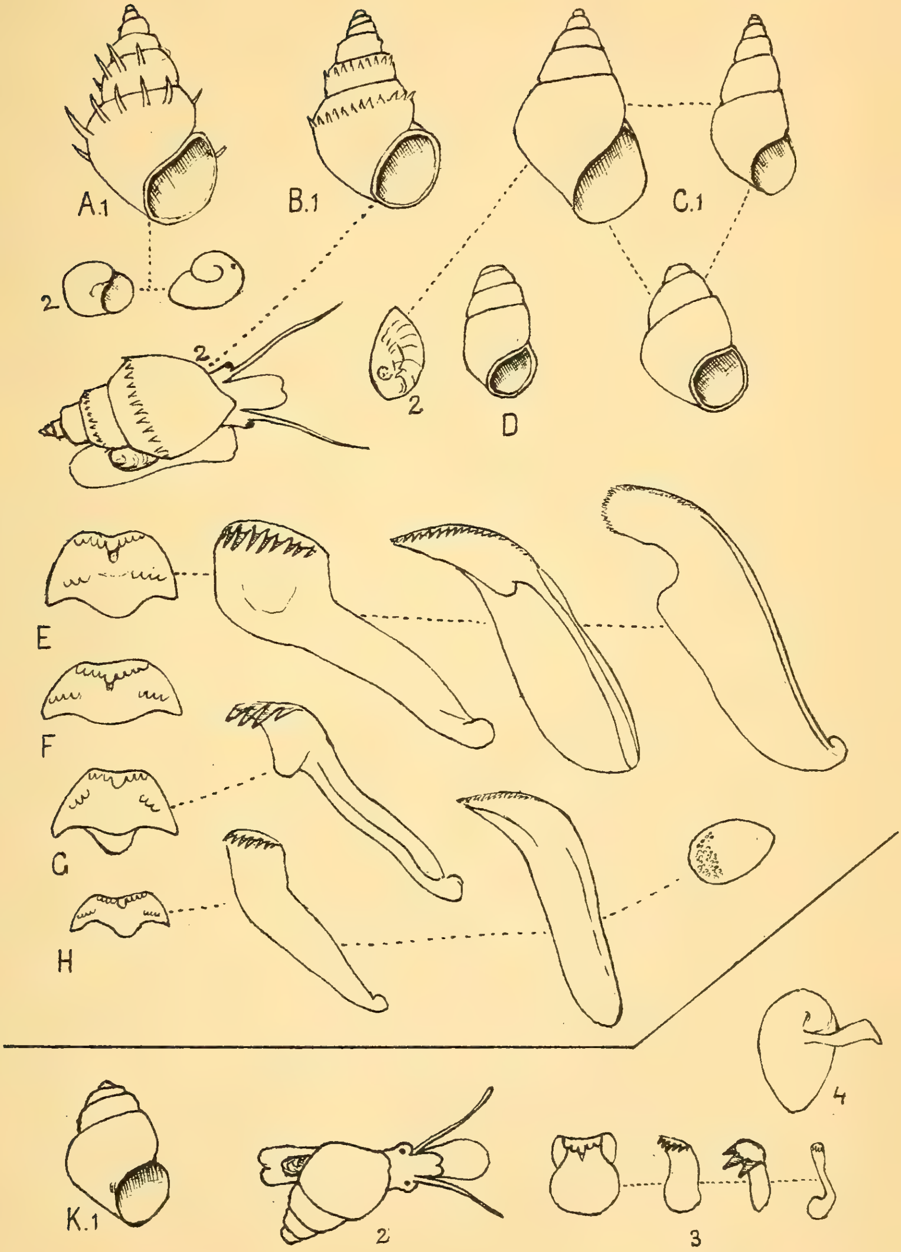
D *Potamopyrgus pupoides*, × 10 times.

E *Potamopyrgus cumingiana*, teeth × 470 times.

F *Potamopyrgus corolla*, median tooth × 470 times.

G *Potamopyrgus antipodum*, median and first lateral teeth × 470 times.

H *Potamopyrgus pupoides*, median, first and second lateral teeth × 470, and operculum from the inside × 20 times.




*New Zealand HYDROBIINÆ, and a New Genus of RISSOINÆ.*

F. W. H. del.

ART. XVII.—*On a new Genus of* Rissoinæ. By Professor F. W. HUTTON.

[*Read before the Philosophical Institute of Canterbury, 3rd November*, 1881.]

Plate I.

THERE is a small mollusc, common in the rock pools in Lyttelton Harbour, that I cannot bring into any genus in Adams' "Genera of Recent Mollusca." The shell is like that of *Barleeia*, but the operculum is sub-spiral, like that of *Rissoina*, but without the marginal ridge. The animal differs from *Rissoina* in having the opercular lobe simple, and the foot emarginate behind, as in *Barleeia*, but from this genus it differs in having the tentacles long and setaceous, and the rostrum emarginate. From all other genera it is distinguished by the process on the operculum.

DARDANIA. Gen. nov.

*Animal.* Foot large, rounded in front, and emarginate behind; opercular lobe small, simple. Rostrum emarginate at the extremity; tentacles long, and setaceous; eyes large, on swellings at the outer bases of the tentacles. *Operculum* ovate, sub-spiral, with a long shelly process from below the nucleus. *Shell* ovate, sub-conical; whorls smooth; aperture oval, entire, rounded in front, peritreme not continuous, outer lip thin; axis imperforate.

D. OLIVACEA. Sp. nov.

Plate I., fig. K.

*Shell* small, ovate, olive brown when alive, purplish black when dry; whorls four, convex, smooth, with fine lines of growth. Length ·08: breadth ·06.

*Animal* light brown, foot and tentacles white. The sole of the foot has a median longitudinal groove, and the tentacles are smooth. The central tooth is as broad as long, and with two denticles on each side of the median denticle. The first lateral tooth has five denticles, the middle one larger than the others. The second lateral has three denticles, the inner one the smallest. The third lateral is narrow, abruptly bent and expanded near the base, it has three minute denticles.

*Habitat:* On seaweed in rock pools; Lyttelton Harbour.

It is probable that some of the New Zealand species described as *Rissoina*, or *Barleeia*, may belong to this genus, as in none of them is the animal or the operculum known.

EXPLANATION OF PLATE I., FIG. K.

K *Dardania olivacea*, × 10 times.
2. ,, ,, animal × 10 times.
3. ,, ,, teeth × 470 times.
4. ,, ,, operculum, inside, × 30 times.

## Art. XVIII.—*On the Fresh-water* Lamellibranchs *of New Zealand.*

By Professor F. W. Hutton.

[*Read before the Philosophical Institute of Canterbury*, 13*th October*, 1881.]

Plate II.

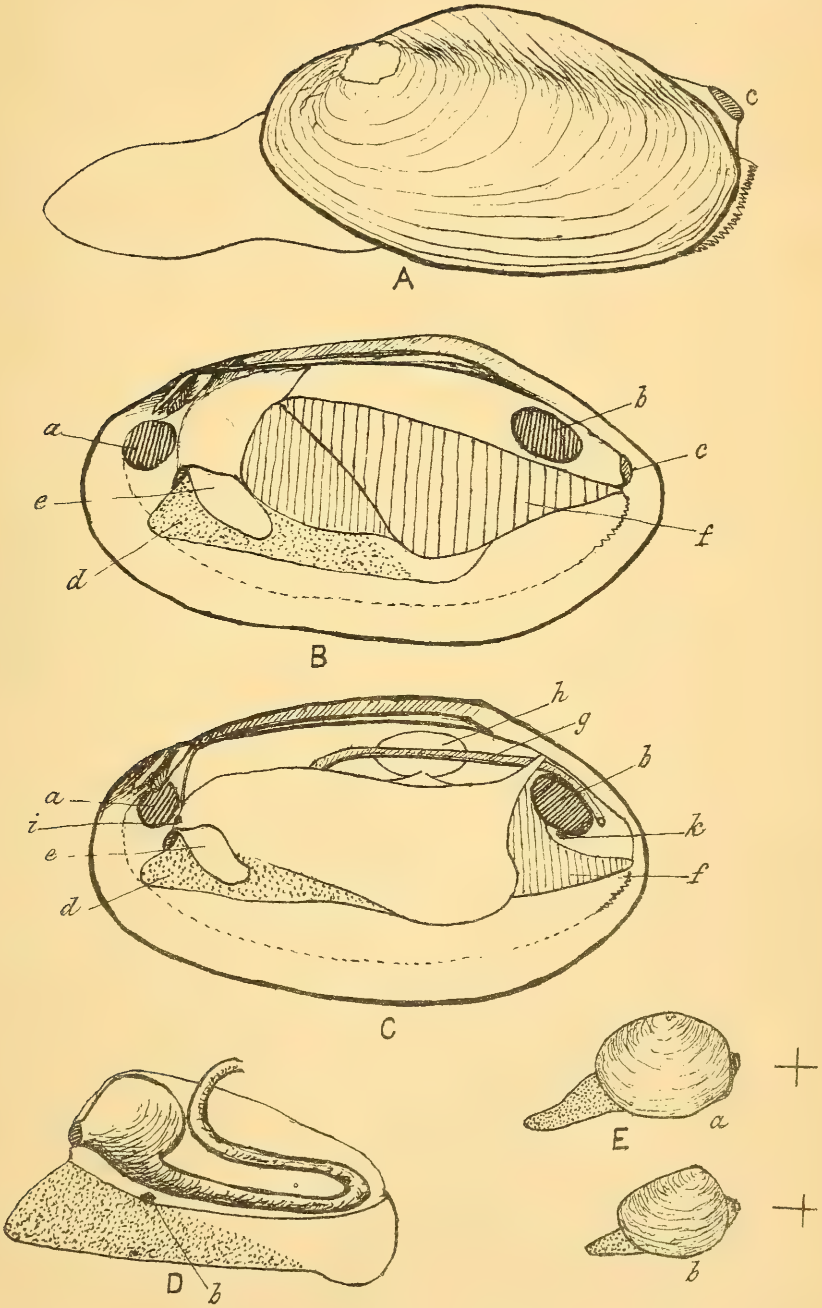
### Unionidæ.

In the second volume of Dr. Dieffenbach's "Travels in New Zealand" (London, 1843) Dr. Gray described two species of *Unio*, brought to England by Dr. Dieffenbach and Dr. Sinclair. These he called *U. menziesii* and *U. aucklandica*. They are distinguished by the first being high and compressed, the posterior lateral teeth crowded, the inner anterior tooth of the right valve large, thick, ovate, rugose, and the other teeth small and compressed. He also distinguished a variety which was more elongated, and rounder behind, and the posterior lateral teeth not so elevated. The second species is thick, the cardinal teeth low, blunt, oblique, and the posterior lateral teeth laminar, and far off. These species were afterwards figured by Reeve in his Conchologia Iconica.

In 1850 Mr. A. Gould published in the "Proceedings of the Boston Society of Natural History" a description of another species from Auckland, under the name of *U. lutulentus*, and this was afterwards figured in the "Mollusca of the United States Exploring Expedition," and also by Reeve. I have not seen Gould's description or his figure, but, according to Reeve, the shell is rudely longitudinally plicated.

In the "Malakozoologische Blätter" for 1861 Dr. Dunker described a *U. hochstetteri*, brought to Germany by Dr. v. Hochstetter from the River Waikato and Lake Taupo, distinguished by being "very indistinctly subverrucose in the middle. This also is figured by Reeve, and shows a shell very much truncated behind, the length being only 1·4 times the height.

In the "Mollusca of the Voyage of the Novara" Dr. Dunker also described and figured a *U. zelebori*. This is rather an elongated shell, the length being twice the height, and with the cardinal teeth compressed, acute, and crenated. Having examined a large number of specimens from various parts of New Zealand I have come to the conclusion that neither the shape of the shell nor the form of the teeth can be depended upon for specific characters, indeed hardly two individuals can be found alike; and from the River Avon, at Christchurch, I have obtained many individuals, living together, which combine in various ways the characters of *menziesii*, *aucklandica*, and *zelebori*, and the animal in all is alike. *U. lutulentus* is, I




*New Zealand freshwater* LAMELLIBRANCHS.

F.W.H. del.

think, distinct, although some specimens are difficult to distinguish from *U. menziesii.* I have not examined the animal. *U. hochstetteri* I have never seen.

*Notes on the animal of U. menziesii.*—Pl. II., figs. A, B, C, and D. The anal siphon is dark purple outside and yellow inside; the orifice is simple. The region of the branchial siphon has numerous cirri, some of which are dark purple, others yellow; inside the shell the margin of the mantle is speckled with yellow pigment spots. The branchiæ are yellow-brown in colour, the outer darker than the inner one. They are attached at their posterior extremities to the mantle below the anal siphon, but are free from this point to the posterior adductor. The outer branchia is attached to the mantle throughout its whole length, and is obliquely truncated anteriorly; the inner branchia is not united to the foot. The foot is large, and its anterior and lower portions, which are not covered by the branchiæ, are slate grey in colour. The labial palpi are white, speckled with yellow, their length is about twice their breadth, and for about half their length the two on each side are united posteriorly. All the nervous ganglia are white, but show nothing remarkable in shape or position. The heart makes fifteen beats a minute. The alimentary canal is remarkably simple; from the capacious stomach it runs along the lower side of the body cavity to the end, and then turns abruptly upward and forward to the stomach, from whence it ascends to the heart. A crystal-style is sometimes present. The animal is diœcious. I have found both spermatozoa and ova in the month of June.

### Cyrenidæ.

In the Catalogue of the "Conchifera in the British Museum," and in the "Proceedings of the Zoological Society of London" for 1854, M. Deshayes has described a *Sphærium novæ-zealandiæ*, which has been also figured by Reeve. It is a small species of a bluish-grey colour "abundantly irregularly transversely banded;" and is said to come from New Zealand and Australia. I have never seen a shell answering to this description, and the New Zealand *habitat* may perhaps be erroneous.

In the "Malakozoologische Blätter" for 1861, Dr. Dunker described a *Sphærium lenticula* from specimens brought to Europe by Dr. v. Hochstetter from Lakes Rotoiti and Taupo. This little shell (pl. II., fig. E) is common throughout New Zealand; but it is a *Pisidium*, and not a *Sphærium.* Usually it is nearly equilateral (fig. E.*a.*), but occasionally very inequilateral (E.*b.*). The two forms are, however, only varieties of one species, as intermediate varieties completely connecting them are found in the same locality. At least both forms and intermediate varieties live together near Christchurch. The longer side of the shell is anterior. The siphons are very short, and completely united, the margin is simple. The foot is long and colourless. The animal is very active and moves about by means of its foot, much in the manner of a Gastropod. It lives not only in mud, but also on aquatic plants.

*Pisidium novæ-zealandiæ* was described by Prime in the "Proceedings of the Zoological Society of London" for 1862, and afterwards in the "Annals of the Lyceum of Natural History of New York" for 1867 with a wood-cut. This may be the same as the variety *b* of *Pisidium lenticula*, as the description agrees very well; but if so the figure, judging from a tracing I had made for me, cannot be very correct, for that represents a nearly equilateral shell with a prominent umbo. The specimens described by Mr. Prime are said to have been brought from New Zealand by Mr. Cuming, so there may be a mistake in the *habitat*, as I believe Mr. Cuming never visited New Zealand.

EXPLANATION OF PLATE II.

A. *Unio menziesii*, with the foot expanded. *c* anal siphon.

B. *Unio menziesii*, left valve and mantle removed. *a* Anterior adductor muscle; *b* posterior adductor; *c* anal siphon; *d* foot; *e* labial palp; *f* branchiæ.

C. *Unio menziesii*, left side of mantle and branchiæ removed, and the pericardium laid open. *a* Anterior adductor; *b* posterior adductor; *d* foot; *e* labial palp; *f* right branchia; *g* rectum; *h* heart; *i* cerebral ganglion; *k* parieto-splanchnic ganglia.

D. *Unio menziesii*, body cavity laid open, showing the mouth, stomach and intestine; *l* pedal ganglia.

E. *Pisidium lenticula*. *a* Type form; *b* variety.

## Art. XIX.—*Notes on some* Pulmonate Mollusca.

By Professor F. W. Hutton.

[*Read before the Philosophical Institute of Canterbury, 2nd June*, 1881.]

Plates III. and IV.

Patula coma, *Gray*. The jaw is slightly arcuate, with the ends attenuated; it is marked with distant striæ which converge slightly towards the upper margin. (Plate III., fig. L.)

The radula is ·01 inch in breadth. Teeth 13–1–13, of which 6 may be called laterals. The central tooth is tricuspid, the side cusps short and rounded and without cutting points, the median cusp long and narrow with a small cutting point at the extremity; the base of attachment is broad and rectangular, and extends beyond the cutting point of the median cusp. The lateral teeth are similar to the central, but the base of attachment is oblique. The seventh tooth has the cusps nearly equal, and the inner side cusp as well as the median has a cutting point. No. 6 is intermediate between No. 7 and the laterals. Towards the margin the cusps get smaller and the cutting points larger, but the outer side cusp never has a cutting point. (Pl. III. fig. A.) The teeth are arranged in nearly straight transverse rows. (Pl. IV., fig. G.) The specimen from which the drawings are taken came from Dunedin, but I have found the same species at Queenstown. There are 5–5½ whorls, and the ribs are less than ·01 inch apart; the aperture is oblique.

PATULA HYPOPOLIA, *Pfeiffer*. The jaw is arcuate, not attenuated at the ends, which are rounded; it is transversely finely striated. It resembles the jaw of *P. igniflua*, (Pl. III., fig. M.)

The radula is ·02 inch in breadth, with about 133 transverse rows of teeth; the rows are nearly straight. (Pl. IV., fig. H.) The teeth are 26–1–26, of which 10 or 11 may be called laterals. The central tooth has a prominent median cusp, with two minute side cusps: the base of attachment is longer than broad, enlarging posteriorly, and extending far beyond the median cutting point. The laterals are bicuspid with a cutting point on each, the inner being the larger. No. 12 is also bicuspid, but the reflected portion and the cutting points are very oblique. Towards the margin the cutting points increase to four. (Pl. III., fig. B.)

This specimen is also from Dunedin, where the species is not uncommon. Some specimens are entirely "horny-cinereous," as in the typical *P. hypopolia*, but some are slightly spotted, and others strongly spotted and marked with rufous, thus passing into *P. iota*. Both forms are sub-carinated. The peculiarity of the jaw in this species and in *P. igniflua*, is no doubt sufficient to remove them from *Patula*; but in the absence of full information I make no attempt to place them properly.

PATULA IGNIFLUA, *Reeve*. The jaw is arcuate, with rounded ends, with distant transverse striæ. It is membranaceous, soft, and pale horn-coloured. There is no median projection. (Pl. III., fig. M.) The striations of the jaw appear to arise from folds in the membrane; it gives the appearance of the jaw being made up of many pieces slightly imbricated, but I could not satisfy myself that they were really distinct.

The radula is ·03 inch in breadth, with about 70 nearly straight transverse rows of teeth. (Pl. IV., fig. I.) The teeth are 37–1–37, with 11 laterals on each side. The central tooth has a single cusp, surmounted by a cutting point; the base of attachment projects beyond the cutting point. The laterals are bicuspid, but without a cutting point on the outer cusp. The inner marginals are also bicuspid, but the cutting point is longer. The outer marginals have the reflected part and the base of attachment much reduced, but the cutting points are very long and sharp. (Pl. III., fig. C.)

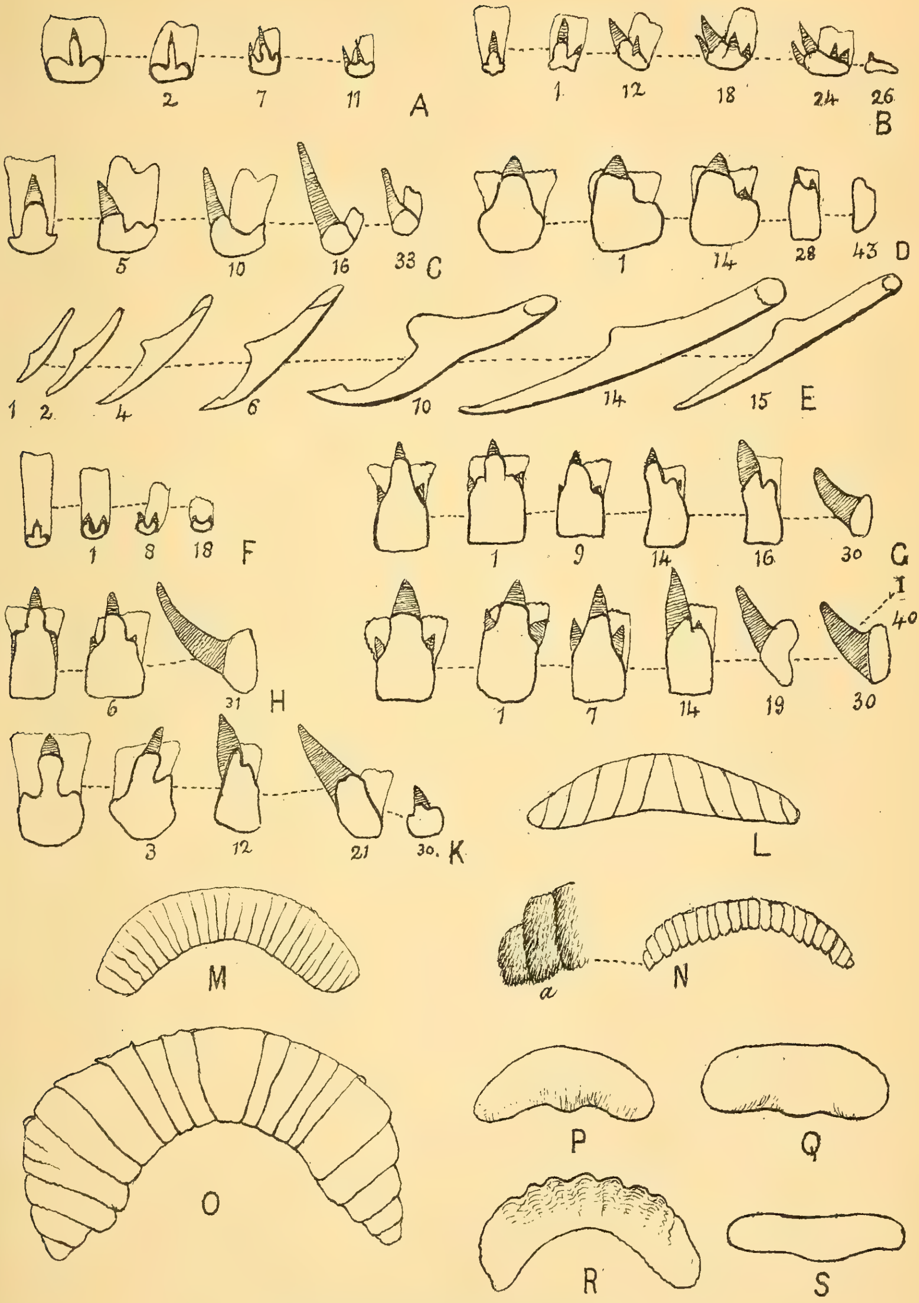
This fine species is not uncommon near Dunedin. It nearly always has obscure spiral grooves. In colour it is either horn-coloured, or irregularly marked, or flammulated with red. There is a variety with membraneous, deciduous ribs, which I suppose may be the *P. portia* of Gray. The dentition of both is the same, and the membraneous ribs are easily removed. If I am right in identifying this ribbed variety with *P. portia*, then Dr. Gray's name will stand for both. There is a mucous gland at the posterior end of the foot.

Placostylus bovinus, *Bruguière.* Jaw arcuate, attenuated at the ends; membranaceous, soft, transversely striated by infoldings of the membrane, giving the jaw the appearance of being composed of many pieces. (Pl. III., fig. o.)

Radula ·17 inch in breadth, and length about two and a-half times as much, with about 140 transverse rows of teeth. These rows are nearly straight, forming a very obtuse angle salient posteriorly. (Pl. IV., fig. k.) Teeth 55–1–55, of which 28 are laterals. The central tooth has a single cusp with rounded shoulders at its base; the cutting point is short and broad; the base of attachment broadens posteriorly and does not extend as far as the apex of the cutting point; the lateral teeth are bicuspid, with the outer cusp small; there is no cutting point on the interior cusp near the central tooth, but at about the twelfth row a small cutting point appears; this gets larger to No. 20, then smaller again, disappearing in the marginals altogether. At about the fortieth row the central cutting point disappears also. (Pl. III., fig. d.)

The specimen from which the drawings were taken was given me by Professor T. Jeffery Parker, and had originally come from the north part of the Auckland district. Although there is considerable difference in the published descriptions of *P. bovinus* and *P. novoseelandicus*, I think that they are the same species, as nearly every specimen that I have examined combines characters of both. Usually they have the general form and colour described as characteristic of *P. novoseelandicus*, together with the seven whorls and the cherry-red mouth of *P. bovinus*. Although the shell has seven whorls, the animal has only three and a-half whorls.

Daudebardia novoseelandica, *Pfeiffer.* (?) The animal has no locomotive disc, but a specimen long preserved in spirit showed a central longitudinal groove on the foot. There is no jaw. Teeth 15–0–15. There are about 35 transverse rows of teeth, which form an obtuse angle of about 100°, salient posteriorly. (Pl. IV., fig. m.) The breadth of the radula is ·16 inch, and its length about three times as much. Teeth aculeate, with a central process of attachment. The apices of the teeth belonging to the




PULMONATE MOLLUSCA.

F.W.H. del.

five inner and two outer rows are simple, but those of the sixth to thirteenth rows are barbed, looking like the fluke of an anchor seen in profile. (Pl. III., fig. E.)

The specimen from which the figures were taken was collected by Mr. T. Kirk, at Waiuku, in the Lower Waikato district. The animal was without its shell, but from the mark on the body it was easy to see that the shell was pauci-spiral, and on the hinder part of the body. As *Daudebardia novoseelandica* came originally from the Waikato, I presume that this is the same species; but while the shape of the shell is that of *Daudebardia*, the teeth appear to belong to *Testacella*.

PARYPHANTA BUSBYI. There is no jaw. The radula is about an inch in length, and ·4 inch in breadth at the anterior end, tapering to a point posteriorly, with about 104 transverse rows of teeth, the rows forming an obtuse angle of about 130°, salient posteriorly (Pl. IV., fig. L). The teeth are 50–0–50. They are all aculeate, and similar, with simple bevelled tips (Pl. IV., fig. A). The first five laterals are small. From the sixth they gradually increase in length to about the thirty-fifth, and then get smaller.

This description is taken from a specimen, very well preserved in spirit, kindly given me by Mr. T. F. Cheeseman. The whole of the animal, including the sole of the foot, is dark blue-black. The upper surface is covered with rather large, flat, granulations. The foot is narrowed in front and behind, the margin produced, and waved. I could see no sign of a caudal gland.

It is evident that this genus should be placed in *Vitrininæ*, near *Daudebardia*.

HELIX FATUA, *Pfeiffer*. The jaw is arcuate, slightly attenuated at the ends, composed of about twenty imbricating plates; its outer surface is rough, with horny hair-like papillæ, which form a fringe round the lower margin. (Pl. III., fig. N.)

The radula is ·007 inch in breadth. The transverse rows of teeth form an obtuse angle of about 200°, salient posteriorly. (Pl. IV., fig. N.) The teeth are 20–1–20. In all the reflexed part is very small. The central tooth has a single cusp, bearing a cutting point, with square projecting shoulders at its base; the base of attachment is rectangular, three times as long as broad, and two-thirds of its length projecting beyond the cutting point of the reflexed portion. All the lateral and marginal teeth are bicuspid, the cusps being equal, and each bearing a cutting point. The cusps gradually diminish in size outward until they can hardly be recognized in the outer marginals. The base of attachment of the inner teeth is rectangular, but becomes oblique in the outer laterals, and then gradually rectangular in the marginals; its length gradually decreases from the central row outward.

The specimen figured came from Dunedin. It resembled the description and size of *H. fatua*, except that it was slightly spotted with rufous. It differed from *H. zealandiæ*, in being only sub-carinated. Its remarkable dentition and jaw of course take it out of *Helix*. Probably it must be formed into a new genus, but I have not the necessary books for determining this point.

Limax agrestis, *Linnæus*. I have no doubt now that my *L. molestus* is this species. The differences that I pointed out were the non-obliquity of the keel, which Mr. Binney says is quite inconstant, and the different shape of the ovo-testis. In this latter point I had not compared our slugs with European examples, but trusted to Mr. Newton's figure in the Quar. Jour. Micros. Science, N.S., vol. 8, p. 26; as, however, I find that the teeth are quite identical, I drop my name. The radula has 93 transverse rows of teeth, each row having 42–1–42. On Pl. III., fig. h., I give figures of a central, lateral, and marginal tooth, from one of my type specimens from Dunedin. The jaw is figured at fig. p.

Milax antipodum, *Pfeiffer*. Jaw very slightly arcuate, with a slight median projection. (Pl. III., fig. q.)

Radula ·06 inch in diameter, and about two and two-third times as long, with about 92 transverse rows of teeth, which are slightly curved, the convexity being posterior. (Pl. IV., fig. s.) Teeth 40–1–40, of which 16 are laterals. The central tooth has a single cusp, the shoulders of which slope gradually into the base, and each carries a small cutting point. In the laterals the shoulders are more strongly marked, but the inner one gradually dies away and its cutting point gets very minute, until on the 13th or 14th tooth it cannot be seen, and the outer one is very small. In the 15th and 16th teeth the median cutting point rapidly increases, and approaches in size the aculeate marginal teeth. (Pl. III., fig. g.)

The specimen figured came from Dunedin, but I have also found it in the bush at Governor's Bay, Banks Peninsula.

Milax emarginatus, *Hutton*. The jaw is narrow, nearly straight, with a slight median projection. (Pl. III., fig. s.)

The radula is ·07 inch in diameter, with about 90 transverse rows of teeth, which are slightly curved, the convexity being posterior. Teeth 46–1–46, of which about 16 are laterals. These teeth differ from those of *M. antipodum* in having the cutting points much larger; the shoulders in No. 1 lateral are much more sloping, and the shape of the reflexed part of No. 14 is quite different. (Pl. III., fig. i.) I have figured the teeth of a small specimen from Dunedin.

Arion fuscus, *Muller*. My *A. incommodus* is, I think, identical with this species, of which I had seen no description until this year. I have only seen it from Dunedin. The ribbed jaw is figured in Pl. III., fig. r. The teeth are 34–1–34, of which about 12 are laterals, and there are about 111 transverse rows. I have figured, from a Dunedin specimen, some of the teeth on Pl. III., fig. K.

ONCHIDELLA PATELLOIDES. No jaw. Radula is ·17 inch in length, and ·1 inch in breadth at the posterior end, tapering to a point anteriorly. There are 84 transverse rows of teeth, which form an obtuse angle of about 125°, salient anteriorly. (Pl. IV., fig. R.) Teeth 130–1–130. The central tooth is tricuspid, the median cusp with a short pointed cutting point; the side cusps with broad incurved cutting points. The laterals pass gradually into the marginals; they all have a single cusp bearing a blunt cutting point. From the anterior end a curved process of the base projects forward; this is short in the rows near the centre, and gets longer toward the margin. (Pl. IV., fig. B.)

BULIMUS GIBBOSA, *Gould (Physa)*? These specimens were given me by Mr. J. D. Enys, and came from the Broken River. The spire is very short, the whorls are rounded, without any trace of keel; the columella plait obsolete. The shells are olive green in colour, L ·3; B ·17. The apex in all is eroded, but the whorls are apparently four. I am doubtful whether this is Gould's *gibbosa*, but it may remain under this name for the present, until the species are better known.

*Animal.* The edge of the mantle is simple, and not reflexed over the shell. Tentacles long and filiform, with a rounded lobe at their outer bases. Eyes sessile at the inner bases of the tentacles. Foot short and rounded behind, truncated and not expanded in front. Rostrum bilobed. Pl. IV., fig. V.) The animal is yellow-brown, minutely speckled with greenish brown. It walks by jerks. The eggs are in transparent capsules attached to stones, etc., usually three or four together, arranged in a single layer.

*Dentition.* The upper jaw is simple, arcuate, and attenuated suddenly at each end; it is transversely striated. The lower jaw is membraneous, soft, and yielding. (Pl. IV., fig. T.) The radula is ·07 in length, and ·03 in breadth; it is parallel-sided and rounded at the anterior extremity. There are 126 transverse rows of teeth, curved slightly forwards. (Pl. IV., fig. Q.) The teeth are 27–1–27. The central tooth has its base longer than broad, and with parallel sides; the reflected portion has a single cusp, which bears two small cutting points, variable in shape and size. There are about ten laterals on each side; they have a single cusp, which bears a tridentate cutting point. In the marginals the cutting point has numerous denticulations, and the reflexed portion gets longer. (Pl. IV., fig. c.)

The simple mantle margin, not reflected over the shell, and the sinistral twisting of the shell itself, would place this species in *Bulimus*; but the shell is not elongated, the aperture is not narrow, and the foot is not dilated anteriorly. Perhaps this and the next species should form a distinct genus; certainly they do not belong to *Physa*. I would propose that Adams' subgenus *Ameria* be retained for them.

Bulimus variabilis, *Gray (Physa)*. Animal and radula like *B. gibbosa*, but with only 112 transverse rows of teeth. Teeth 18–1–18, of which seven or eight are laterals. Generally the teeth are similar to those of *B. gibbosa*, but the base of the central tooth is as broad as long at its posterior margin, and the reflected portion is simply convex anteriorly; the teeth are larger and coarser, and the outer marginals are not so long. (Pl. IV., fig. d.)

This description is taken from the common species found in the neighbourhood of Christchurch. It is very variable in shape, the whorls being either rounded or slightly flattened behind; the body whorl usually bears indications of a keel, formed by a single row of fine short hairs, but sometimes this is absent. The spire is more produced than in *B. gibbosa*, and the whorls are not so much flattened behind as in *P. mœsta*. Whorls 4; columella plait distinct.

Probably the other species of *Physa* described from New Zealand will all be found to belong to the same genus.

Latia neritoides. I have to thank Mr. T. F. Cheeseman for numerous specimens, preserved in spirit, collected by him in Lake Pupuke, near Auckland. I have never seen the genus in the South Island.

*Animal.* The eyes are at the outer bases of the tentacles, which, in spirit specimens, are short, incurved, and transversely ringed. (Pl. IV., fig. u.)

*Dentition.* There is no jaw. The radula is ·08 inch in length, and ·04 inch in breadth, the sides nearly parallel. There are 30 transverse rows of teeth, which form an angle of about 115°, salient anteriorly. (Pl. IV., fig. p.) The teeth are 27–1–27. The central tooth is small, the reflected portion half the length of the base, and bicuspid, but apparently without any cutting points. The laterals are all nearly alike, and increase in size outwards to about the sixteenth, and then diminish. The base is constricted in the middle, and the outer side has two teeth near the posterior end. The reflected part is oblique to the base, single cusped, with a rounded cutting point. (Pl. IV. fig. e.)

The position of the eyes, outside the tentacles, would appear to take *Latia* out of the *Limnæidæ*, and the absence of a jaw, as well as the arrangement of teeth on the radula, are other characters by which it is distinguished. It may form the family *Latiidæ*.

Amphibola avellana. In a paper on the anatomy of this species, in the "Ann. Nat. Hist." for 1879, I briefly described the dentition, but the description is not sufficiently accurate, and I have inadvertently stated that


PULMONATE MOLLUSCA.

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the teeth point forward. There is no jaw. The radula has 44 transverse rows of teeth, which form an angle of about 105°, salient anteriorly. Pl. IV., fig. O.) The teeth are 29–1–29. The central tooth has five or six denticles on each side of the median cusp, and on the right side the margin is finely but variably denticulated; the median cusp bears a single blunt cutting point. On each side there is a single lateral tooth, which, however, is often divided into two; it is very variable in shape, but more or less quadrate, with a variously denticulated cutting point. Outside this the teeth are all aculeate, and increase in length toward the margin. (Pl. IV., fig. F.)

In the paper already mentioned, I stated that I had failed to discover how the oviduct was connected with the albumen gland, but on the 5th September, 1879, I found a specimen in which the oviduct was distended with ova, and which showed clearly that my supposed accessory gland is the commencement of the oviduct. The sketch on Pl. IV., fig. W, is from this specimen.

LYMNÆA STAGNALIS. This species has been introduced intentionally into the river Avon at Christchurch, and is now abundant below the Acclimatization Gardens.

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## EXPLANATION OF PLATE III.

NOTE.—The numbers under the teeth give the longitudinal row of that tooth from the centre. Teeth belonging to the central row have no number.

A. *Patula coma*. Teeth × 480.
B. *Patula hypopolia*. Teeth × 480.
C. *Patula igniflua*. Teeth × 480.
D. *Placostylus bovinus*. Teeth × 150.
E. *Daudebardia novoseelandica*. Teeth × 80.
F. *Helix fatua*. Teeth × 480.
G. *Milax antipodum*. Teeth × 280.
H. *Limax agrestis*. Teeth × 280.
I. *Milax emarginatus*. Teeth × 280.
K. *Arion fuscus*. Teeth × 480.
L. *Patula coma*. Jaw × 80.
M. *Patula igniflua*. Jaw × 40.
N. *Helix fatua*. Jaw × 80; *a* end of jaw further enlarged.
O. *Placostylus bovinus*. Jaw × 15.
P. *Limax agrestis*. Jaw × 15.
Q. *Milax antipodum*. Jaw × 15.
R. *Arion fuscus*. Jaw × 35.
S. *Milax emarginatus*. Jaw × 15.

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## EXPLANATION OF PLATE IV.

A. *Paryphanta busbyi.* Teeth—*a* ordinary view; *b* from above; *c* side view × 80.

B. *Onchidella patelloides.* Teeth—*a* central tooth; *b* lateral tooth; *c* marginal tooth; *d* side view of marginal tooth × 480.

C. *Bulimus gibbosa.* Teeth × 480.

D. *Bulimus variabilis.* Teeth × 480.

E. *Latia neritoides.* Teeth × 280; *a* base from behind.

F. *Amphibola avellana.* Teeth × 280; *a* central: *b* first lateral; *c* and *d* marginals.

G. *Patula coma.* Portion of radula × 30.

H. *Patula hypopolia.* Portion of radula × 30.

I. *Patula igniflua.* Portion of radula × 30.

K. *Placostylus bovinus.* Radula × 2.

L. *Paryphanta busbyi.* Radula, natural size.

M. *Daudebardia novoseelandica.* Radula, natural size.

N. *Helix fatua.* Portion of radula × 70.

O. *Amphibola avellana.* Radula × 15.

P. *Latia neritoides.* Radula × 15.

Q. *Bulimus gibbosa.* Radula × 15.

R. *Onchidella patelloides.* Radula × 6.

S. *Milax antipodum.* Radula × 6.

T. *Bulimus gibbosa.* Jaw × 30.

U. *Latia neritoides.* Head of animal. (Spirit specimen.)

V. *Bulimus gibbosa.* Animal—*a* from above; *b* from below.

W. *Amphibola avellana.* Reproductive organs—*a* hermaphrodite duct; *b* albumen gland; *c* oviduct; *d* vas deferens.

Note.—The dotted lines on the radulas show the direction of the transverse rows of teeth.

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## Art. XX.—*Notes on the Anatomy of the Bitentaculate Slugs of New Zealand.* By Professor F. W. Hutton, of Canterbury College.

[*Read before the Philosophical Institute of Canterbury*, 3rd March, 1881.]

Plate V.

In the "Transactions of the New Zealand Institute," vol. xi., p. 332, I described a new genus of bitentaculate slugs under the name of *Konophora.* This year, through the kindness of Professor Parker, I have been enabled to examine another specimen, and find that after having been in spirit for some time a lateral groove appears dividing the body from the foot, as in *Janella*, and that the anatomy is so like that of *J. bitentaculata* that a new genus seems hardly necessary for its reception. I therefore propose to regard *Konophora marmorea* as a species of *Janella*, distinguished from the other two species by not tapering rapidly to the tail, by its conical eye-peduncles, and by the form of the central row of teeth, as described further on.

The only specimen of *J. papillata* that I have had for dissection was in such a bad state of preservation that I was unable to make out the details of the alimentary and reproductive systems, but I saw enough to convince me that they are constructed essentially on the same plan as those organs in the other two species; in fact I think that it may be only a variety of *J. bitentaculata*. I propose, therefore, to give a general account of the anatomy of the genus, and also to point out the differences between *J. bitentaculata* and *J. marmorea*. I have to thank R. W. Fereday, Esq., for living specimens of *J. bitentaculata* which he found on flax (*Phormium*) at Fendal Town, near Christchurch.

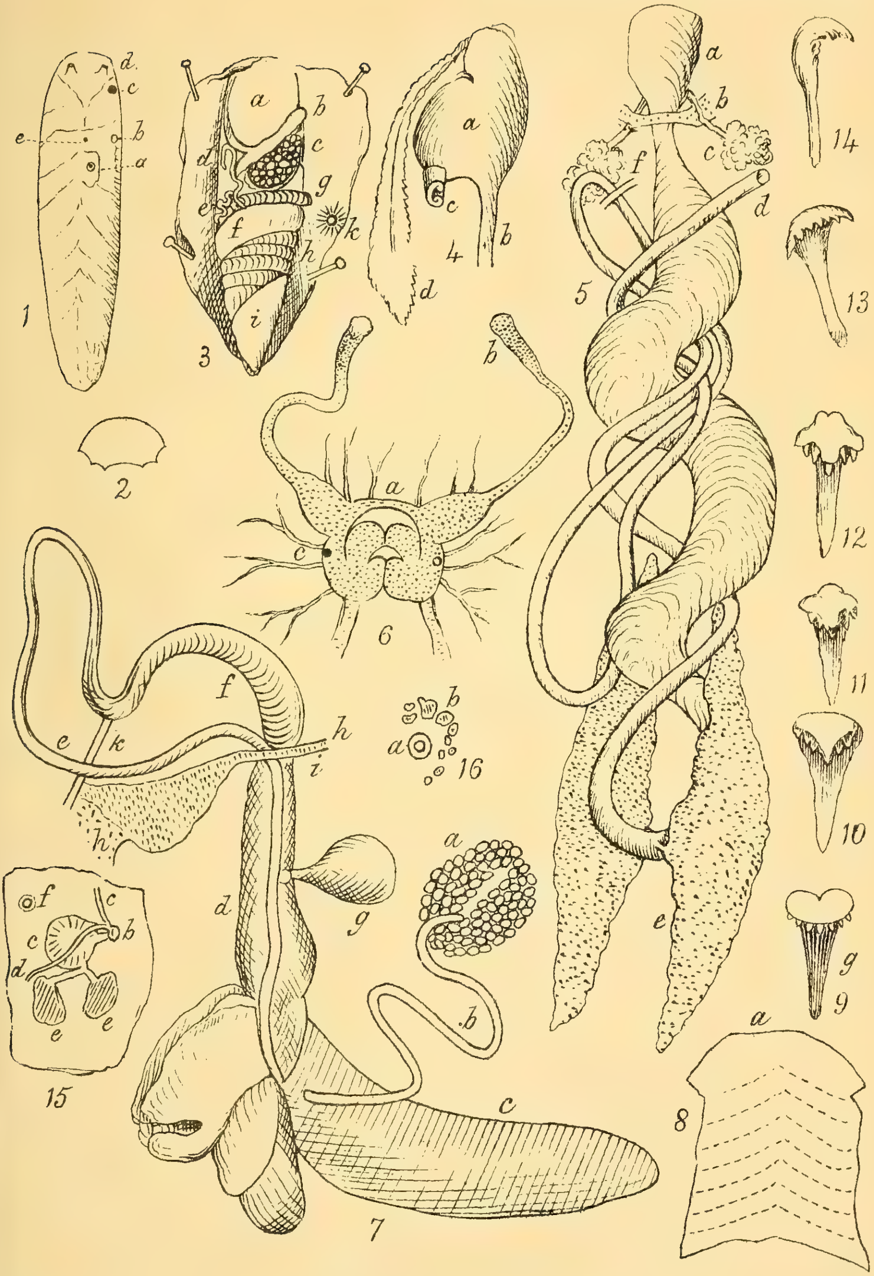
*External characters.* The anus is situated on the right side, below and a little in front of the pulmonary opening. The reproductive organs open behind the right eye-peduncle, (fig. 1). There is a mucous pore situated on the dorsal groove, just in front of the pulmonary opening. The foot is scarcely distinct from the body, and shows no locomotive disc, but after the animal has been placed in strong spirit a lateral groove appears on each side, and the foot shows three longitudinal grooves, a broad central one, and a narrow one on each side, (fig. 2). Twelve to sixteen minute calcareous plates form a rudimentary shell. They are situated inside the pulmonary cavity; the largest in front of the opening, and the others forming a row on the inner or left side of the opening, (fig. 16). These particles have been figured by Dr. Knight, ("Trans. Lin. Soc." xxii., p. 381.)

*Alimentary system* (figs. 4 and 5). The buccal mass is large, and of the ordinary shape, but the retractor muscles arise from the musculature of the foot, immediately under the nerve collar. The length of the radula is not quite twice its breadth, and each half is rolled up into a separate spiral (fig. 4 *c*), as figured by Dr. Knight in his paper already quoted. The teeth are about 255–1–255, varying slightly in number, and there are about 130 transverse rows. The central tooth is about $\frac{1}{1000}$ of an inch in length, and varies considerably. In *J. marmorea* the anterior end is emarginate, and there is no central cusp (fig. 9). In *J. bitentaculata* there is a central cusp, and the anterior end is either simple or has a central swelling, which is either single or divided into two (figs. 10, 11, and 12). In the single specimen I had of *J. papillata* the central teeth were like figs. 10 and 11, but none like fig. 12. There is no distinction between lateral and marginal teeth (figs. 13 and 14); all are alike, and similar in all the species. They have been very accurately figured by Dr. Knight. The inner laterals are rather more than $\frac{1}{1000}$ of an inch in length, and they gradually diminish to about half that size at the margin. They are arranged on the radula in transverse lines that form an obtuse angle, pointing anteriorly. (fig. 8).

On each side of the œsophagus there is a large salivary gland (fig. 5 *c*), the ducts opening into the posterior portion of the buccal mass. Below the buccal mass and œsophagus lies a peculiar tongue-shaped organ (fig. 4 *d*), which is ductless, and fastened in its anterior half to the body wall, but free posteriorly. It is composed of rounded nucleated cells, and is grooved along its upper surface. It may represent the organ of Semper in other slugs.

The stomach is long, and makes nearly three right-hand spiral turns. It passes gradually into the intestine, which turns forward, and follows the stomach back through its windings to the œsophagus; it then turns suddenly back, round the posterior branch of the aorta (fig. 5 *f*), and again descends nearly to the end of the stomach; it then turns suddenly forward, and once more following the convolutions of the stomach, ends in a short straight rectum, which opens on the right side below and in front of the respiratory opening. The liver (fig. 5 *e*) is formed of two compact spindle-shaped lobes. In *J. marmorea* the intestine turns forward immediately after receiving the hepatic ducts, but in *J. bitentaculata* it descends nearly to the posterior end of the liver, making another half turn before it turns forward.

*Reproductive system* (fig. 7). The ovotestis is subrotund in form and divided longitudinally below by a groove running from the hermaphrodite duct, which is purplish. It is of a dead white or pale yellow colour. It is remarkable for its position in the animal, lying in front of the rectum, while in all other slugs with which I am acquainted it is placed posteriorly, among the folds of the liver. The albumen gland is long and tongue-shaped, and of a pale yellow. In *J. marmorea* there are two other large accessory glands at its base, but these are absent in *J. bitentaculata.* It is, however, quite possible that these so-called accessory glands may be folds of the oviduct which I was unable to unravel. The vas deferens separates from the oviduct at its commencement in *J. marmorea*, and at about the middle in *J. bitentaculata.* If the supposed accessory glands in *J. marmorea* are but folds of the oviduct, then the vas deferens would separate in the same position in both species. The penis is long, narrow, and tapering, and the vas deferens enters it at its posterior extremity. The retractor of the penis (fig. 7 *k*) arises from the musculature of the foot, on the left side, in a line with the respiratory opening; it is inserted into the posterior extremity of the penis. The spermatheca (fig. 7 *g*) is purplish brown, globular, with a short neck; it is situated on the oviduct, a short distance from the genital opening. The penis lies across the animal's neck, over the nerve collar. The spermatozoa are gradually thickened at one end, which is spirally twisted. In *J. marmorea* the ovo-testis lies on the upper surface, and is exposed when the animal is opened from the back; in *J. bitentaculata* it is hidden, but can be seen from below.




BITENTACULATE SLUG.

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*Excretory and circulatory systems* (fig. 15). The pulmonary cavity is closed internally by a delicate membrane, slightly radiately plicated, and lies centrally in the animal. The heart is immediately to the left, and outside it. The ventricle is yellow, the auricle colourless. The aorta divides immediately into anterior and posterior branches. The renal organ is double, and lies behind the pulmonary chamber. The duct from the right organ passes over to the left, where it joins the duct of the left organ, and both open by a common duct into the respiratory cavity.

*Nervous system* (fig. 6). This is very compact and concentrated. The parieto-splanchnic and pedal ganglia are in contact, but not fused together. The whole nerve collar is white. The right peduncular nerve passes over the oviduct, close to the genital opening (fig. 7 *h*). The auditory vesicles are placed on the outer margins of the pedal ganglia.

EXPLANATION OF PLATE V.

Fig. 1. *Janella marmorea*, natural size. *a.* pulmonary orifice; *b.* anus; *c.* opening of reproductive organs; *d.* eye peduncles; *e.* mucous pore.

Fig. 2. The same. Section across body after having been in spirit, showing the three-grooved foot.

Fig. 3. The same laid open. *a.* buccal mass; *b.* penis; *c.* ovo-testis; *d.* vas deferens; *e.* hermaphrodite duct; *f.* albumen gland; *g.* rectum; *h.* stomach and intestine; *i.* liver; *k.* pulmonary opening.

Fig. 4. The same; buccal mass from the side. *a.* buccal mass; *b.* œsophagus; *c.* odontophore; *d.* organ of Semper.

Fig. 5. The same; alimentary system. *a.* buccal mass; *b.* commissure of cerebral ganglia; *c.* salivary glands; *d.* rectum; *e.* liver; *f.* posterior branch of aorta.

Fig. 6. The same; nerve collar. *a.* commissure of cerebral ganglia; *b.* eye peduncle retracted; *c.* auditory vesicle.

Fig. 7. The same; reproductive system. *a.* ovo-testis; *b.* hermaphrodite duct; *c.* albumen gland; *d.* oviduct; *e.* vas deferens; *f.* penis; *g.* spermatheca; *h.* peduncular nerve; *i.* opening of reproductive organs; *k.* retractor muscle of penis.

Fig. 8. The same; radula laid open, magnified five times. *a.* anterior end; the dotted lines show the direction of the transverse rows of teeth.

Fig. 9. The same; central tooth, magnified 700 times.

Figs. 10 and 11. *Janella papillata*; central teeth magnified 700 times.

Fig. 12. *Janella bitentaculata*; central tooth magnified 700 times.

Fig. 13. The same; lateral tooth, magnified 700 times.

Fig. 14. Side view of the last.

Fig. 15. The same; excretory system, from below. *a.* pulmonary chamber; *b.* heart; *c.* anterior branch of aorta; *d.* posterior branch of aorta; *e.* renal organ; *f.* anus.

Fig. 16. The same: rudimentary shell, from below. *a.* respiratory orifice; *b.* calcareous plates forming the shell.

## Art. XXI.—*Notes on some* Branchiate Mollusca.

By Professor F. W. Hutton.

[*Read before the Philosophical Institute of Canterbury, 7th July,* 1881.]

Plates VI and VII.

Octopus Maorum. *Dentition.* The central tooth varies much in shape; usually it has only a median cusp, which carries a long cutting point at its end, and a small one on each side, but sometimes there is a small cusp behind each smaller cutting point. The first lateral is rudimentary, with a small curved cusp. The second lateral is short and broad, its breadth being four or five times its length, and is more or less curved; it has a short triangular cutting point at each end, the outer one of which is hidden by the base of the third lateral. The third lateral has a quadrate base, and a long curved cutting point, blunt at the end. The marginal plate is large, its breadth more than twice its length; it tapers outwards; the anterior margin is slightly concave, the posterior is convex. (Pl. VI., fig. a.)

The drawing is taken from a very small specimen obtained at Wellington.

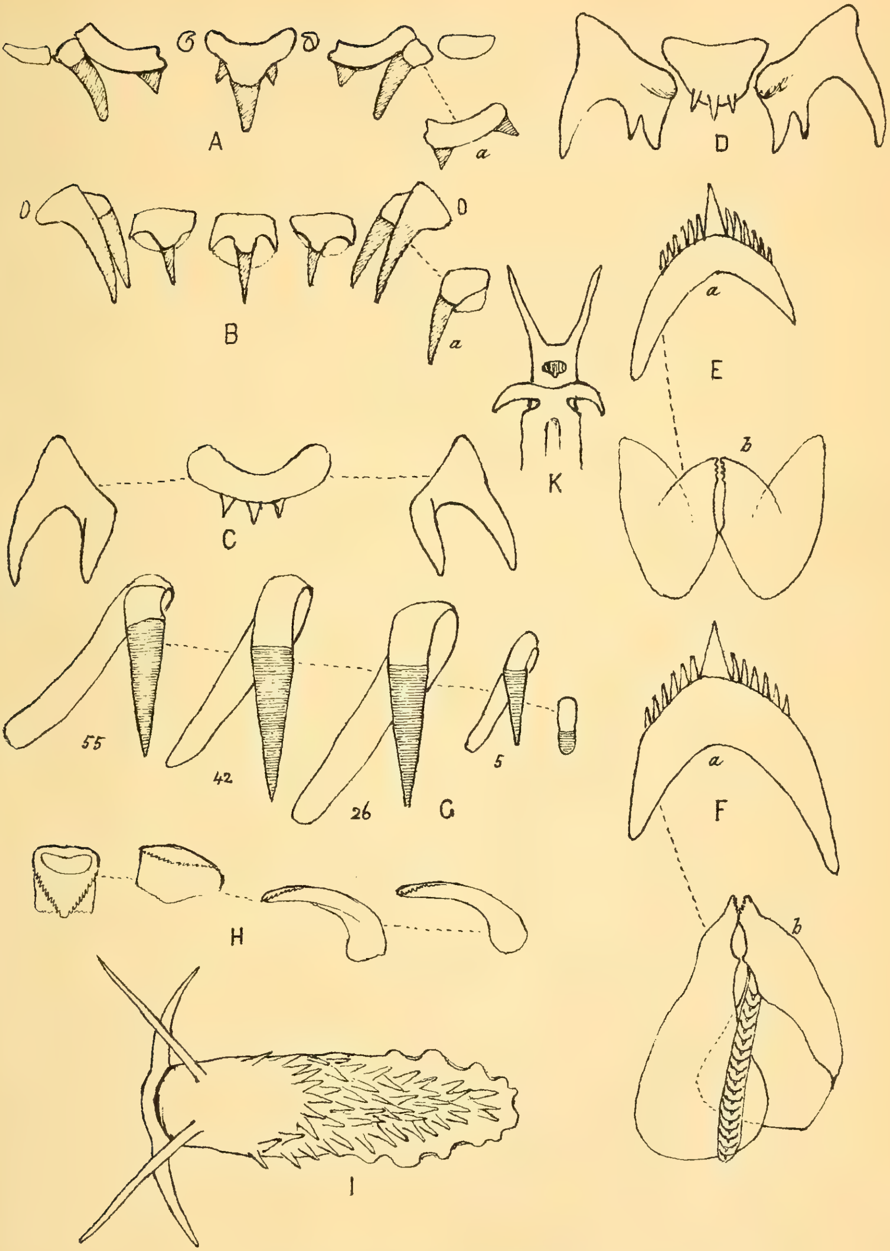
Ommastrephes sloanii. *Dentition.* The central tooth is tricuspid, the median cusp rounded, the side cusps sharply pointed; the median cusp carries a long narrow cutting point. The first lateral is bicuspid; the outer cusp is sharp and without a cutting point, the inner cusp is rounded, and with a narrow sharp cutting point slanting slightly inward. The second lateral has a quadrate base, and a single cusp bearing a long sharp curved cutting point. The third lateral is like the second, but has an aculeate base. The marginal plate is small and oval. (Pl. VI., fig. b.)

The drawing is from a very small specimen obtained at Dunedin.

Euthria lineata. *Dentition.* The central tooth is nearly twice as broad as long, with three sharp denticles on the upper anterior surface. The laterals have a long curved denticle on the outside and two small ones close together on the inside. They lie close to the central tooth. (Pl. VI., fig. d.) The nucleus of the operculum is apical, forming the apex. The drawing was made from a specimen an inch in length, intermediate between varieties A. and C. It was obtained at Sumner.

Cominella funerea. *Animal* yellowish white. The eyes are half way up the tentacles, which are marked with black in the region of the eyes. Top and sides of the head with dead-white spots. Siphon long and recurved, white speckled with black. Foot slightly expanded and emarginate in front, rounded behind; with two black spots in front.

*Operculum* with the nucleus apical, within the apex, the margins simple.




BRANCHIATE MOLLUSCA.

F.W.H. del.

*Dentition.* The central tooth is curved, rather swollen at each end, its breadth four times its length; it has three equal denticles in the middle on its anterior surface. The lateral teeth have two denticles, the outer being the longer, and more curved; they lie distant from the central tooth. (Pl. VI., fig. C.)

The specimen from which the drawing was made was obtained at Sumner.

COLUMBELLA CHOAVA. *Animal* yellowish white, with a narrow black longitudinal line on the back of the head, between the eyes; some scattered dead-white spots on the body and siphon. Tentacles thick, not tapered, approximated; the eyes at their outer bases. Siphon curved. Foot expanded in front, and notched at each side. No operculum. (Pl. VII., fig. O.)

*Dentition.* 1–0–1; the central portion of the radula is thickened, and divided transversely into membraneous plates, which are broader than long, but the plates bear no teeth. The lateral teeth are versatile; they are curved, pointed at the end, and with two small denticles on the concave side. (Pl. VII., fig. P.)

This species occurs occasionally on seaweed in Lyttelton Harbour. I described the animal in the "Transactions of the New Zealand Institute," vol. xiii., p. 201, by mistake, under the name of *Defranchia luteo-fasciata.*

STRUTHIOLARIA PAPULOSA. The *dentition* is remarkably like that of *Trochita.* The radula is delicate and short, with only about 24 transverse rows of teeth. The central tooth has a quadrate base; the reflected portion is triangular, rather longer than broad, and denticulated on each side. The first lateral has a breadth of nearly twice its length, and the short reflected portion is slightly denticulated on the margin. The second and third laterals are nearly similar, but the base of the second is rather broader and squarer than that of the third; they are versatile. Both are long and curved, the apex blunt and slightly bent over; both are denticulated at the end and on either side near the apex, the denticulations stronger on the outer side. (Pl. VI., fig. H.)

In the male the denticulations are stronger than in the female, in all other respects they are alike. The drawing is taken from a specimen collected at Nelson by Mr. J. D. Enys, in it the teeth are separated to show their form. In their proper position the apices of the second and third laterals nearly meet in the centre. The breadth of the radula is ·019 inch, and its length about ·07 inch, in a full-sized specimen.

TROCHITA NOVÆ-ZEALANDIÆ. *Dentition.* The radula has about 44 transverse rows of teeth; the second and third laterals are versatile. The central tooth has a broad rounded base, the reflected has a median cusp with four small denticles on each side; the cusp has a sharp cutting point, The first lateral is somewhat triangular in shape, its breadth being three times its height; the reflected portion is denticulated on the margin, and there is a large cutting point at the inner end, with a small one inside it. The second and third laterals are nearly similar, the apices are blunt and denticulated; the outer margin is denticulated in both, while the third lateral has also some denticulations on the inner margin. (Pl. VII., fig. A.)

Littorina cincta. *Animal.* Foot sooty brown; head brownish black, with a white space round the eye; tentacles brownish black with white tips, and a white triangular mark at the base.

*Dentition.* Radula very long; ·01 inch in breadth. Central tooth ·002 inch in length, with a rounded cutting point. The first lateral has two large cutting points; the second lateral has four, and the third lateral five cutting points. The length of the third lateral is ·004 inch. (Pl. VII., fig. D.) The drawings were made from a specimen from Sumner, the axis of which was ·43 inch. The *operculum* is sub-spiral, the nucleus near the end.

This species varies very much in colour.

Littorina cærulescens. *Animal* and *operculum* as in *L. cincta.* The *dentition* is smaller than in *L. cincta*, and the cutting points finer. In a specimen with an axis of ·42 inch, the length of the central tooth was ·015 inch, and that of the third lateral ·025 inch. Breadth of radula, ·006 inch. (Pl. VII., fig. E.) According to Mr. Gwyn Jeffreys, this species is identical with *L. neritoides*, Lin.

Fossarina varius. *Animal.* Foot white, simple and truncated in front; head dark purple black, with a reddish tinge on each side of the neck; rostrum short, tipped with yellow; tentacles moderate with the eyes at their outer bases, white irregularly ringed with black. *Dentition.* This much resembles that of *Littorina*, but the third lateral tooth is not broad at the apex, and the radula is short. (Pl. VII., fig. B.) The radula is ·005 in breadth. The *operculum* is subspiral, with the nucleus central. (Pl. VII., fig. C.)

This species is common at Sumner, associated with *L. cincta* and *L. cærulescens*, on the rocks, above low-water mark.

Janthina communis. The radula has numerous aculeate teeth, which decrease in size towards the anterior end; they do not seem to be arranged in transverse rows. The teeth have a simple hooked apex, and a slightly expanded emarginate base. The length of a posterior tooth is ·03 inch, that of an anterior tooth is ·008 inch. (Pl. VII., fig. F.)

The specimen was given me by the Hon. G. McLean, who captured it in a towing net off the coast of the North Island.

Turbo smaragdus. *Dentition.* The cusps of the teeth are smooth, with cutting points. The central tooth and the laterals have one cutting point each; the marginals have two each, the inner being the larger; in the first three or four marginals these points are very large and acute, in the other marginals they are rounded. (Pl. VII., fig. g.)

Zizyphinus punctulatus. *Dentition.* All the teeth have denticulated apices without cutting points. The first two or three marginal teeth are denticulated on the outside only; the rest, as well as the central tooth and the five laterals, on both sides. (P. VII., fig. h.)

Anthora tiarata. *Dentition.* The central tooth is broader than long, the cutting point, with five strong denticles on each side, at the base. The cutting points of the laterals have four or five denticles on the outside, the inside is smooth; the cutting points increase in length outward. All the marginal teeth are small, being well marked off from the laterals; the cutting points are small and denticulated on the outside. (Pl. VII., fig. n.)

Cantharidus texturatus. *Animal.* Foot white along the sides, marbled with dark purple, which colour forms a transverse band on each side of the operculum; the hinder part is light reddish brown margined with white. Head purplish red, with a pale line down the middle. Tentacles long, white, fringed. Eye peduncles reddish. Filaments, three on each side, white. Side lappets white.

*Dentition* as usual, the central tooth longer than broad. (Pl. VII., fig. i.)

I have found what I take for this species occasionally at Lyttelton, but always small. It answers well to the description, except that the grooves between the ribs are smooth.

Cantharidus pupillus. The *dentition* resembles that of the last species, but the central tooth is slightly broader in proportion. (Pl. VII., fig. k.)

Cantharidus huttonii. *Animal.* Foot white or yellow, thickly marked with blue-black, concentric, interrupted, lines. Head black with three white triangular marks on the vertex between the tentacles; rostrum black, broadly margined with bright yellow or white, with black, concentric, interrupted lines like the foot. Tentacles fringed; white with a black longitudinal line. Eye peduncles short, white. Side lappets white, fringed on the left side, smooth on the right. Filaments three on each side, like the tentacles. The animal is very slow in its movements, and varies much in colour.

*Dentition.*—The central tooth is as broad as long, and has a minute cutting point; the central lobe is nearly obsolete. The first four laterals have a single, large, sharp cutting point, which is denticulated at the inner base. The fifth lateral has a small cutting point outside the large one. (Pl. VII., fig. m.) In these respects it is like *C. texturatus.*

Cantharidus tenebrosus (?). I am very doubtful as to the correct determination of this shell, for although it is bluish black, transversely sulcated, the sulci whitish, and coarser than those of *C. huttonii*, in shape it is shortly conical, and as broad or broader than high, and when young is perforated. The largest specimen that I have seen measured ·3 inch both in height and in breadth, but usually the height is ·2, and the breadth ·23. It is not uncommon on seaweed in Lyttelton Harbour. Perhaps it may be a variety of *C. pupillus*.

*Animal.* Foot blue black, concentrically speckled or striped with yellowish white. Proboscis blue black, narrowly bordered with dusky white or yellow. Eye peduncles short. Tentacles purple, with a dark line down the middle. Filaments purplish, three on each side.

*Dentition* like *C. huttonii*, but the central tooth has the median lobe behind well developed. (Pl. VII., fig. L.)

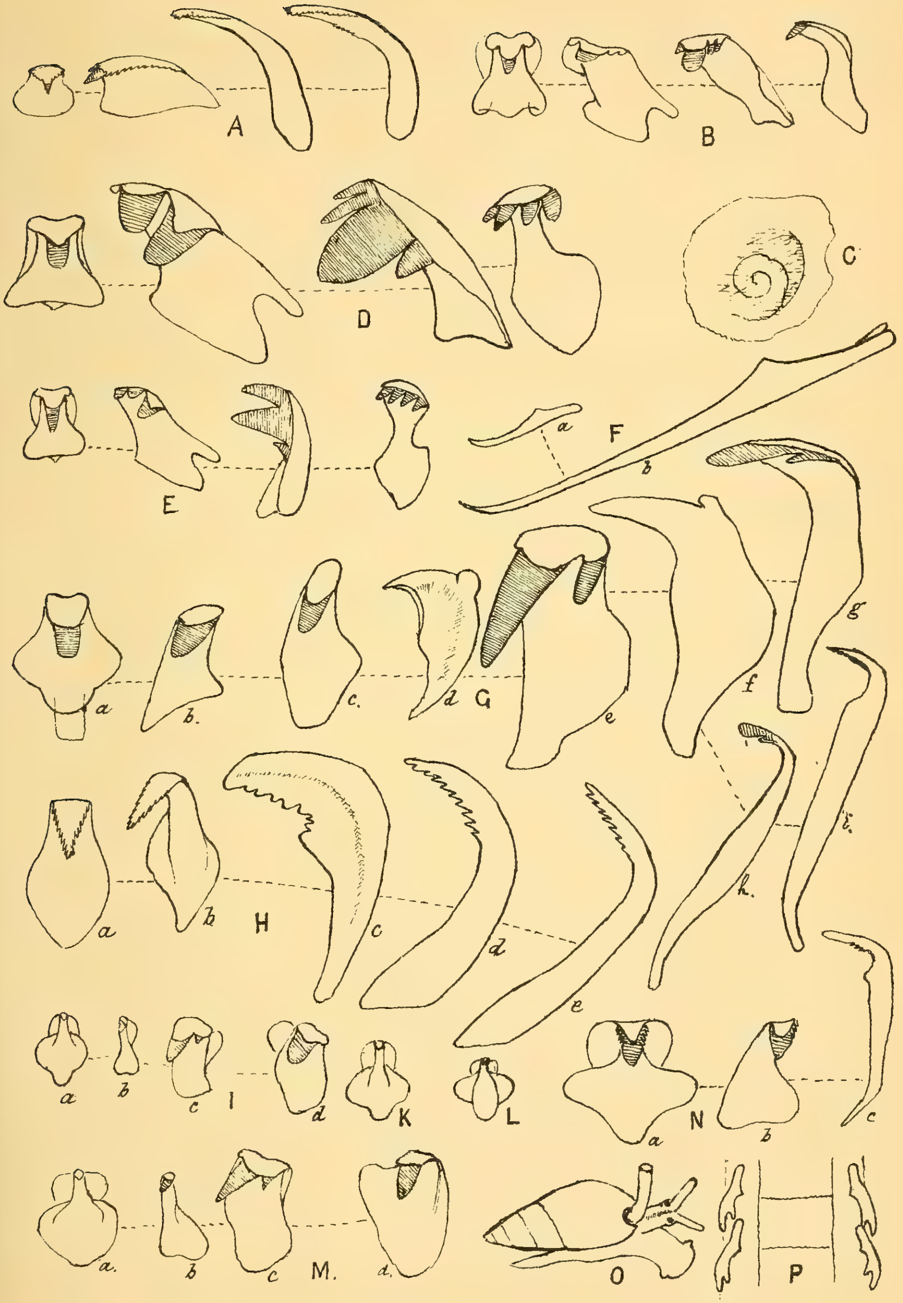
Doris wellingtonensis. *Dentition.* The radula is folded longitudinally along the central line, the two halves being in apposition, and has about thirty-four transverse rows of teeth. The teeth are about 65–1–65. The central tooth is small and blunt; the laterals have a long, narrow, oblique base, turned over and bearing a narrow, acute, cutting point. They increase in size from the centre to about the thirtieth longitudinal row, and then decrease outwards. The cutting points are much worn in the anterior rows. (Plate VI., fig. G.)

Æolis plicata, *sp. nov.* (Pl. VI., fig. I.) Head, neck, and body white; branchiæ in close transverse rows on the back, dark brown, each margined with white. Body not tapering behind. Margin of foot fringed and crumpled, except near the head, where it is simple; it is divided in front, but not produced. On the side, below the branchiæ, several rows of small white papillæ (?) arranged in festoons. Tentacles distant, subulate, tapering, projecting outward, white. No eyes. Oral tentacles shorter, thickened at the base, tapering, projecting laterally, and curved backward; white. Length about three quarters of an inch.

Found on the roots of *D'Urvillæa utilis*, cast upon the beach at Sumner.

*Dentition*, 0–1–0. About 17 or 18 teeth on the radula, in a single series. Each tooth crescent shaped, with a pointed tooth in the centre, and six smaller denticles on each side (Pl. VI., fig. F. *a*.) Jaws two, the apices acute and denticulated, the posterior portion flattened. (Pl. VI., fig. F. *b*.)

Æolis corfei. The teeth of this species resemble those of *Æ. plicata*, they have a central tooth with six denticles on each side. There are 18 or 19 on the radula. Jaws two, the apices denticulated; the posterior portion reflexed. (Pl. VI., fig. E. *a* and *b*.) This species should I think be put into




BRANCHIATE MOLLUSCA

F.W.H. del.

*Æolis*, instead of into *Montagua*, as the branchiæ are tolerably crowded. On Pl. VI., fig. K, I have given a sketch of the anterior portion of the animal from below, showing the lateral processes at the end of the foot.

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## DESCRIPTION OF PLATE VI.

A. *Octopus maorum.* Teeth × 80. *a* second lateral detached.

B. *Ommastrephes sloanii.* Teeth × 80. *a* second lateral detached.

C. *Cominella funerea.* Teeth × 150.

D. *Euthria lineata.* Teeth × 150.

E. *Æolis corfei.* *a* tooth × 150; *b* jaw × 16.

F. *Æolis plicata.* *a* tooth × 150; *b* jaw with radula × 16.

G. *Doris wellingtonensis.* Teeth × 80. The numbers indicate the number of the longitudinal row of that tooth from the centre. The central tooth has no number.

H. *Struthiolaria papulosa.* Teeth, detached, × 80.

I. *Æolis plicata.* Animal × 2.

K. *Æolis corfei.* Anterior extremity of animal from below.

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## DESCRIPTION OF PLATE VII.

A. *Trochita novæ-zealandiæ.* Teeth × 140.

B. *Fossarina varius.* Teeth × 280.

C. *Fossarina varius.* Operculum × 8.

D. *Littorina cincta.* Teeth × 280.

E. *Littorina cærulescens.* Teeth × 280.

F. *Janthina communis.* Teeth × 80. *a* an anterior tooth; *b* a posterior tooth.

G. *Turbo smaragdus.* Teeth × 80. *a* central tooth: *b* first lateral; *c* fourth lateral; *d* the same, side view; *e* first marginal; *f* the same, side view; *g* second marginal; *h* a middle marginal; *i* an outer marginal.

H. *Zizyphinus punctulatus.* Teeth × 80. *a* central tooth; *b* a lateral; *c* first marginal; *d* second marginal; *e* an outer marginal.

I. *Cantharidus texturatus.* Teeth × 160. *a* central tooth; *b* first lateral; *c* fifth lateral; *d* first marginal.

K. *Cantharidus pupillus.* Central tooth × 160.

L. *Cantharidus tenebrosus.* Central tooth × 160.

M. *Cantharidus huttonii.* Teeth × 160. *a* central tooth; *b* first lateral; *c* fifth lateral; *d* first marginal.

N. *Anthora tiarata.* Teeth × 160. *a* central tooth; *b* first lateral; *c* a marginal.

O. *Columbella choava.* Animal.

P. *Columbella choava.* Portion of radula with teeth × 470

Art. XXII.—*Description of two little-known Species of New Zealand Shells.*
By W. Colenso, F.L.S.

[*Read before the Hawke's Bay Philosophical Institute, 14th November*, 1881.]

Although just forty years have passed since I first detected and made known these two shells, one marine and one fresh-water, which I now bring before you, I have good reasons for believing they are still but little known. Their scientific description, etc., was early published in the "Tasmanian Journal of Natural Science,"* but I do not find them noticed in any of the modern conchological works in our library, under my own or any other specific names; neither are they included in the exhaustive "List of New Zealand Mollusca," recently laboriously compiled from almost all conchological authorities by Professor Hutton, and published last year by the New Zealand Government. I therefore conclude that they are still but little known. This, however, may be easily accounted for, if, as I suppose, the single localities in which I separately found them are their only known habitats; as such are quite out of the way of both the scientific and general traveller; and although I sought them diligently in my early and general collecting of the shells of this country, I never met with these species anywhere else. At the time, however, of their discovery, I distributed several specimens to various parts of the world.

You will not fail to note, in examining the specimens before you, how exceedingly well they have kept both their original colours and freshness of epidermis, more resembling specimens newly obtained, than those of forty years slumbering in a cabinet. In again giving their scientific description, I shall, on account of conformity, confine myself to the terms I used in the original drawing up, although at that very early period without scientific books.

## Genus **Patella**.

Patella solandri: *Shell* oval, anteriorly truncated, much depressed, faintly striated longitudinally, diaphanous, fragile, covered with a thin epidermis; *inside*, smooth, glossy; *vertex*, very much anteriorly inclined, sub-acute, produced, slightly recurved; *margin*, entire, obsoletely crenulated within; *colour*, bluish green, concentrically streaked with brown, beautifully blotched, or tortuously undulated, with same colour towards margin; 5–7 lines long, 4–5 lines broad.

*Hab.* Adhering to the underside of large smooth stones; Tokomaru (Tegadoo) Bay, East Coast, North Island of New Zealand.

* Discovered in December, 1841, and published in "Tasmanian Journal of Natural Science," vol. ii., pp. 226, 250.

Genus **Unio.**

Unio waikarense. *Shell*, oblong, or oblong-ovate, concentrically and irregularly sulcated, sub-diaphanous, inflated; anterior side produced, obtuse, slightly compressed; *posterior slope*, keeled, sharp: *base*, slightly depressed; *umbones*, decorticated, flattish, much worn; *primary tooth*, large crested; *epidermis*, strong, overlapping at margin, wrinkled on anterior slope; *colour*, brownish-yellow on posterior side, shading into dusky-green on the anterior, with alternate light-coloured lateral stripes; 3½ inches broad, 2¼ inches long.

*Hab.* Waikare Lake, mountains, interior of the North Island of New Zealand.

The largest and handsomest of all the known New Zealand species of the genus.

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## Art XXIII.—*Notes on New Zealand* Mollusca.

By Mr. Justice Gillies, Auckland.

[*Read before the Auckland Institute, 11th July*, 1881.]

During my recent trip to England I took with me the late Dr. Sinclair's collection of New Zealand shells, mostly collected in the North Island, and had them named according to the specimens in the British Museum by the aid of Mr. G. B. Sowerby, junr., and Mr. E. A. Smith, of the British Museum, to both of whom my best thanks are due for their kindness. On my return to the colony I have compared these with Professor Hutton's type specimens, in the Colonial Museum, Wellington, and in the Dunedin Museum. The following is the result of my researches, which may probably prove useful to those interested in New Zealand conchology. The pages given refer to the new edition of the "Catalogue of New Zealand *Mollusca*," by Professor Hutton; Wellington, 1880.

PAGE

16. *Helix reinga*—Doubtful if ever found in New Zealand.

41. *Conus aplustre*—Add to catalogue. I have a single specimen from the Bay of Islands, but it is doubtful whether either this or *Conus zealandicus* really belong to New Zealand. They may have been dropped from some South Sea whaler, of which many visit the Bay of Islands.

42. *Acus kirki* is *Terebra tristis* of Deshayes and *T. antarctica* of Smith.

PAGE

43. *Pleurotoma zealandica*—Amend description as follows: instead of "tapering gradually" read "gradated," and instead of "caudal keel small, set round with dusky," read "cauda set round with small brown keel."

44. *Drillia cheesemani*—Omit, as this is the same as *Pleurotoma zealandica*, Smith.

45. *Defranchia luteo-fasciata*—Substitute *Drillia sinclairi*, Smith, manuscript. *D. luteo-fasciata* is a very small West Indian shell described by Reeve.

48. *Trophon stangeri* is clearly the same as *Fusus cretaceus* of Reeve.

54. *Cominella lurida* and *huttoni* are the same, and are the *quoyana* of the British Museum.

54. *Cominella funerea* is *C. costata.*

55. *Nassa rutilans, etc.*, are not New Zealand. I have *N. cancellata*, A. Adams, *N. semigranosa*, and *Strombus variabilis*, all found at Bay of Islands, but all doubtful, as before remarked as to *Conus.*

59. *Fasciolaria trapezium*—Add to catalogue. I have one specimen collected by the late Dr. Sinclair.

60. *Mitra rubiginosa*, Hutton—Should be changed as there is a *M. rubiginosa* of Reeve, Proc. Z. Soc., 1844.

62. *Marginella albescens* can hardly be distinguished from *M. australis*, although a little smaller.

63. *Marginella muscaria*, Lam.—Substitute for *Erato lactea*, Hutton.

66. *Cypræa*—I have a specimen of *Cypræa* found on the beach at the Bay of Plenty in            , by Rev. Mr. Chapman, but I fear that both this and *C. punctata* are dropped shells, not New Zealand.

68. *Struthiolaria inermis* is the same as *australis.*

70. *Scalaria lyra* is not the *lyra* of Sowerby. It is most like *rubrolineata*, but the band is on the middle of the whorl of the latter.

70. *Scalaria jukesii*—Add to catalogue. I have specimens; also of another new species.

*Scalaria wellingtonensis*—Add to catalogue. Described in "Trans. N. Z. Inst.," vol. xii., p. 307.

73. *Eulima chathamensis* is *Rissoa variegata*, Angas.

92. *Calcar cookii* is *Cookia cookii* of the British Museum.

*Calcar imperialis* is *Imperator heliotropium* of the British Museum.

PAGE

95. *Diloma æthiops* is not *Monodonta reticularis* of Gray; the latter ought to be replaced in catalogue, as I have both.
96. *Diloma gaimardi* is same as *D. sulcatus*, Wood.
96. *Trochocochlea mimetica*, Hutton, is *M. reticularis*, Gray.
98. *Zizyphinus granatus*, Chemnitz, is not the same as *Z. tigris*, Martyn; the *granatus* of Dunedin Museum is *tigris*.
103. *Margarita fulminata* should be a *Gibbula*.
*Margarita*, nov. sp.—Add to catalogue. Perhaps *Gibbula inconspicua* of Hutton, p. 102.
106. *Emarginula candida*, A. Adams—Add.
*Emarginula tenui-costata*—Add.
*Tugalia ossea*—Add.
107. *Tectura pileopsis*—Add.
*Tectura fragilis*—Add.
110. *Patella stellaris*—Add. Like one named *corticata* in Dunedin Museum, but not quite.
113. *Lepidopleurus crocinus*, Reeve—Add. This is probably *L. empleurus*, Hutton.
118. *Ischnochiton antiquus*, Reeve—Add.
121. *Haminea zealandiæ* and *obesa* are the same.
136. *Anatina tasmanica* is *A. angasii*.
143. *Tellina disculus* is not the same as *sublenticularis* of Sowerby.
159. *Cardita zealandica* is the same as *compressa* of Reeve.
167. *Mytilus edulis* is neither *edulis* nor *dunkeri* of Reeve.
171. *Pecten vellicatus*, Hutton, is the same as *convexus*, Q and G, and *roseapunctatus*, Reeve.
*Adamsia typica*—Add.

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## ART. XXIV.—*Additions to the New Zealand* Crustacea.

By CHARLES CHILTON, B.A.

[*Read before the Philosophical Institute of Canterbury*, 13*th October*, 1881.]

Plate VIII.

THIS paper contains the descriptions of three new species of *Crustacea*, two belonging to the *Brachyura* and one to the *Isopoda*. I also describe the male of a species of *Amphipoda*, the female only having been hitherto known.

## BRACHYURA.

### Genus **Hymenicus**, Dana.

(Miers' Cat. N.Z. Crustacea, p. 50.)

*Hymenicus marmoratus*, sp. nov. Plate VIII., fig. 1.

Carapace smooth, naked and flat; sub-triangular with the sides arched, about as broad as long; front projecting and trilobate. Antero-lateral margin with two teeth, the posterior one sharp, long, and very distinct, the anterior one short and blunt. Abdomen of male sub-triangular, first segment broadest and more or less rectangular, penultimate segment narrower than the preceding, the last segment sub-triangular, rounded at the apex. Anterior legs rather large and swollen; tarsi of the remaining legs somewhat densely haired, the other joints being sparsely haired. Colour—variously marked with white and reddish-brown. Length ·25in.

*Hab.* Common amongst sea-weed in rock-pools in Lyttelton Harbour.

Though common at Lyttelton Harbour this crab does not appear to have been hitherto described. It is closely allied to *Hymenicus varius*, but differs in the shape of the carapace, in having the two teeth on the antero-lateral margin well marked, and also in colour.

### Genus **Elamena**, M.-Edwards.

(Miers' Cat. N.Z. Crustacea, page 52).

*Elamena (?) lacustris*, sp. nov.

Carapace nearly circular, rather broader than long. Rostrum broad, strongly depressed, concave above, sides parallel, obtusely pointed at the end. Antero-lateral margin of the carapace with two nearly obsolete teeth. Last pair of legs much shorter than the preceding. Colour (in spirit)—carapace brown, legs yellowish, spotted with brown. Breadth ·15in.

*Hab.* Lake Pupuke *(fresh water)*, North Shore, Auckland.

This species is remarkable from the fact that it is an inhabitant of fresh water.

I am somewhat doubtful about referring it to *Elamena*, as I have only seen a single specimen, a female.

Professor Hutton kindly handed over this and the preceding species to me for description.

Types of both have been lodged in the Canterbury Museum.

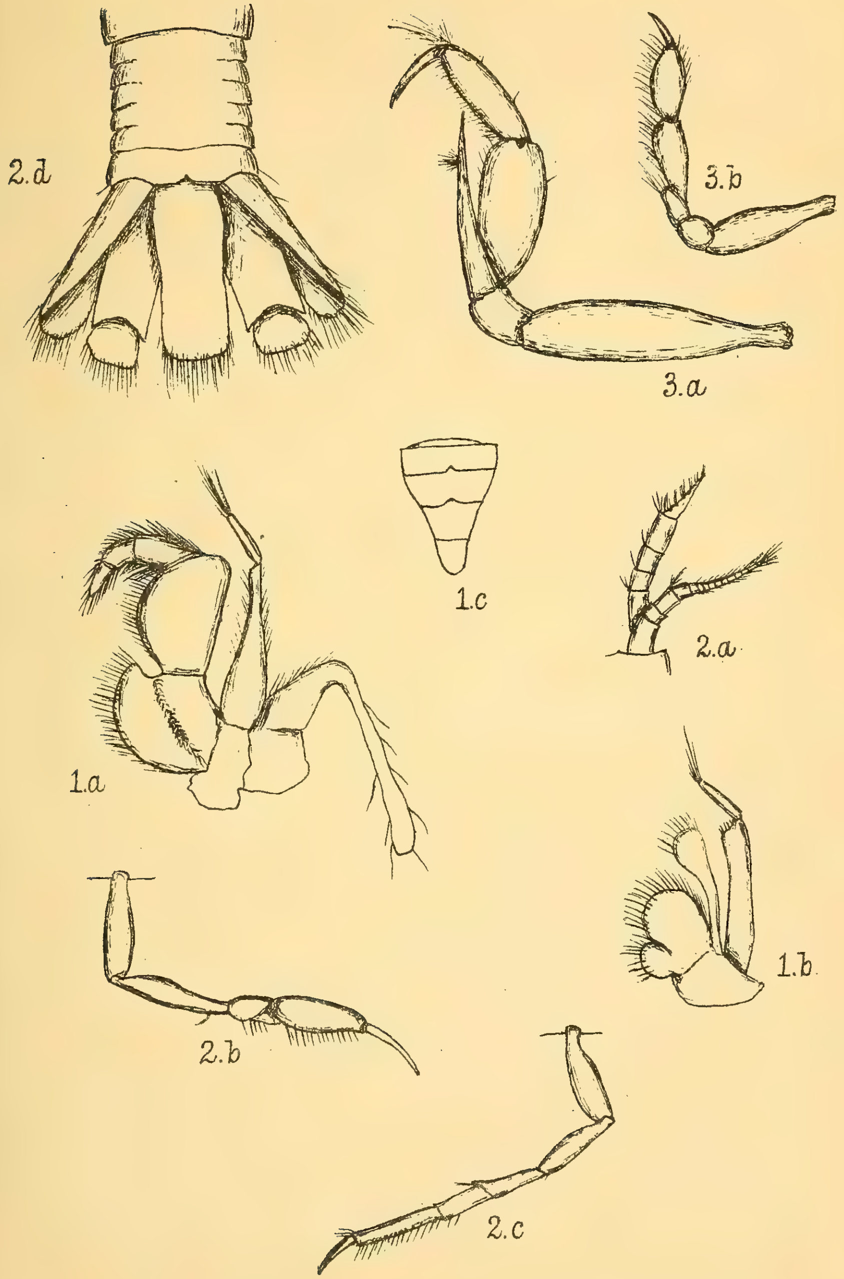
## ISOPODA.

### Genus **Anthura**, Leach.

(Bate's and Westwood's Brit. Sessile-eyed Crust., vol. ii., p. 157.)

*Anthura (?) flagellata*, sp. nov. Plate VIII., fig. 2.

Body long, slender, sub-cylindrical, thoracic segments sub-equal. Antennæ near equal, the inner one with a distinct flagellum. First three pairs of thoracic legs sub-chelate, the first pair being considerably larger than the




New Zealand CRUSTACEA.

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two following, and having the hand stout and ovate, and the finger long and curved; the second and third pairs similar in shape and equal in size; the four posterior pairs are all nearly equal to one another, and are non-chelate. First five abdominal segments confluent; the last segment has its posterior edge notched at the centre. Its appendages are broad, operculiform, and biramous, the inner branch formed of a single joint, broad and concave, enclosing the other branch, which has two broad joints, the basal one being much longer than the terminal joint. The terminal segment (telson) squamiform, rectangular, with the posterior angles rounded. The posterior edges of the telson and of the appendages of the last abdominal segment are fringed with numerous long setæ. Length, ·3 in.

*Hab.* Among seaweed in rock-pools, Lyttelton Harbour.

This species differs from *Anthura* in that the first five (instead of four) abdominal segments are confluent and that the inner antenna has a distinct flagellum, but as I have only a single specimen I have not made a new genus for it.

## AMPHIPODA.

*Microdentopus maculatus*, G. M. Thomson (Ann. & Mag. N.H., ser. v., vol. iv., p. 331).

This species was described by Mr. Thomson, from a single specimen, a female. It appears to be moderately common amongst seaweed in the rock-pools at Lyttelton. Amongst some specimens answering very well to his description I took one which also agreed with that description in every particular except as regards the gnathopoda. These (plate VIII., fig. 3) are very peculiar, the meros is produced inferiorly into a long acute spine reaching slightly beyond the extremity of the succeeding joint, the carpus; this spine bears a small tuft of setæ about one-third of its length from its extremity. The carpus is large, and is rather more than twice as long as broad. The propodos is much smaller; its inner edge is fringed with numerous setæ. The last joint forms a strong finger slightly curved at the end, its inner edge is smooth; numerous long setæ arise at its base. The second pair of gnathopoda are of more normal shape, the meros not being produced into a spine.

The first pair of gnathopoda closely resemble those of *Aora gracilis* and *Aora typica*,* though slightly different from both of them. Mr. Thomson has taken *Aora typica* in Dunedin Harbour, and he speaks† of its resemblance to *Microdentopus maculatus*, and hints that they may possibly be male and female of the same species. The animal I have, though distinct

* "Brit. Mus. Cat. Amphip. Crust.," pp. 160–2, pl. xxix., figs. 7 and 8.

† "Trans. N.Z. Inst.," vol. xiii., p. 218.

from *Aora typica*, is, however, so very like *Microdentopus maculatus* in every part except the gnathopoda that I have little doubt that it, and not *Aora typica*, is really the male. This is also confirmed by the fact that the two were found together.

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DESCRIPTION OF PLATE VIII.

Fig. 1. *Hymenicus marmoratus.*
- a. Third (external) maxillipede × 22.
- b. Second maxillipede × 22.
- c. Abdomen of male × 5.

Fig. 2. *Anthura (?) flagellata.*
- a. Antennæ × 22.
- b. Third thoracic leg × 22.
- c. Sixth thoracic leg × 22.
- d. Abdomen and telson × 22.

Fig. 3. *Microdentopus maculatus.*
- a. First gnathopod of male × 22.
- b. Second gnathopod of male × 22.

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## Art. XXV.—*On some Subterranean* Crustacea. By Charles Chilton, B.A.

[*Read before the Philosophical Institute of Canterbury, 3rd November*, 1881.]

Plates IX. and X.

The existence of blind Amphipodous Crustacea in wells and caves of England and Europe, has been long known; in this paper I record the existence of similar animals in New Zealand. The Crustacea which form the subject of this paper were obtained from a well at Eyreton, about six miles from Kaiapoi, North Canterbury. The well was made about seventeen years ago, it is not more than twenty-five feet deep, and it is fitted with a common suction pump, through the medium of which these interesting animals were obtained.

From this well I got three species of Amphipoda and one of Isopoda. In none of these have I seen any trace of eyes, though I have examined living as well as preserved specimens. The most interesting species is the Isopod; the only other blind Isopod inhabiting wells or caves that I know of is the genus *Cæcidolea*, a species of which is found in the Mammoth Cave of Kentucky, and another in the Wyandotte Cave.*

* See "Nature," 1872, pp. 11, 445, and 484.

The Isopod that I have to describe is remarkable from the fact that it has only six pairs of legs, whilst the normal number is seven pairs. In many Isopoda the young have at first only six pairs of legs, the last thoracic segment being but slightly developed and destitute of appendages,* and hence it might, at first sight, be thought that the animal I have is only an immature form. This, however, I think can hardly be the case, for there is nothing embryonic about the appearance of the animal, and moreover, I have examined altogether twenty-two specimens, varying in length from ·16 of an inch to ·46 of an inch, and these all agree in wanting the last pair of thoracic legs. These specimens were obtained at various times from January up to October, 1881, and I think it is hardly possible that these can all be immature forms, and that during the whole time not one mature form should have been obtained. If it is, therefore, a mature form, the absence of the last pair of thoracic legs must I suppose be due to arrested development.

## ISOPODA.

### **Cruregens**, (nov. gen.)

Generic characters:—Body sub-cylindrical. Head small. First six thoracic segments sub-equal, the seventh *small and without appendages.* Antennæ sub-equal, neither having a flagellum. First pair of thoracic legs large and sub-chelate, the second and third sub-chelate but smaller, the three posterior pairs simple. First pair of abdominal appendages forming an operculum enclosing the branchial plates; last pair biramous. Telson squamiform.

In the antennæ, the shape of the body and of the thoracic legs, this genus resembles *Paranthura*, Spence Bate, and in the shape of the telson and the last pair of abdominal appendages, it is like the closely allied genus *Haliophasma*, Haswell, but it differs from both in the absence of the last pair of thoracic legs.

*Cruregens fontanus*, sp. nov. Pl. X. figs. 1 to 12.

Eyes none. Short blunt rostrum between the bases of the upper antennæ. Upper antennæ slightly shorter than the lower, formed of four joints; first joint of lower antennæ long, second short, third and fourth about as long as the first, the fourth being followed by a short terminal joint. First pair of thoracic limbs strong and sub-chelate; hand large, broadest at the proximal end, narrowing distally, the palm armed with stout spines, the finger strong and slightly curved; the wrist about twice as long as broad. Last pair of abdominal appendages two-branched, first branch consisting of a single long narrow joint, the other of two joints, the

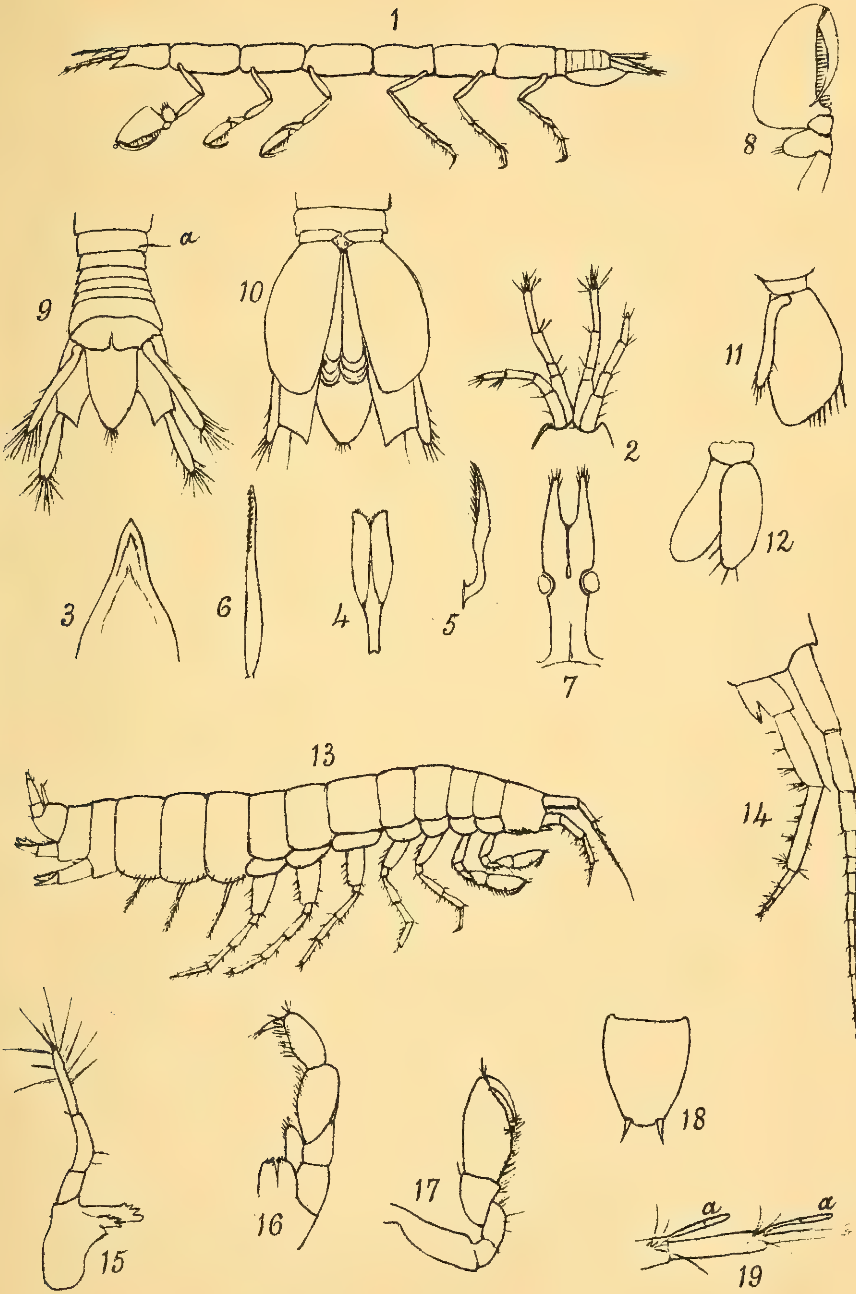
* "Facts and Arguments for Darwin," Fritz Müller, pp. 70–72.

basal one broader and longer than the terminal one. The ends of both branches supplied with numerous rather long setæ. Telson squamiform, sides arched, ending in a blunt point tipped with a few short setæ. Colour transparent. Length of largest specimen ·46 inch.

*Hab.* Pump at Eyreton.

As this Isopod is exceedingly interesting, I have endeavoured to describe and figure it in some detail. The mouth parts are all small and exceedingly difficult to make out, owing to the various parts being to a considerable extent anchylosed together; and I have to thank Professor Hutton for valuable aid in their dissection. Though I have by his aid succeeded in making out the various parts which form the mouth, I cannot, in the absence of sufficient books of reference, be quite certain of their homologies. All the parts of the mouth project forwards; just below the antennæ there is a strong moderately sharp labrum or upper lip (pl. X., fig. 3). The appendage which, by its position, should correspond to the mandibles does not appear to perform the function of mandibles. The two parts, right and left, appear to be here anchylosed together, and no trace of any palp is to be seen; the distal ends are fringed with very short indistinct setæ, and the opposite end is notched (fig. 4). The first maxilla is simple, spoon-shaped at the end, which is fringed with setæ (fig. 5). The second maxilla is also simple, straight, and towards the end it is supplied with short teeth (fig. 6). Though this appendage, by its position, appears to correspond to the second maxilla, yet it is the only one that looks at all like a masticatory organ. If the right and left halves were rubbed longitudinally together they would, owing to the short teeth at their ends, form a most efficient triturating organ. The most posterior of the mouth organs, the maxillipedes (fig 7), are somewhat concave and operculiform, enclosing the rest of the mouth parts. The basal parts of the two halves on the two sides are anchylosed together, and to the head itself, but the terminal portions are free, and the ends, which are at some distance apart, are tipped with setæ. On each side, near the middle, is a peculiar looking small round piece, which is articulated to the rest of the limb. This may possibly represent a rudimentary exopodite, while the free terminal portion may be the endopodite of the typical Crustacean limb.

The appendages of the abdomen on each side consist of a short basal joint supporting two more or less oval branchial plates (fig. 12). In the appendages of the first abdominal segment the outer branch is much enlarged and forms an operculum over the branchial plates; the inner branch, which lies under the operculum, is narrow (fig. 11). In the view of the abdomen from below (fig. 10), the two halves of the operculum have been slightly separated from one another to show the branchial plates underneath.




SUBTERRANEAN CRUSTACEA.

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## AMPHIPODA.

### Genus **Crangonyx.**

(Brit. Mus. Cat. Amphip. Crust., p. 178).

*Crangonyx compactus*, sp. nov. Plate X., figs. 13 to 19.

Eyes not visible. Upper antennæ rather more than one-fourth the length of the body; peduncle with the first joint longer than the second, and the second longer than the third; flagellum rather longer than the peduncle; secondary appendage small and slender, consisting of one long and one short joint. Peduncle of lower antenna longer than that of the upper, the "olfactory denticle" large and prominent, last two joints of the peduncle equal in length, with their posterior edges fringed with several tufts of setæ; flagellum short, rather more than half the length of the last joint of the peduncle. Appendage of the mandible with three joints increasing in length distally, the last bearing several long setæ. Gnathopoda subequal, propodos only slightly broader than the carpus, palm about one half the length of its inferior edge, defined by a stout spine on each side. Pereiopoda subequal. Pleon having the inferior edge of the three anterior segments furnished with five or six small setæ. Three posterior pairs of pleopoda short and broad; first two biramous, third unibranched, the branch longer than the peduncle and composed of one rather long joint followed by a very small one. Telson half as long as the posterior pair of pleopoda, narrowing slightly towards the extremity which bears two short stout spines. Colour—transparent.

Length, ·3 of an inch.

*Hab.* Pump at Eyreton.

This species is readily recognized by the short stumpy appearance of the three posterior pairs of pleopoda. The secondary appendage on the upper antenna is small and very easily overlooked. On the flagellum of the upper antenna there are some "sensory setæ." These are small and cylindrical, not quite as long as the joint they are on, and they are divided by a transverse septum about the middle. On the basal portion of the flagellum there are two of these setæ on each joint, but towards the distal end there is only one on each joint.

This species is rather rare.

### Genus **Calliope.**

(Brit. Mus., Cat. Amphip. Crust., p. 148.)

*Calliope subterranea*, sp. nov. Plate IX., figs. 1 to 10.

*Female.*—Cephalon without a rostrum. Eyes absent. Upper antenna longer than the lower, about two-thirds the length of the body. The joints of the peduncle decreasing in length and breadth distally. There is a rudimentary secondary appendage only about half as long as the first joint of the flagellum. Peduncle of lower antenna equal in length to that of the upper, the last two joints equal in length. Appendage of the mandible three-jointed, the second joint larger than the first, the third short and curved. Second gnathopoda more slender than the first. Last three pairs of pereiopoda increasing in size from before backwards, the various joints being pretty abundantly supplied with stout setæ. Last three pairs of pleopoda slender, biramous, the penultimate the smallest and having the rami slightly unequal, the rami in the other two being equal. Telson short, as long as broad, the posterior border slightly concave.

*Male.*—Differs in having sensory capsules and setæ on both pairs of antennæ, and in having the gnathopoda much larger than those of the female. First pair of gnathopoda much larger than the second, propodos very large; palm broad, defined by one long and two short spines, the long one being about two-thirds the length of the finger. Second pair much smaller, palm defined by a short, stout spine. Colour—transparent.

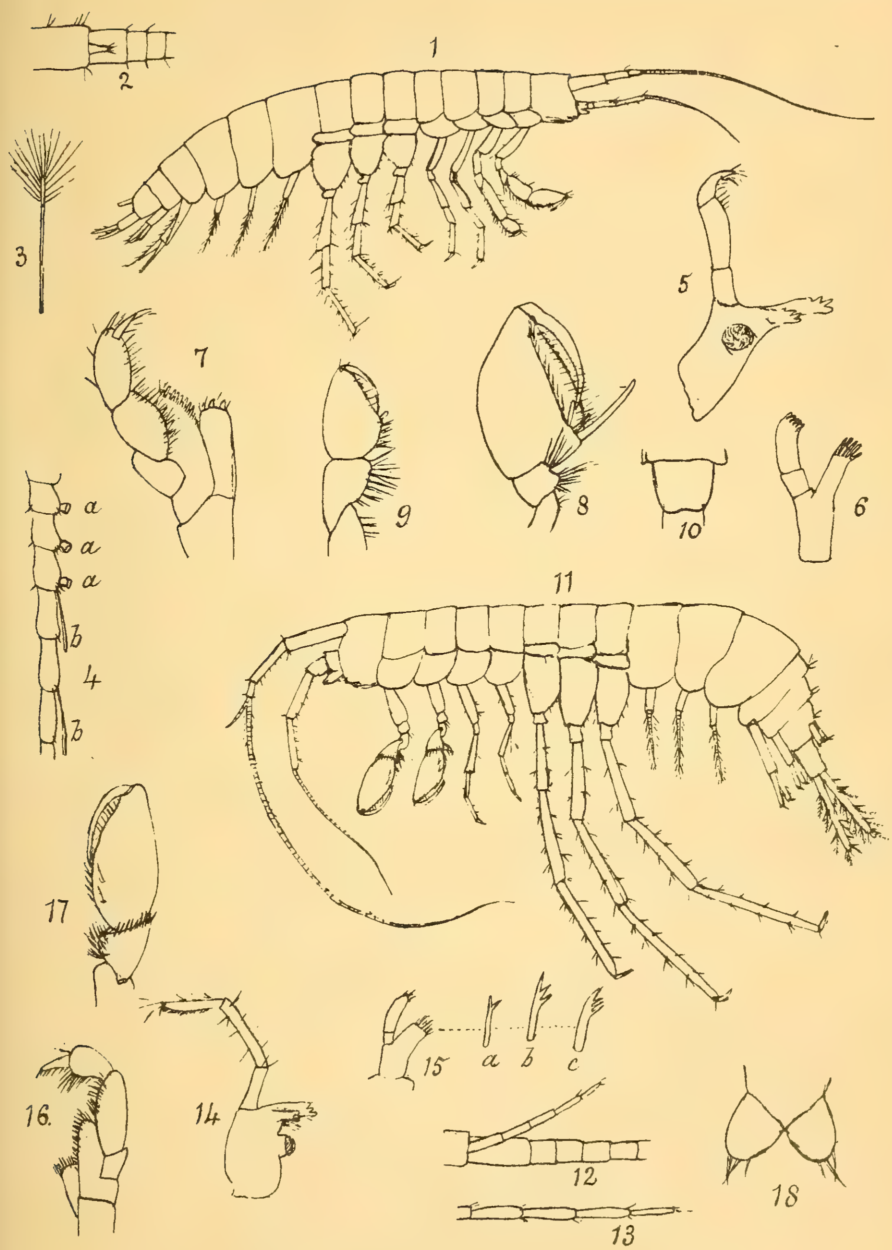
Length of female (with eggs), ·3 inch. Male (largest specimen), ·5 inch.

*Hab.* Pump at Eyreton.

This species differs from the other species of *Calliope* in the absence of eyes and in the presence of a rudimentary secondary appendage on the upper antenna, but I have not considered this sufficient to warrant its removal from the genus. The female is very abundant, but the male is rarely obtained.

The number of joints in the flagella of the two antennæ varies very much (in the female) according to the size and therefore presumably according to the age of the animal. Thus in very small specimens I found 15 joints in the flagellum of the upper antenna and 7 in the lower, while in full-sized specimens there were about 55 in the upper and 21 in the lower.

In the male, peculiar "sensory capsules" are found on both antennæ. They are to be found on the last two joints of the peduncle and on the proximal half of the flagellum of the upper antenna; on the distal half simple sensory setæ (fig. 4 *b*) are found on every other joint. The sensory capsules are also present on all the joints of the flagellum of the lower antenna except the last two or three. They are cup-shaped and slightly constricted towards the middle, and they are situated on a slight protuberance of the joint of the flagellum (fig. 4 *a*). On the peduncle of the upper antenna of the male there are other peculiar-looking setæ which are evidently sensory. They are long and slender, with several very fine divergent filaments at the distal end (fig. 3). Similar capsules and setæ




SUBTERRANEAN CRUSTACEA.

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appear to have been found in *Niphargus puteanus* by M. Alois Humbert. * The form of the mandibles, second maxilla and maxillipedes will be readily understood from the figures given.

### Genus Gammarus.

(Brit. Mus. Cat. Amphip. Crust., p. 203.)

*Gammarus fragilis*, sp. nov. Plate IX., figs. 11 to 18.

Eyes none. Superior antennæ about as long as the body ; first joint of the peduncle about as long as the next two together, the third joint being only one-third the length of the second ; secondary appendage with about five joints, the joints of the flagellum increasing considerably in length distally. Peduncle of inferior antennæ about as long as that of the upper, the last two joints equal in length with their inferior edges setose ; flagellum longer than the peduncle. Appendage of the mandible with three joints, the second being longer than the other two. Gnathopoda subequal, propodos long ovate, finger curved. Last three pairs of pereiopoda very long, increasing in length from before backwards, the last pair reaching as far as the last pair of pleopoda. Last three segments of the pleon with stout setæ on their posterior dorsal margins. Of the three posterior pairs of pleopoda the first reaches as far as the end of the second, but the third is very long ; its two branches are equal in length and supplied with numerous stout setæ and a number of delicate plumose setæ. Telson double, each part having the posterior end rounded and tipped with two or three setæ.

Colour—transparent.

Length (largest specimen), ·65 inch.

*Hab.* Pump at Eyreton.

This species is readily reeognized by the great length of the last pair of pleopoda and of the last three pairs of pereiopoda. It is not very common, but it is larger than any of the other species.

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### DESCRIPTION OF PLATE IX.

Fig. 1. *Calliope subterranea*, female, × 9.
Fig. 2. ,, ,, Base of flagellum of upper antenna showing the rudimentary secondary appendage.
Fig. 3. ,, ,, Sensory seta from peduncle of upper antenna of male.
Fig. 4. ,, ,, Portion of flagellum of upper antenna of male showing sensory capsules *a*, and sensory setæ *b*.
Fig. 5. ,, ,, Mandible.
Fig. 6. ,, ,, Second maxilla.
Fig. 7. ,, ,, Maxillipede.
Fig. 8. ,, ,, First gnathopod of male.
Fig. 9. ,, ,, Second gnathopod of male.
Fig. 10. ,, ,, Telson.

* See Ann. and Mag. Nat. Hist., ser. 4, vol. xix., 1877, p. 243.

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| Fig. 11. | *Gammarus fragilis* × 7. | | |
| Fig. 12. | ,, | ,, | Base of flagellum of upper antenna, with the secondary appendage. |
| Fig. 13. | ,, | ,, | Extremity of upper antenna. |
| Fig. 14. | ,, | ,, | Mandible. |
| Fig. 15. | ,, | ,, | Second maxilla; *a b c*, different forms of setæ from the same. |
| Fig. 16. | ,, | ,, | Maxillipede. |
| Fig. 17. | ,, | ,, | First gnathopod. |
| Fig. 18. | ,, | ,, | Telson. |

## DESCRIPTION OF PLATE X.

| | | | |
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| Fig. 1. | *Cruregens fontanus* × 7½. | | |
| Fig. 2. | ,, | ,, | Antennæ, from above. |
| Fig. 3. | ,, | ,, | Labrum. |
| Fig. 4. | ,, | ,, | Mandibles. |
| Fig. 5. | ,, | ,, | First maxilla. |
| Fig. 6. | ,, | ,, | Second maxilla. |
| Fig. 7. | ,, | ,, | Maxillipedes. |
| Fig. 8. | ,, | ,, | First thoracic leg. |
| Fig. 9. | ,, | ,, | Abdomen and telson, from above; *a*, last thoracic segment. |
| Fig. 10. | ,, | ,, | Abdomen, seen from below. |
| Fig. 11. | ,, | ,, | Appendage of first abdominal segment. |
| Fig. 12. | ,, | ,, | Branchial plates. |
| Fig. 13. | *Crangonyx compactus* × 9. | | |
| Fig. 14. | ,, | ,, | Antennæ. |
| Fig. 15. | ,, | ,, | Mandibles. |
| Fig. 16. | ,, | ,, | Maxillipede. |
| Fig. 17. | ,, | ,, | First gnathopod. |
| Fig. 18. | ,, | ,, | Telson. |
| Fig. 19. | ,, | ,, | Extremity of upper antenna showing sensory setæ *a*. |

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## Art. XXVI.—*History of Fish Culture in New Zealand.*

By W. Arthur, C.E.

[*Read before the Otago Institute, 18th February*, 1881.]

Plates XII.—XIV.

The experience of other countries, as France, Germany, England, and America, has demonstrated the fact, that the cultivation of *water*, acre for acre, can be made more profitable to a community than the cultivation of the *land*. Fish culture, begun as a scientific experiment in natural history, has expanded into a great national industry—and, with the exception of that of England, the respective Governments of the above-named nations have assisted actively by money votes, and otherwise, in this most useful work. Breeding establishments—or fish hatcheries, as the Americans call them—have been set agoing in Scotland, England, Ireland, France, Germany, Canada, and the United States—and in every case the results have been surprising. By means of ova and young fish distributed from these hatcheries, and with the assistance of wise fishery laws, duly and strictly enforced, streams and rivers where previously the yield of salmon had been steadily decreasing yearly, or had ceased altogether, have been replenished and stocked again in a surprisingly short space of time. Mr. Ashworth, in the west of Ireland, among other achievements, has actually stocked a river and lake with salmon, where no such fish ever had been or could have got before,—the principal means used being the construction of a salmon ladder to let the fish get up past an impracticable waterfall. In the United States, also, Professor Baird has reported that Canadian salmon in 1878 (the produce of fry liberated there in 1874) were seen running up the Connecticut river in hundreds, and some which were caught were as heavy as 19 lbs. in weight. He adds, that these are the first salmon seen in that river for three-quarters of a century! What then, I ask, may we not accomplish in New Zealand—but particularly in the South Island—where we have lakes, rivers, and burns of the finest water, cool, clear, and perennial? Virgin waters where no ruthless pike—the scourge of trout—lurks amid reeds and rushes—waters which even now, with our fish culture in its infancy, have yielded a return of a hundredfold. Our inland fisheries are yet destined to become a source of valuable fish supplies to our population, and our legislators therefore have a grave responsibility on their shoulders, because of their past neglect in the matter of the conservation of our rivers with their water rights; and because of the scanty and doubtful assistance given hitherto to those societies which have been struggling to people our tenantless waters with valuable food fishes.

In laying before you a record of pisciculture in New Zealand, I propose to give an epitome of the work in other countries for easy reference—next, as shortly as possible, the work done by the various Acclimatization Societies in New Zealand, in geographical order from Auckland to Southland; and lastly, I shall endeavour to describe our actual operations in fish hatching, as carried on at our breeding ponds on the Opoho Creek, immediately to the north of Dunedin; illustrated by a few drawings; as such a description may be useful, not only here but for comparison with the process and results in old countries. In addition to this arrangement, I shall attach an appendix giving results, so far as practicable, in a tabulated form, with dates when obtainable.

*Epitome of modern fish culture.*—In the year 1763 a German, named Jacobi, has been chronicled as having rediscovered the lost secret—the natural process of fish propagation—as known to Don Pinchon in the fourteenth century. For thirty years, it would appear, Jacobi practised successfully the breeding of fish, by placing the ova of salmon and trout in gravel under water, contained in wooden boxes. In 1834, in Scotland, Mr. Young at Invershin and Mr. Shaw at Drumlaurig began the same artificial process with the salmon, as an experiment to determine (as they did determine) the identity of the parr with the salmon. These experiments, with the subsequent success of the celebrated salmon ponds at Stormontfield on the River Tay (begun November, 1853), may be said to have inaugurated and given that impetus which has set agoing fish-breeding establishments in so many different parts of the world. In the year 1840, Joseph Remi, a Frenchman living on the Moselle, in ignorance of what had been long known, himself discovered by long and patient watching that the female deposited the eggs and the male fish then impregnated them. The outcome of this was the erection of the well-known French fish hatchery at Huningue, established in August, 1852. Thaddeus Norris in his work on American fish culture gives the year 1864 as that in which salmon and trout were first reared artificially in the United States. This was accomplished by Mr. Johnston of New York. Mr. Samuel Wilmot was the first to succeed in hatching out and bringing up to 1lb. in weight many of the whitefish (*Coregonus albus*). This he did in 1867 at his breeding ponds, Newcastle, Ontario, Canada; and it would appear that Canada took the lead as to time in establishing in America the now great industry of fish hatching. Mr. Wilmot in his report to the Minister of Marine and Fisheries, Ottawa, for 1878, says: "Although fish culture was not adopted as a governmental work in any of the States of the Union till after its practical application in Canada, it has nevertheless made prodigious strides since, quite eclipsing in its onward course any other country in the world. At the present time no less than twenty-seven State Legislatures enact laws and grant aid towards the encouragement and advancement of artificial fish culture, etc."

But a new era in pisciculture has been established, by the successful transport of salmon ova alive from England to Australia, in 1864. This is known as the "Norfolk" shipment, and out of it 3000 young salmon fry were hatched out in Tasmania, on the river Plenty. Many were lost in some unaccountable manner, but eventually 500 were turned into that river. Since then there have been various reports that the *Salmo salar* had returned from the sea and been identified as grilse. This may or may not be; but it should be remembered that salmon-trout were also introduced into Tasmania, and ova of the bull-trout *(S. eriox)* appears to have come by mistake among the salmon ova—these three species, at certain stages of their growth, being very difficult of distinction from one another. This much seems certain, that salmon in Tasmania are not an undoubted or complete success as yet, but the feasibility of conveying fish eggs in ice from England to Australia, through the tropics, has been abundantly demonstrated.

### Operations of the various Acclimatization Societies in New Zealand.

#### *Auckland Society.*

This society was formed by a few gentlemen in February, 1867. Four acres of land, obtained from the Domain Board of the city of Auckland, were fenced in, the ground cleared drained and planted, a house built for a curator, together with aviaries, and water was laid on.

*Prussian Carp*, the first fish introduced by this society, were obtained to the number of 114, whereof 12 were placed in the Takapuna Lake, during 1867. The advisability, or otherwise, of getting perch was also discussed at this time, as it was reported to be as objectionable as pike. Other societies have got it—whether it deserves its bad name or not—and I would only remark that I do not think it a valuable fish, unless perhaps for reservoirs.

*Brown Trout* ova were first received from the Salmon Commissioners of Tasmania in the year 1870, whereof 60 young fish hatched out, and were put into Edgecumbe's Creek, Western Springs. In subsequent years a considerable number more were distributed. (See appendix.) In 1875, *Californian Salmon* ova were introduced by the Napier Society, but the ice failed on these getting as far as Auckland, and part of the ova was accordingly left there as a precaution. Of this lot 10,000 ova were put in the upper waters of the Thames and Waikato rivers by Mr. Firth and nearly as many more retained to be hatched at the society's ponds. Only a few of the latter came to anything, and these (some hundreds) were distributed in the Thames, Wairoa, and Tauranga districts. By subsequent shipments many thousands more were liberated in the rivers.

The *Whitefish* ova *(Coregonus albus)*, in 1877, were for the first time imported from San Francisco. These proved almost a total loss; only nine fish hatched out, of which only two survived in the ponds. In 1880 better success was got, the ova being put in Lakes Taupo, Rotorua, etc.

The *American Brook Trout (Salmo fontinalis)* were introduced this year, (1877), in the form of 5000 ova. But of these 400 only came to life, whereof half were put in a tributary of the Waikato, near Cambridge, and the remaining 200 into the top waters of the Kaukapakapa stream, Kaipara district.

The *Catfish, (Pimelodes cattus)* was also obtained in 1877, by Mr. T. Russell, from America. In all 140 living fish arrived, and these were put in St. John's Lake. This fish is esteemed good eating, and may be caught by hook and line.

Besides other shipments of brown trout and Californian salmon, this society in 1871 got a direct consignment of salmon ova from England, by way of New York; but this was altogether a sad failure. The acclimatizing of salmon and of trout does not seem as yet to be a success in the province of Auckland. The temperature of its rivers and lakes is, I believe, not too high for Californian salmon (these can live in water at 83°), but I fear it is so for the brown trout. Unless in high mountain ranges, where the streams flow in a southerly direction, and other conditions are favourable to a mean temperature of 48° or 50° Fahr., it is doubtful if trout will succeed at all; or, if they do, will they thrive and propagate? I ought to mention, however, that when fishing in the Deep Stream some years ago I found its temperature up to 62° Fahr. A gentleman just arrived in Dunedin from Victoria has assured me that the trout in that colony are fat, sluggish, and give no sport when caught with rod and line. The secretary of the Auckland society, Mr. Cheeseman, F.L.S., in a letter which I received in May last, thus summarizes the results of their principal venture in fish rearing:—"With regard to trout, you will find in the report for the last year a statement of all our introductions; but I am sorry to say that we have no evidence to prove that trout exist in any of our streams at the present time. With respect to the Californian salmon, repeated statements have been made during the last year of specimens having been caught in the Thames, Waikato, and their tributaries, and it is probable that there is some foundation of truth in them, although I have not myself seen a young salmon."

*Hawke's Bay Society.*

This society, which has been at work for a number of years, has evinced considerable spirit and perseverance in the introduction and establishment of brown trout and Californian salmon, and with a fair amount of success. I cannot illustrate this better than by giving here the chief incidents of fish culture in Napier, as communicated to me by the secretary, Mr. J. N. Williams, of Hastings, on May 17th, 1880. He says:—"In reply to yours of the 20th April, I am sorry to say I cannot give you much information about fish-breeding in this district, as so little has been done, and there are no annual reports. I cannot find any record of importations previous to 1876, and it was not until the following year that any attempt was made to form regular fish-breeding ponds. This has been done by making artificial ponds, similar to those in the Christchurch gardens. These ponds are fed from two artesian wells, giving together a water supply of about fifty or sixty gallons a minute.

"The fish placed in these ponds in 1877 have done well, and are now large enough for giving ova, of which we hope to get a plentiful supply this winter.

"With the exception of 300 fish received from Christchurch, we are indebted to Otago for the whole of our *trout.* The trout placed in the Ngaruroro river have done well, and large fish have occasionally been seen. In the other streams they have not been observed as yet, as the Maraetotara, Tukituki, Mangaone, Korokipo, Porongahau, Pakowhai, Maharakiki, Maraekakaho, Upper Rangitikei, etc.

"The rivers in which the *salmon* were placed are many hundreds of miles in length, and all take their rise in a wooded, broken, uninhabited country. It is therefore scarcely a matter for surprise that no fish have been seen up to this time.*

"The attempt to import *whitefish* last year was not successful. We were informed from Wellington that, as the ova would hatch immediately on arrival, it would not be necessary to incur the expense of making the patent boxes advised by the American Government. The ova were consequently placed in the ordinary hatching trays used for trout. The fish began to come out a few hours after arrival, but did not live longer than from twenty-four to thirty-six hours. We removed numbers of the young fish to a box fed directly from the well, but with no good result, as they died just in the same way as those in the race. As an experiment, I removed the last dozen eggs left in the trays to a box fed from the well, in imitation of the American plan. These all hatched, and were observed in the box for twelve days after, but, unfortunately, owing to a defect in the arrangements, which were hastily made, the young fish then escaped into the trout pond, and were probably eaten by trout. The conclusions I have drawn from the above facts are:—That the fish died from fungus, and not from the temperature of the water, which was 54 degrees. That an attempt to hatch either trout or salmon ova in the same way in the month of January, would have been attended with equally fatal results from the cause above-named. That our climate and waters may be too warm for the successful production of whitefish, but that it yet remains to be proved.

"Enclosed you will find a statement of the fish distributed, and of the rivers in which they have been placed." (See appendix.) "Carp are plentiful in some of our lakes, but I have not considered them worthy of mention."

*Wanganui Acclimatization Society.*

The operations of this society in fish-culture, will also be best recorded in Mr. Brewer's, the secretary's, own words. Writing to me in May, 1880, he says:—"Our first successful consignment of *brown trout* arrived here

* These rivers are Ngaruroro, Mangaone, Mohaka, Tukituki, Waipawa, Manawatu.

about three years and a half ago, and were turned out in a stream about ten miles from Wanganui. The consignment consisted of 300, and they were procured from Mr. A. W. Johnson of Opawa. I have been informed by credible witnesses that they have seen specimens of good-sized fish in this stream. We have had since then about 3,000 young trout partly from Johnson and partly from the Christchurch Acclimatization Society. Our first hatching of any number took place last year, from the 4000 ova you were good enough to send, and 100 sent by Johnson as a sample. The water used for the purpose is not very good, but I succeeded in hatching out about 3600, which after they had lost their egg-sac were turned into the various streams of the district. What we consider our most valuable work, however, was the introduction of *salmon* into the Wanganui river. This river is a perfect paradise for salmon. When you get a few miles up, it flows over long shingly beds, interspersed here and there with deep, dark pools. In some places the water is not much more than three to four feet deep on the gravel beds, and in other places there are rapids, forming at their base the turbulent rocky water in which salmon delight. The only other fish except eels in this river, is the *opokaroro*, or native grayling. I was very anxious to get this river stocked, and when the last lot of ova arrived from San Francisco, about two and a half years ago, a portion of them were sent to Mr. Johnson's establishment to be hatched out. From him I got 3000 young fish, but to my intense disgust the weather came on hot and muggy, a great portion of them died, and the rest had to be turned out in Wellington to save their lives. This was disheartening, but I would not give up, but got another consignment of 3500. These luckily arrived in fair order; I had canoes with Maori crews ready, blankets well watered, rigged up over the cans, and we took them straight off the ship forty miles up the river."

"Another valuable consignment we had about three years ago, consisted of fifty dozen of *perch* from Ballarat. After being taken from the lake there, they were acclimatized for some time in the Yan Yean, at Melbourne. They were then put into canvas bags filled with water, and slung on frames on board ship. These arrived in capital order, but a few were lost by a bag bursting, and a few I believe were stolen. With a second consignment we were not so successful, only about half arriving in fair order. These fish have been used to stock the lakes in the district. We have not interfered with them at all, although the first lot were turned out some three years ago; as we thought it best to give them ample time to reproduce their species. Our fish experiments having been so recent, we are not in a position to give much reliable information; but we know that both salmon and trout have been seen, some of the latter a good size, and we hope in another year to be able to give a good account of them. It has been decided to devote more than two-thirds of our income this year to procure salmon ova from San Francisco, the whole of which, if they arrive in good order and are successfully hatched, will be put in the Wanganui river."

"The following little incident will show how easily a slight accident may mar the best efforts of those engaged in fish acclimatization, and cause them to lose all the fruits of their labours. On the arrival of the last consignment of salmon, which consisted of about 3,500 young fish, I had a canoe manned by a Maori crew all ready for the purpose of taking them some fifty miles up the Wanganui. I was accompanied by Major Nixon, a very old resident here, who was personally acquainted with the various tribes of Maoris living in the up river district, and who was much liked and respected by them. It was about midday when the fish arrived, and we started immediately. It was an exceedingly hot day, and when we came to a part of the river where the banks were high and precipitous the heat was almost unbearable. We had a framework rigged up over the cans, over which we placed blankets, leaving both ends open so as to get all the air possible. One of our party was detailed off to keep the blankets constantly wet by pouring water over them. The fish were rather sickly on arrival, caused, no doubt, by their long confinement on ship board. However, we were glad to find that in spite of the heat, thanks to the precautions we adopted, they freshened up wonderfully after a quantity of the cold river water had been put into the cans; and I had great hopes of bringing them all safely to their destination. My crew were not afraid of work and poled and paddled away until about nine o'clock, when we arrived at the pah, where we were going to stop the night. The place seemed all that could be desired on account of the fish, as, although the pah was on the top of the cliff, there was a shingly beach at the landing place, with water varying from two inches up to three or four feet. The Major explained the object of our visit to the natives. They were very much interested, and rendered us every assistance. In a few minutes we had the cans out of the canoes and placed in the river so that the water could (as I thought) flow just over the top of the cans. I thought this was splendid, and as my blankets had been carried up, I went up myself to find out what sort of a sleeping place I was going to get. I found we were to be accommodated in a large *whare*, where there were at least a dozen more, and our luxurious bed consisted of a Maori mat laid on the earthen floor. However, as I had seen a bit of campaigning in my early days, I did not think this an intolerable hardship.

The Major being deep in confab with the old chief, recounting some of the stirring scenes of olden days, and fighting their battles o'er again, I found it was of no use going to bed for a time, so lighting my pipe I strolled down to the river to have one last look at the cans. The scene was a marvellously pretty one. High precipitous cliffs clothed with dark foliage threw a dense shadow over part of the river, but the moonlight irradiated with a silvery sheen that part of the water in which the fish had been placed. It looked like a good omen, and I stood there rearing fancies, and in imagination almost saw an angler with his long rod whipping the stream, and by and bye landing one of the speckled beauties. Turning to go up again, some indefinable impulse for which I cannot account, made me stoop down and put my hand in the water, when, to my horror, I found it quite warm! I gave a yell which made the Maoris and the Major come tumbling down the declivity in double quick time, and which the latter described as being something like that of a Red Indian on the war-path. In a few seconds we had the cans in the canoes and taken into the centre of the river. Upon examining them I found the fish were just beginning to turn over on their backs, and were looking as if their last day was come. However, we got cold water in the cans from the deep part of the river, and they began to revive. We then lowered them by ropes to the river bottom and there left them, I going up to keep a lively company with the fleas, which seemed to very much appreciate a change of diet from Maori to pakeha! At the first glimmer of dawn we were up, got the cans from the river, and found the salmon as fresh as paint. Starting at once without waiting for breakfast, we had the fish all turned out at their destination by 11 o'clock, and we then camped on a gravelly shingle bed and cooked our breakfast, which I can assure you we enjoyed, in fact I myself put away nearly a whole 'billy' full of new potatoes. On returning past our first camping place I found out the reason of the water being warm. That part of the river where the canoes landed was a kind of back-water. At night it looked like a rippling stream, but in the day time you could see that there was scarcely any motion in the water. Being shut in by cliffs and a hot sun pouring on it all day, it naturally became warm, and if I had not put my hand in the water just before retiring for the night, we should have had to come back to Wanganui with the sad report that all the salmon were dead, which would, no doubt, have been attributed to our own carelessness and mismanagement. The Wanganui river flows for miles over gravelly reaches interspersed with rapids and deep dark pools, looking a very paradise for salmon and trout. A number of the latter, as well as some perch, have been put in, and we hope in a year or two more to have some good fishing."

*Wellington Society.*

Fish rearing in the province of Wellington, which was started in 1874, does not appear to have been either very extensive or very successful. I am indebted to Dr. Hector for the following summary of the work there :—

"*Trout* were liberated by the Wellington Acclimatization Society in the Kaiwarawara Creek, the Hutt River, and the Wainuiomata, in 1874. From the first they have disappeared, and in the latter they keep to the higher waters, where they get more congenial food.

"*Californian Salmon* were turned out in 1877 in the Hutt, seven miles from the sea; the Manawatu, in the gorge, thirty-five miles from the sea; Wairau, fifteen miles up; Wanganui, ten miles up. Except two doubtful fish in Wellington Harbour, nothing has yet been seen of them."

Reviewing the above somewhat statistical history of fish breeding in the North Island of New Zealand, I find that the Auckland society has taken the lead. It got the first imported fish into New Zealand, Prussian carp in 1867, but its first trout in 1870; and Californian salmon in 1875, unintentionally, however, as regards the salmon. The American brook trout and catfish have also been introduced by it. The results, however, as regards trout and salmon, as well as whitefish, are doubtful as yet. In Napier, Wanganui, and Wellington, there is every prospect, from the number of large fish seen in different rivers, that the trout *(Salmo fario)* will succeed; but as to the Californian salmon it would be premature to hazard any decided opinion, beyond repeating this, that the temperature of the rivers need not of itself operate hurtfully, as in California the adult fish at least, lives in water sometimes as high as 83°. At the same time I must observe that the best authorities say that the fry descend, or are carried down to the sea by the floods consequent on the snow melting every summer on the mountains, and as these floods are of *cold* water, we have but a partial approach here to such a condition in our rivers.

*South Island.*

In the *South Island* of New Zealand, I may say that the rearing of trout and Californian salmon, also of English salmon and sea trout, has chiefly occupied the attention of the various societies in so far as regards fish culture. And, owing no doubt to the fact of the streams discharging colder water, and that the work was begun sooner—the success has been much greater than in the North Island.

*Grey District Society.*

This society has introduced *trout (S. fario)*, and *Californian salmon, (S. quinnat)*. Of the former, several thousands of ova were got from the Otago society in the years 1878, '79, and '80. The 1879 lot was almost entirely a failure, owing I believe to the length of the voyage (some ten days) occupied by the steamer Wanganui between Port Chalmers and Greymouth—to the hot weather of October, 1879, and to the ova being considerably advanced in development when shipped. But the ova received from Dunedin, in September, 1880, arrived in splendid condition—some 4,000—which were packed in ice. I have not heard anything as to the growth of trout on the West Coast, more than that some have been seen 14 inches long. Neither as to the Californian salmon introduced in 1877, further than that the *West Coast Times* of October, 1879, reported that the Chinese whitebait fishermen had been taking numbers of young salmon in the Hokitika river. But of course this report requires confirmation. Also they are said to have been seen in the Grey river, in 1880.

### *Nelson Society.*

This society has successfully introduced the brown trout, and for several years past angling has been permitted in one or two rivers. In December, 1877, about 25,000 young Californian salmon were put into the Wairoa and Motueka rivers. In May, 1880, the Nelson society reported that their American whitefish experiment was a failure. (Parliamentary Papers for 1880). I have not been able to get any more information regarding fish culture in Nelson.

### *Marlborough Society.*

This society has worked perseveringly, since 1878, in getting fish for its rivers, and with very good prospects as to the final results, It was formed in the year 1874, and began operations by introducing birds. Regarding fish breeding, the secretary, Mr. Paul, has communicated the following in May of this year. "Up to the year 1878, no systematic attempts had been made to introduce fish. H. Redwood, Esq., of Spring Creek, had brought from Christchurch, in 1876, 200 *young trout*. For three years it was doubtful whether they had survived; the river they were placed in being fed by water which is filtered underground, through shingle, for some considerable distance. The matter, however, is now placed beyond doubt. Several fish of about two pounds weight have been seen, which means that a considerable number have survived. In 1878 the society procured from Dunedin 3,000 ova. Of these only 700 were reared, owing, we believe, to the very advanced stage in which they were received—they were hatched out a few hours after arrival. These were fed on raw liver forced through a colander, for about four months, and then liberated.

"In the beginning of the same year 500 young American *salmon*, part of a Government shipment, were received.

"A few of the young fish of 1878 have been seen, but nothing is known of the fate of the salmon. Last year we procured 800 young fish from Nelson and 9,000 ova (trout) from Dunedin. We were more successful in the hatching than on the previous occasion, obtaining about 70 per cent. of live fish. These were distributed in eighteen different small streams, as well as in the three large rivers of this portion of the province. The native trout and eels are very plentiful in our rivers, and *kawai* ascend some six miles from the sea, making the natural enemies of the *Salmonidæ*, in their early stages of growth, masters of the situation. We do not, therefore, intend to relax our efforts in propagation, until we are certain that there are in the rivers such numbers of trout and salmon as will keep the native fish in check.

"So far as we can learn, the trout are the English lake trout * which attain a large size, but we are not able as yet to give any information as to the quality of the fish.

"There is no portion of the colony so well watered in comparison with its extent as the plain of the Wairau, on which the chief town Blenheim is situated. The principal river is the Wairau; besides there are the Opawa, Omaka, and Waihopai, all excellent trout streams, with innumerable mountain rivulets. In other valleys of the province are the Pelorus, in which 200 trout and 200 American salmon have been placed. The head waters of the Awatere received 200; the river itself, from the large quantities of floating clay it holds in solution, not being considered suitable. Flaxburne, further south, received 300; besides these, there is the Clarence, a very rapid and large river, which we have not been able to reach as yet. The plain of the Wairau is a large alluvial deposit of about 120 square miles in extent. The portion adjacent to Cook Strait, about 80 square miles, is very flat and more or less subject to be flooded. Being only a few feet above sea-level, the river and its branch the Opawa, get backed up by the tide for a distance of eight miles from the sea. This extent of water swarms with trout feed—large quantities of whitebait also ascend the rivers at the season in which salmon would ascend for spawning. In fact the amount of feed is unlimited, and what is a danger now, will be of great benefit in the future, when we get trout and salmon well established. In the meantime the young fish run great risks, and hence our endeavours to place them in the mountain streams, where they will not run so much risk. We therefore intend to make an effort to procure ova every year, until complete success is ascertained.

"We hatched the ova in long narrow boxes, partially filled with clean gravel and fed by an artesian well. To these was attached a long wooden tank, 10 feet long, 4 feet wide, and 3 feet deep. The water always remained uniformly cool and pure. We attribute the deaths (about thirty per cent.

* This is a mistake, the original ova were from tributaries of the Thames and from the Itchen.—W.A.

last season) to the imperfect aeration of the water in the large tank. It was remarked that when the fish came to the surface they had great difficulty in descending again. Many died in this state, and the distention of the abdomen led us to believe that the water required more air. A few died from fungoid growth on the gills. This is probably a blood disease, from impure or insufficient oxidation of the blood. We intend to experiment next season, in order to find out the cause of such a large percentage of deaths, and remove it if possible.

"So far as feeding went, we found the raw liver answer very well. Two of our members of committee, who are large farmers, and kill a considerable number of sheep, built some small tanks and fed a few hundred trout each on maggots from the sheepskins. It was surprising to see the avidity with which the young fry seized them. These did much better than those fed in the central pond; but they had a much better flow of water, so that it would not be safe to predicate that the difference in success resulted from the manner of feeding."

*Canterbury Acclimatization Society.*

The records of *trout* rearing in Canterbury do not appear to be so complete and accurate as they might have been. However, from some Annual Reports, and a pamphlet on "Trout Culture" in Canterbury, by Mr. S. C. Farr, kindly sent me by that gentleman, I am enabled to give a condensed statement of what has been done.

I find that, in 1867, the Salmon Commissioners of Tasmania placed 800 *trout* ova at the disposal of the Canterbury society. These were brought from Tasmania to Christchurch by Mr. Johnson, the society's curator, but although apparently packed very carefully in ice, when placed in the hatching boxes at Christchurch, in September of above year, only three hatched out. By some fatality, these three young fish escaped, and although two were captured by Mr. Hill, in a "box-race," their subsequent existence seems involved in much doubt, as nothing in the form of a report now exists. Altogether, this experiment was a failure.* The consignment of trout ova, however, in 1868, from Tasmania, through the Otago society, seems to have been under better guidance, as 433 young trout were reared and distributed in such rivers as the Avon, Heathcote, Little Rakaia, etc., and in Lake Coleridge. Other lots of ova were obtained from the same source, also from trout kept in confinement at the society's ponds; so that now (1880) the waters of Canterbury may be said to be fairly stocked with *Salmo fario*. But how have they thriven in their new habitat?

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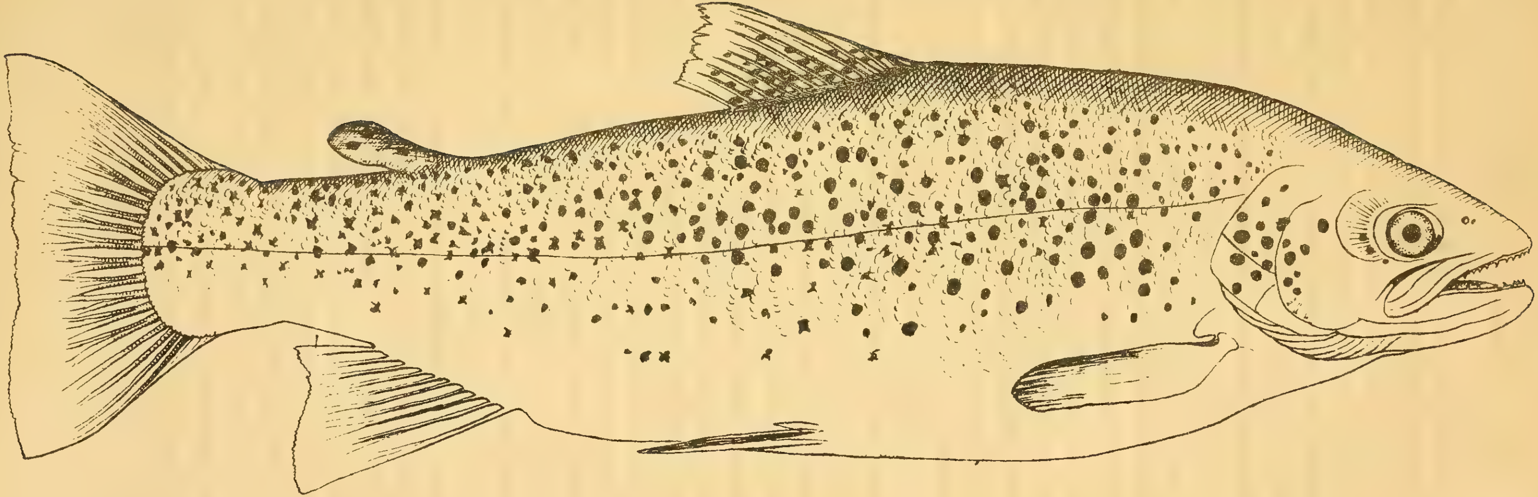
* The water used for hatching at the ponds was got from an artesian well, I believe, in Christchurch.



FEMALE TROUT, (*Salmo fario.*)
4/5. nat. size.

W. Arthur, del.

From year to year since 1876 they have been found to be so numerous and to have attained so great a size that angling has not only been permitted but some very excellent baskets of trout have been taken in the Avon and the Cust. In fact there could be hardly finer fishing anywhere—so far as numbers and weight go—the local Press during the season publishing almost daily an account of the success of some keen angler. In 1877, Mr. Farr states that he saw trout which weighed 11lbs. and 14lbs., and had heard of others weighing 20lbs.; and a Christchurch paper of November 24th, 1880, has the following:—" A trout weighing 21lbs. was caught in the River Avon yesterday." I could easily add other cases of heavy trout being caught, but these will suffice to show the rate at which brown trout have gained weight in the Avon and the Cust. Supposing the heaviest of these fish to be one of those hatched out in 1868, then it shows an average yearly growth of 1¾lbs. This indicates the capacity of the particular breed to become heavy, and the present excellence of the food supply.

As to the trout in Lake Coleridge, I have heard that they have done well, but I have no corroborative facts in my possession in support of this.

*Salmon (British).*—Two boxes of salmon ova brought from England to Melbourne, as part of a large shipment by the "s.s. Durham," were obtained by the Canterbury society from Mr. Macandrew, of Otago. These were received at Lyttelton in April, 1876, but only 175 ova appear to have hatched out, which were placed in the river Ashley in 1878. Nothing is to be found in any of the society's reports, showing whether these English salmon have survived or not, so their fate is involved in doubt as yet.

But the Californian salmon (*Salmo quinnat*) introduced from San Francisco in November 1876, and in the following year, appear to have been a great success, so far at least as hatching out the ova and distributing the young fish go. About 80,000 ova altogether were hatched, and 65,000 parr liberated in different rivers of Canterbury, these rivers being the Waimakariri, Rangitata, Shag, Hurunui, Heathcote, Ashley, Opihi and Little Rakaia. As usual rumours have arisen from time to time regarding specimens of these salmon having been taken in the rivers. It was reserved, however, for Dr. Campbell and other members of the society to put the question to the test. Provided with the proper authority from the Governor they netted the Cam, a branch of the Waimakariri river, in July, 1880, and succeeded in getting three salmon from 5 to 8lbs. in weight. These were compared and found to be identical with the specimens of *Salmo quinnat* confined in the society's ponds, and which had been retained there from the original hatching of Californian salmon. At the same time, curiously enough, a gentleman happened to be in Christchurch who had been engaged for years on "Canneries" on the west coast of America. He was shown the fish in Dr. Campbell's surgery, and identified them as Californian salmon. This, however, is scarcely proof of identity of species or genus. But from a description and drawing (fig. 1, one-fourth nat. size) of part of the 8lb. fish sent me through Dr. Campbell, I have had no difficulty in recognizing it as of the genus *Oncorhynchus*, the distinguishing feature in which is the possession of more than 14 rays in the anal fin (Günther); but there are not enough data in my possession to determine the species. The *Salmo quinnat* is the species said to have come here, and it is of the genus *Oncorhynchus*, quite a distinct fish from the *Salmo salar*. The fin rays in this specimen (which has been preserved) are these:—

D.13—P.16—V.9—A.15—C.19.

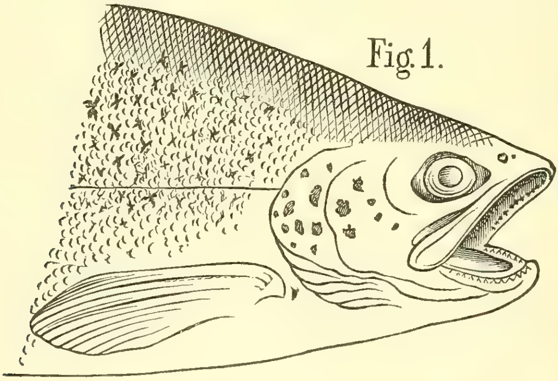


Fig. 1.

*Coregonus albus* (American whitefish).—In February, 1878, 20,000 ova of this fish were received from San Francisco through the New Zealand Government, whereof 12 hatched out, and 8 survived, which were placed in a tributary of Lake Coleridge by Sir J. Cracroft Wilson. Very much better results attended the next experiment in January, 1880, when 500,000 ova, less bad ones, were placed in the hatching boxes at Christchurch, immediately on their being landed from San Francisco, January 17th. Hatching began on the 20th, and ended on the 29th, the temperature, by means of ice in the water, being kept at 54°. The number hatched out was estimated at 50,000, but great numbers died from fungoid disease. These were removed daily until February 24th, when about 25,000 remained. The race water used averaged 56° Fahr. On February 24th, these fish, by the society's admirable arrangements, and under the care of the Messrs. Farr and Sir Cracroft Wilson, were successfully conveyed from Christchurch by rail and buggy to Lake Coleridge in twelve hours, and there liberated, only 200 being lost *en route*. Two cans, of the capacity of six gallons each, were used, and these put inside larger ones, the space between filled with water, the temperature of which was kept low by ice. Blood was used to feed the fish from the first. Describing the liberation of these whitefish, Mr. Farr says, "looking after them for a few seconds, we noticed that they took a spiral course to the depth of about eight inches, then dived suddenly downwards, and were lost to sight in the deep azure water." "The temperature of the water at the surface was 60°, and at 50 feet it was 59°." Of other fish, I find that *perch* were obtained from Hobart Town prior to 1877, but owing to their not thriving in the gardens, it was determined to turn them out in the Heathcote river. *Tench*, also *goldfish*, were obtained and reared; 20 of the former and 26 of the latter being in the society's possession in 1879.

*Otago Acclimatization Society.*

This society, which was founded in January, 1864, devoted its efforts for some years to procuring English insectivorous and song birds, wherein great success was attained. But in 1868 it sent its manager, Mr. Clifford, to Tasmania, who got from the Salmon Commissioners there, 800 ova of the *trout (Salmo fario)* as mentioned in my paper on Brown Trout, read before this Institute in July, 1878.* A subsequent lot of 1000 was obtained in the following year from the same source, and both were very successfully hatched at the society's ponds at Opoho, by or under the immediate care of Mr. Clifford; 720 of the former, and nearly all the latter, being hatched out. In July, 1870, Mr. Clifford brought from Tasmania fully 1000 ova of brown trout, and 140 ova of the sea-trout, and successfully hatched out at the society's ponds every ovum. No such feat had ever before been achieved in fish-culture, so far as I have read or seen. These young trout formed the original stock, from which most of the streams in Otago may now be said to be stocked in measure.* I should, however, mention here that a previous lot of 400 ova brought from Tasmania for the Otago society, in September, 1867, by Mr. Johnson, Curator to the Canterbury Acclimatization Society, proved to be all dead on arrival in Dunedin. The original trout ova from England, brought successfully to Tasmania, were obtained from the river Weycombe, Buckinghamshire, and the Wey and Itchen, Hampshire. Our brown trout are descendants of these, but I have not been able to trace the identity further, nor to find out more than that all the ova from the above three English streams did not hatch out equally well in Tasmania.

* For a list of streams in which brown trout have been put, see paper "On Brown Trout in Otago," "Trans. N.Z. Inst.," vol. xi., p. 208. But nearly every river and stream has received some.

Since 1868, and up to the end of 1880 the society has distributed about 110,390 trout ova to different provinces in the North and South Islands of New Zealand. For the season of 1880 just past, there were 57,500 thus disposed of. The method of packing these, recently and successfully carried out by Mr. Deans, has been in small deal boxes about 15 inches square by 6 inches deep. A good layer of soft damp moss is laid on the bottom, which carries a layer of eggs or ova of the trout, with gauze above and below. On the top of these eggs another layer of wet moss is carefully spread, then another layer of eggs, and so on, the top being well protected by moss; also the sides of the box. Not more than three layers of eggs are at any time put into one box, as it has been found, or is believed, that too much pressure is injurious and often fatal. A top of deal is then screwed on, having a hole in it, there being one or two also in the bottom. Two or more boxes of ova thus packed are then secured inside of a larger box or case. They rest on sawdust, and the spaces—two to three inches—left clear at the sides are also filled with sawdust, a bag containing the same non-conductor of heat being spread out flat on the top of the ova boxes. Next the lid of the larger box or case is screwed down—which also with the bottom of this box has several holes for the passage of water. Of cold fresh water a couple of pints daily, during the transit of the ova, are poured through the hole in the cover to keep the moss wet and cold. We have found the ova has carried thus for a week or eight days successfully to places as far off as Napier and Auckland. But during this last season ice has been used, a sufficient quantity being packed on top of the ova boxes. The result has been eminently good, not five per cent. of the ova having gone bad. I may add that our system is just a modification of the American plan, and as I think an improvement on it. The Americans use scrim or gauze to separate each layer from the moss, and pack six or seven layers thus with moss between, one on top of the other. This causes too much weight to come on the lower tiers of eggs, and consequently losses are increased.

Of young trout distributed throughout Otago during the same period, I find from the society's records that 150,000 have been put into 150 streams, rivers, and lakes; whereof about 40,000 were turned out from January to end of December, 1880. These trout have in the Shag River, Water of Leith, Fulton's Creek, Lee and Deep Streams, Waiwera, Kuriwao, Teviot, and about Lake Wakatipu and Hayes Lake, increased enormously in numbers, and that in the face of losses caused by such enemies as shags, ducks, eels, large trout, bad floods during spawning time, poaching, and so on. In many other waters they have also increased and established themselves, but not to so great an extent as in those above-named. Into the Deep Stream 100, and into the Lee 98 young trout were turned in 1869, and no additions have been sent to these at any time (till lately, when some were sent to the Lee), yet these rivers are full of trout! As to the growth of these trout I may give the following facts: in December, 1879, I caught trout in the Oamarama weighing 5lbs. each. I also hooked and played for half-an-hour (in company with Mr. J. A. Connell) a trout which I know must have weighed about 8lbs., but which was lost in netting. Trout were first put into this stream in 1875. One of the young Messrs. Grieves of Rocklands station, in February or March, 1880, caught a trout in the Upper Taieri which weighed 20lbs.; and Mr. John Roberts informs me that his shepherds have seen them 30lbs. weight, and have caught and weighed them a good deal over 20lbs. Trout were first put into this river in 1870. Now supposing the 5lb. and 20lb. fish to be survivors of the original stock in these two rivers, their yearly growth shows an increase at the rate of 1¼lb. and 2lbs. respectively! This is a wonderful rate, and shows that at the present time there must be abundant and suitable food in the two streams I have selected for examples. (See specimen of a trout, pl. XII). In my previous paper already alluded to, I stated that I found the rate of growth from 1lb. to 2¾lbs., according to the stream the specimens were taken from.

*Salmo umbla* (the charr).—Of this fish 1,000 ova were presented to the Otago society, and arrived in the "Timaru" in April, 1875. Of these, 300 hatched out at the ponds. From a growth on the umbilical bag many died, and of the twelve left at last, the whole lot escaped, and have disappeared in the Opoho Creek.

*The English salmon (Salmo salar)* was successfully introduced to Otago in 1868, by the Provincial Government. The ova came out in the "Celestial Queen," having been taken from Tweed and Tay salmon, Severn Salmon, and Irish salmon. Messrs. Youl and Ramsbottom appear to have had most to do in England with the collection and despatch of these ova—numbering 200,000. The ship got to Port Chalmers on 2nd May, 1868, after a very long passage of 107 days; the ova, together with those of sea trout, brown trout, and *Salmo umbla* (the charr), and some live gudgeon, carp, and tench, with some English oysters, having been put under the charge of Mr. Dawbin. The live fish all died on board, and the ova of the fish just mentioned, excepting those of the salmon, appear all to have died also. (Of the oysters two only survived, and these were given to Mr. Seaton, Portobello, to plant in the bay). The numbers shipped were, sea trout, 1,500 ova; brown trout, 1,500; and *Salmo umbla*, 6,000. The trout ova were along with those of the *Salmo umbla* given to the Acclimatization Society to hatch out at Opoho; but, though every care was taken, they all died. The salmon and sea trout ova were sent round by sea to the breeding ponds erected at that time on the Waiwera stream, and all arrived safely. Mr. Dawbin put about 40,000 good salmon ova into the hatching boxes, and the sea trout ova. The result of this experiment is now a matter of history. About 1,500 were reared as far as the smolt stage (specimens of these may now be seen in the Otago Museum), when they became greatly reduced in numbers by escaping into the Waiwera, and by the depredations of shags. At the last the remainder, only 250 in number, were turned out into the river Waiwera by Mr. Dawbin in 1869, and none have ever been seen again, while it is almost certain now that none ever will. Thus ended miserably that large venture in the acclimatizing of the English salmon; and in reviewing the operations, at this distance of time, I am of the same opinion as then, that the Government acted very unwisely in the selection of a tributary of the Molyneux, polluted as the latter was and is by "tailings" from the gold diggings, as the best stream into which to put the young of the salmon. The Aparima, or even the Wyndham, would have been far more likely rivers in which success might have been reckoned on.

Subsequent shipments from England by steamers *viâ* Melbourne, were more successful, (although one or two were wholly failures). The ova in these former cases were entrusted to Mr. Howard, of the Wallacetown Salmon Ponds, near Invercargill, an enthusiast, and a well informed man in fish culture, and this important trust was not misplaced. Of the "Oberon" shipment, 96 young English salmon smolts were put into the Aparima, or a pond adjoining it, in 1874. In 1876, of the "Durham" shipment, 1,400 were liberated in the same river; and of that by the "Chimborazo," 2,500 were growing in the boxes in June, 1878, these being afterwards, I believe, turned out in the same river. The first of the above ova were got from the rivers Severn, Tweed, Tyne, Ribble and Hodder, the second from the Ribble, Hodder, Lune, Severn, and Dart, and the last from the Tyne, Avon, and Lune. I am indebted to Mr. Howard for these particulars. From the printed report of the "Durham" lot, it would appear that the ova packed in *Sphagnum* moss by Mr. Buckland, arrived in far better condition than those sent in common moss, and which were packed by Mr. Youl. The latter was covered with mould, while the former moss was found to be perfectly clean and free from fungoid growths. For two years past I have occasionally received information from Riverton residents that young salmon had been seen in the estuary of the Aparima. And lately, Mr. Ellis, of Merrivale, made particular enquiries, and assured me there could be no doubt of the fact, for he knew a party who had bought from fishermen young salmon and eaten them! On the other hand Mr. Howard went specially to Riverton to try and settle the question, and he has kindly written to me that as yet there is in his opinion no proof of the return of salmon to the above river. Under these circumstances, it must be admitted that we have no certainty of the fish referred to being salmon. At the same time no better river in New Zealand could have been fixed on for salmon "planting," than the Aparima. There is nothing more to add here but to explain that Mr. Howard's experiments were conducted under directions, first of the Salmon Commissioners of Southland, and latterly by those of the Colonial Government—the Otago society not having had anything to do in the matter.

*Sea trout (S. trutta).* Of these, 140 ova were brought from Tasmania, in July, 1870. From these 80 young fish were put into the Shag river by Mr. Young, in 1871. Also Mr. A. C. Begg informs me that some sea trout were put into the Water of Leith, about the same time, by Mr. George Duncan. I have tried to find from what river in England the original ova sent to Tasmania, came, but the secretary to the Salmon Commissioners there, assures me that he cannot now possibly find any record of this fact. This valuable fish has, however, thriven well in Otago Harbour and along the coast to the north, as specimens from 1 lb. up to 20lbs. have been taken by fishermen, and many are still taken illegally. It is, however, curious that no undoubted sea trout has as yet been caught, or found spawning, in any of our rivers. The number of ova of sea trout brought from Tasmania by Mr. Clifford in July, 1870, was 140, and he succeeded in rearing every one! Of these 134 were sent to Mr. Young on December 22nd, 1870, and put into his pond at Palmerston.

The *Californian salmon* (*Salmo quinnat*, or *Oncorhynchus quinnat*) was first introduced into Otago by the Colonial Government of New Zealand from San Francisco. A box supposed to contain 50,000 ova was presented to the Otago society by the Government, and this got to Port Chalmers on 7th November, 1877, by the s.s. "Taupo." One lesser box containing the ova was found inclosed in the larger one, surrounded by sawdust, and having a pad of the same on top. Ice had been used to keep the temperature low and the moss wet all the voyage. The ova, in seven layers in the ova-box, lay each between two webs of scrim, supported on moss and covered by the same. The ova on examination were found healthy-looking; only from two to five per cent., I estimate, were actually dead, and these were often found in clusters adhering to the cotton web. The bad eggs were either white or variegated white and red, while the healthy ones had a fine dark pink colour, and were transparent or comparatively so. On opening the boxes I found the temperature of the moss to be 47° Fahr., of the melted ice 40°, of the air 52°. The water in the filter supplying the hatching-boxes stood at 50°, and the water in the troughs or hatching-boxes themselves, reduced by ice, showed the temperature of 48° when the ova were placed in them. The following morning at 6.30 o'clock, I found the air at the hatching-boxes, Opoho, to read 44°, and the water 47° in the boxes.

For the first four days many ova died, but others began to hatch, and this operation was completed in a fortnight. Only 15,000 ova, however, were estimated to be the result, so there could not have been the full number as supposed in the box. Of these, 2,000 were deformed and died, and the 13,000 survivors were put into the Kakanui river in January, 1878, being then very vigorous, and about 2½ inches long each. Nothing has been seen or heard of them since.

The *whitefish* (*Coregonus albus*) were brought from San Francisco by the New Zealand Government, and on 21st February, 1878, two boxes were presented to our society, one to be handed to the Oamaru society if applied for. On opening one box at the Opoho ponds we found the ova all dead or hatched out, so the other box was opened to endeavour to save some few ova if not too late. There were many good eggs in this box, out of which we succeeded in hatching about 1,000 young whitefish. The two boxes were supposed to contain 50,000 eggs each, and on being opened I found the temperature of the moss 46° Fahr., of the water flowing from the creek into the hatching-house 54°, and of the water in the hatching-boxes themselves 53°. (See table of temperatures in the Appendix.) The young fish were hatching out as the eggs were being put into the hatching-boxes, and came out in one day or two. On 19th March Mr. Deans started with the young fish for Lake Wanaka, but they all unfortunately died ere he got half way. Probably they were neither old enough nor strong enough to stand the journey. During hatching water varied from 49° to 57°, and when a week old the young fish were fed with blood. In the case of the last shipment sent us in January, 1880, we had the boxes conveyed straight from the Bluff to our hatching-boxes, near Queenstown, Lake Wakatipu, on the 19th. The water used was from a cold spring, but no gravel was put in the boxes, which were covered over to exclude light, and an awning formed a roof for the hatching place. The ova were hatching when put into the water, which had a temperature of 48° to 52°, but none lived longer than thirty-six hours. Mr. Deans observed that some of the fish before they died appeared to have fungus, the tails getting quite white in appearance. So great was the mortality that Mr. Deans turned them all out into Lake Wakatipu, part at Beach Bay and part at Half-way Bay, 21st January, 1880, but nothing more has been seen of them. The surface water of the lake had a temperature of about 56°. Dr. Black kindly made an analysis of the water of this spring used at Queenstown, also of Wakatipu and of Opoho water, with this result:—

*Organic matter in solution.*

| | |
|---|---|
| Rowell's spring .. .. .. .. .. .. .. | 1·1 grs. per gal. |
| Wakatipu .. .. .. .. .. .. .. | 0·5 ,, |
| Opoho .. .. .. .. .. .. .. | 2·3 ,, |

*Degrees of hardness.*

| | | |
|---|---|---|
| Rowell's | 7·1 degrees, hardish | |
| Wakatipu | 3·1 „ | very soft |
| Opoho | 3·6 „ | „ |

*For table salt.*

| | |
|---|---|
| Rowell's | A very little |
| Wakatipu | Scarcely a trace |
| Opoho | A little more than average |

Of other fish, I find that *perch*, 21 in number out of 24 got from Tasmania in 1868 by Mr. Clifford, survived the voyage, and these were put into the Water Company's reservoir, Dunedin. They have thriven so well that numbers have, during succeeding years, been transferred to various lakes and lagoons, as the Waihola and Wakatipu lakes, and lagoons at Tomahawk, West Taieri, Clutha, Gore, etc. *Tench* and *goldfish* were also introduced about this time, and some of these are now in the society's ponds at the Botanic Gardens. The first tench, 18 in number, were put into the Dunedin reservoir in 1868. Mr. Worthington at Queenstown has reared successfully many thousands of young trout during the last few years, and distributed them in various rivers there.

*Southland Society.*

*Brown trout*, 400 in number, were got by this society in 1868, through the Otago society, from Tasmania. They formed the parent stock at the Wallacetown salmon ponds, whence the young fish were distributed in numerous rivers and streams of Southland to the number of 9,944 from 1869 to 1876.* Such of the breeding fish as had been confined to the ponds for a number of years grew to a great weight (10lbs. in some cases), but otherwise they were not healthy. Fungus attacked them, which, though temporarily cured by dipping in salt water, carried off a number subsequently, so that Mr. Howard deemed it best to liberate the most of the remainder in the Makarewa river. The water supplying the ponds is obtained from a spring flowing out of a shingly terrace beside Mr. Howard's house, and close to the ponds. It is difficult to account for the disease just mentioned developing itself in apparently strong fish; and the report of the Commissioners on the salmon disease in England at present throws very little light on its *cause*. It appears at the same time that the germs of this fungoid growth are present more or less in all waters, and that if the individual salmon is not in sufficiently vigorous condition, it is very liable to contract the disease. This disease also it seems shows itself first on the bare or scaleless parts, as the gill-covers, fins, etc. Thorough

* The chief rivers stocked are Waiau, Waihopai, Waikiwi, Puni, Oreti, Centre Creek, Eyre Creek, Makarewa, Winton, Upper Mataura, Benmore, Otemaiti, Waimatuku, and Morley.

aeration of water is an essential to the health and even life of the *Salmonidæ*. It is fair, therefore, I think to assume that the proximate causes of the appearance of fungus on these breeding fish were want of sufficient aeration of the spring water, and a diminution of constitutional vigour due to their confinement. On the other hand I must state that I had this spring water analyzed by Dr. Black, of the Otago University, when nothing at all injurious to fish life could be discovered in it. Also that fish have been confined in wells where they seemed to live without any discomfort or ailments. Yarrell gives, for instance, the case of a trout which was kept in a well on Dumbarton Castle, where it lived for 28 years, each detachment of troops when stationed there being careful in feeding and protecting it. My opinion, therefore, as expressed above, I give with diffidence; at the same time I believe there is some truth in it.

*Sea trout.*—The Salmon Trustees report that the fry bred in 1870 spawned in 1875. In the year 1876 there were 850 put into the Oreti river (ten large fish being retained at the Wallacetown ponds).

In *English salmon* rearing Mr. Howard bears off the palm as the most successful of any in New Zealand who have tried it. The results of his care and skill at the Wallacetown ponds I have already chronicled above, so I need not repeat them here, further than this, that if these fish succeed in the Aparima, Mr. Howard will have been the means of securing to posterity in New Zealand the finest fish ever brought here.

Of *Californian salmon* there were reared and distributed by the same gentleman, many thousands. In 1876–7 he liberated in Shag Creek 3,600, Winton Creek, 1,200, and Irthing, 12,800, these streams being tributaries of the Oreti River. And in the season 1877–8, he put into the Oreti River 35,000; in the Makarewa, 18,000; and in the Waipahi, 10,000. Reports have reached me of strange fish having been seen in the Oreti, in the summer of 1880, but there is no evidence whatever that they were salmon. On 1st May, 1877, Dr. Hector liberated about 500 healthy young Californian salmon in Revolver Bay, Preservation Inlet. In February, 1878, Dr. Hector was also successful in hatching some hundreds of American *whitefish ova* in a stream at the Te Anau Lake, but nothing has since been seen of these fish. In January, 1880, Mr. Howard had a great many hatched out in Lake Wakatipu, but these died, and the rest were turned adrift in the Frankton arm of the lake.

The efforts of the Southland society appear to have ceased in 1875, the subsequent distributions of young fish having been under the direction of the Salmon Trustees, or Trustees under the "Southland Acclimatization Grant Act," and latterly under the orders of the Government, Mr. Howard being entrusted with the actual operations.

The success of the brown trout in such rivers of Southland as the Waimatuku, Makarewa, Oreti, Waikiwi, Waihopai, and Puni has not been very decided as yet. Whether it will be in the future is a matter of some uncertainty.

In reviewing the operations of the various societies in the South Island of New Zealand, it is manifest that they have given better results than those obtained by the societies in the North Island, and that probably for the reasons already given above. In the case of the whitefish ova in 1880 the Canterbury society alone were successful, and it is significant that they only of all the societies fed the young fish with blood from the first. Of private individuals who have done a great deal with their own breeding ponds in fish culture, Mr. Johnson, of Opawa, Canterbury, and Mr. W. A. Young, of Palmerston, Otago, have specially distinguished themselves. Mr. Young in past years has reared and liberated in different streams many thousands of trout.

*Fish hatching, as practised in Otago with Trout Ova.*

This interesting process, in pursuance of the arrangement proposed in the beginning of this paper, I will now endeavour to describe. As at home so here, the winter season is that during which we find our acclimatized trout effect their spawning. Or rather I should say that while trout in England and Scotland spawn in October and November, we find that in Otago they do so later, that is from the latter end of June to the end of July, and sometimes on to the middle of August, which months correspond to December, January, and February in Britain. Previous to the winters of 1879 and 1880, besides ova taken from spawning fish in the Water of Leith, ova had been got from the natural spawning beds or "ridds" in Lovell's Creek, Fulton's Creek, Lee Stream, and Shag River. This was done by the Acclimatization Society, by whom the trout were introduced, and who have power by law so to do; Mr. Clifford, the original and successful acclimatizer of these fish, being now succeeded by Mr. Deans, the society's manager, a most careful and trustworthy operator. But during the winters of 1879 and 1880 the ova have been entirely got from fish caught in the Leith.

*The spawning fish.* A mild night, without moon but not too dark, and the water clear, are the most favourable conditions under which the fish may be taken. Provided with a lantern throwing a good strong light, attached to a waist belt or carried in the left hand, a large scoop net in the right hand, and his legs enveloped in gum boots or waders, the manager quietly enters the bottom of a pool. His attendant, carrying a large metal bath or tub for transport of the fish, moves along the bank of the Leith, and keeps near him. On approach, a fish, which can readily be seen by an experienced person, moves up stream, slowly, however, as compared with what its movements in daylight would be. By quickness the net can generally be passed under the fish ere it can get away, and should the fish be near spawning or milting, it is at once transferred to the tub with a sufficient supply of water. Thus confined the trout shows considerable restlessness at first, but gets soon more reconciled seemingly to its novel habitation, as it becomes more quiescent. But should the fish when taken not be near maturity or ready to propagate, it is returned to the river for a time. Working thus up stream, pool by pool, and stream by stream, so much only of the river is gone over as gives a number of fish sufficient to transport in the tub. When this is attained, Mr. Deans and his man carry the tub and its contents carefully to an enclosed stream or small pond, within the gardens. This is called the "hospital" or the "lying-in pond," and there the milters and spawners are kept till ripe or ready for stripping. More than a score of trout, some 10 lbs. to 12 lbs. weight, have thus been caught on a good night, but some nights scarcely a fish can be seen or taken in the Water of Leith. A deep hole with a weir and apron below Anderson's flour mill, is a favourite resort where numbers of large fish congregate.

As regards the greater ease of taking fish by a lantern or torch at night, than without that and during daylight, it has long been held as an opinion that the fish become so dazzled or dazed by the light as to be incapable of swimming away. From my own observations, however, when assisting in the capture of trout in the Leith, I can only admit that the above opinion is partially correct. The light appears (particularly when a dark-lantern is used) to rivet the attention or eyesight of the fish, to the exclusion of the darker body of the man, so that but for the motion of the light the fish would probably not recognize its danger. But as the light moves, so does the fish, and should the rays fall on part of the man's body or on the net, its motion is quickened, and it makes off.

The proportion of males are few compared with the number of female fish captured, so far as I have seen. Thus I was present on the 10th of July last at a stripping of trout at the lying-in pond, when only three or four males were got, while there were twenty-four females handled! So also in angling I always catch far more females than males, as on March 26th, 1880, out of thirteen trout I caught in the Deep Stream on that day and the following one, there were not more than two undoubted males. In connection with this I may refer to the fact that some years ago I and others caught *male* trout in the Lee Stream, which were lean and emaciated and evidently wasting away from some unexplained cause. That cause was certainly not want of power or inclination to feed, as they took the fly or bait greedily.

The colours of the trout during the spawning season here, are deepened, just as has beeen remarked with the *Salmonidæ* at home. For example, on the occasion of stripping just mentioned above, I noticed that the males, and more particularly the larger ones, were very dark and golden tinted, the fins, and notably the adipose and caudal, having much deep pink; while the spots 'black and crimson' were very conspicuous. The females were clear and silvery, like sea trout, and crimson spots were visible, which probably in the summer season would not be discernible on the same individuals. The hook on the lower jaw of the males seems to grow larger and softer during the spawning season in our rivers, just as observed elsewhere.

As the Water of Leith is a small stream, and the trout taken for stripping are often of great size, 10lbs. to 16lbs. in weight, the manager when done with the fish, and on their recovery, has for the last few years returned only the lesser fish to the Leith, the larger ones being removed to the Waikouaiti, Waitati, Silverstream, Waitahuna, Clutha, and Waipahi rivers; or put them into the Waihola and Tuakitoto Lakes, and the Tomahawk lagoon. The object of this is to make room in the Leith for the growth of the younger trout.

*Stripping the fish.*—A crockery basin or bowl being ready, having a small quantity of pure water in it, the female fish ripe for stripping is removed from the tub wherein she and others have been placed temporarily. The fingers of the left-hand, if a heavy fish, are passed through the gills and the tail is seized by the right. Lifted thus from the tub, so soon as she becomes manageable, the left hand and knees keep her in position over the basin, while the fingers of the right passed gently down her belly from above the ventrals to near the vent, effect the stripping. If the female be very ripe the eggs will flow with little or no pressure from the fingers, but if not, then a certain number only may come away, when she is returned to the lying-in pond at once, and allowed to mature. * When stripped the poor female trout has a very collapsed appearance; the belly, which before was full and distended, being empty, straight, and doubled in! On being, however, returned to the pond she soon recovers, very few ever dying from the effects of this artificial spawning. A short time—not more than a minute and a half or two minutes—suffices for handling thus a fish. Next in order, when the basin is full enough (it should not have too many) of eggs, a male is got, and similar handling with that just described gives the necessary quantity of milt, provided the fish be ripe. The milt from one male we find quite sufficient to impregnate the ova of several females, and that of a young male seems to be as efficient as that of a more mature trout. The milt and eggs are stirred gently with a spoon to ensure thorough contact. The female eggs are of a glossy dark pink colour on passing from the ovaries, but I have noticed a faint yet distinct alteration to a semiopaque and slightly milky tint, on impregnation taking place. I have preserved specimens of unimpregnated and impregnated eggs in glycerine, so as to retain the natural colours, and this difference in certain lights I believe I can still distinguish.

* Mr. Howard, of Wallacetown ponds, uses a board with netting attached to one side to secure the fish during stripping.

Occasionally, but not often, we have found a female give eggs of a light straw colour, and these have hatched out quite as well as those of the ordinary hue, with no difference in time, or in the appearance of the fry. On August 28th, 1880, we had in the hatching boxes at Opoho, ova of this colour from two females of 5lbs each, it was also much smaller than the pink ova from equally heavy female trout. This peculiarity in colour has been observed to occur sometimes with trout in English rivers, as mentioned by Mr. Frank Buckland, in his book on "Fish Culture." In this last season's stripping one female gave 30 eggs much larger, twice the diameter of her other eggs, and as big as Californian salmon ova. They were of a light violet colour, and most hatched out, but 17 only survived, and these are thriving well and are kept by themselves. Her other ova were of the usual size and colour.

As to the number of ova produced by our trout, we find it to be 800 to 1000 for every pound weight of the fish.

*Hatching boxes.*—The hatching boxes and house, dam, and ponds for the young fish, are on the banks of the Opoho Creek, at the north end of Dunedin. The place is awkward of access, but excellently chosen as regards coldness of water and protection from the sun's rays. The creek, flowing as it does down the shady side of Signal Hill and through bush, is cold, but has a considerable quantity of vegetable matter in solution (see analysis given above); not too much, however, as we have found, by the health and success attending our young fish, reared in it. The arrangement of these breeding ponds and the water supply is shown by a diagram which I have made to accompany this paper (pl. XIV). The water passes from the dam through a small fluming of timber four inches by four inches, past the hatching house to the fish ponds, and after flowing through these is allowed to discharge into the creek. At the hatching house a small pipe connects this fluming and the filter-box. The filter-box consists of two chambers, into the first of which, containing the filtering materials, the water flows from the box fluming. The water then passes through the bottom of the partition into the second chamber, where it rises and is drawn off by the several pipes as wanted, which supplies the hatching boxes. These boxes, twelve inches by six inches, built of planks one inch thick, and from four to seven feet long, are placed in parallel rows on either side of the hatching house. Each has sufficient inclination given to it to secure a gentle flow of water, the water passing through a zinc grating from one box to another. Clean gravel about an inch deep, being the debris of trap rock from the Opoho Creek, covers the bottom of each box, and the water, to the depth of two inches, covers this layer. The hatching house is boarded with Hobart Town palings, and has a calico or scrim roof resting on battens.

*Hatching the ova.*—In these boxes, as just described, the impregnated ova are carefully put and distributed all over the gravel in a single layer, wooden covers being then put upon the top of each box. Wide-mouthed bottles drop in the ova well. Notwithstanding all care, there is always more or less of a deposit from the water on the eggs, particularly at the lower ends of the boxes (see note in appendix). This, however, we have never found injurious, though it is objectionable. It can be removed by a camel hair brush, moving the water with a spoon, or increasing the flow of water, the latter being a cure to be avoided if possible. I may here mention in passing, that Mr. Frank Buckland made some experiments to ascertain what weight would be required to crush the eggs of the salmon, when he found it to be 5lbs. 6ozs. I have not tried what trout eggs will bear, they are considerably smaller than those of salmon of equal weight, but that fact does not indicate lesser strength, and it is very probable that they are as strong as those of the nobler fish. This astonishing strength seems to be a wise provision of nature, as in the natural ridds the ova of both these fish are liable to rough treatment and great pressure from superincumbent gravel.

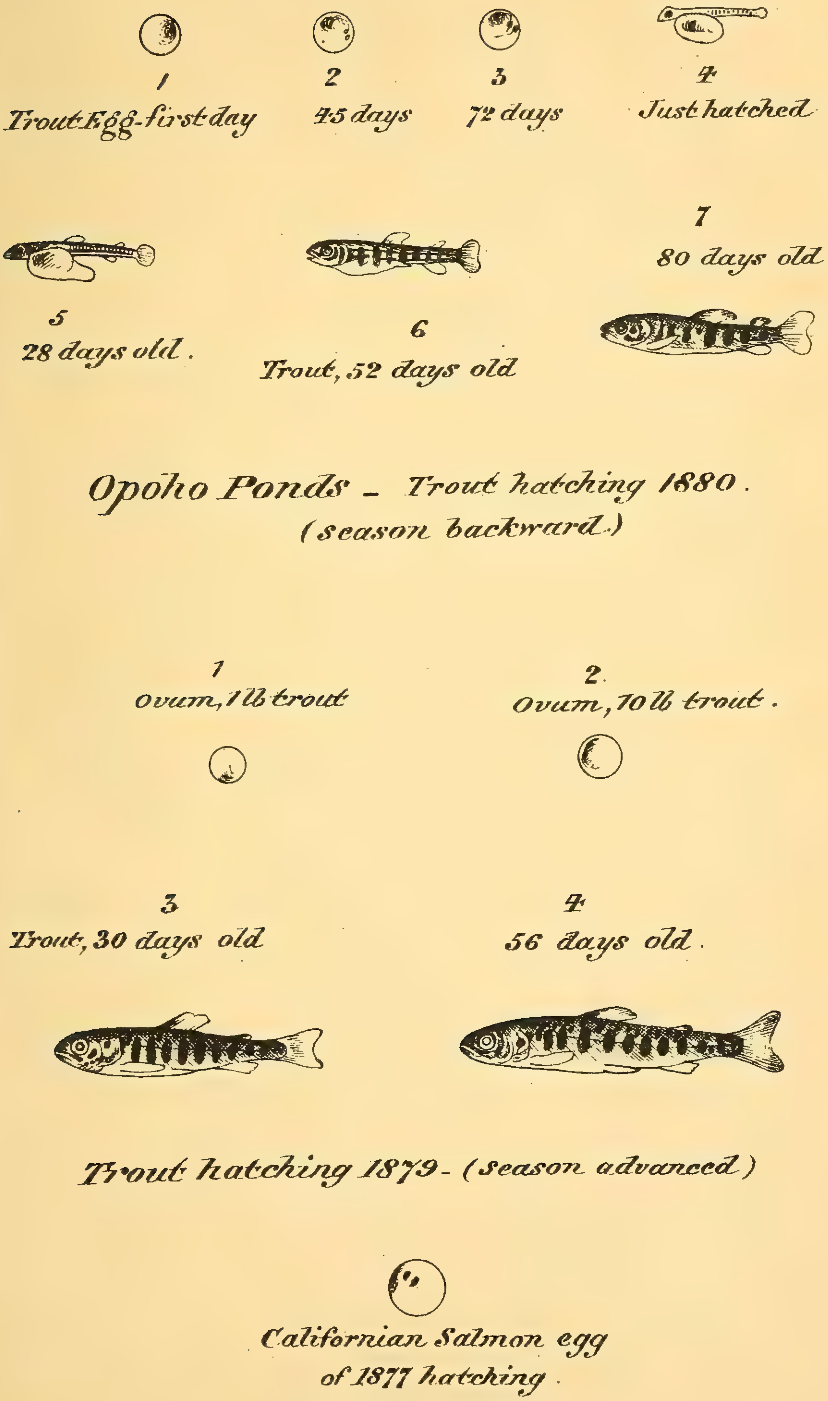
The period of incubation, if I may use the expression, is found at the Opoho ponds to average 78 to 88 days under ordinary conditions of weather, and the time from impregnation till the eyes of the fish appear, 45 to 50 days. A difference in the temperature of the water of $1\frac{1}{2}$ degrees is found to make a difference of 10 days in the time of hatching. The average temperature ranges from 42° to 52°, but the strongest and healthiest trout hatch out in water at 48°. The period of hatching is from 8 to 14 days, that is between the first and the last trout breaking out of the egg. The umbilical bag in the young trout hatched in September and October, 1880, took from 50 to 56 days before it was entirely absorbed. From the time of the sac being absorbed the fry are fed with grated raw liver until liberated, the sac being supposed to contain all necessary nourishment up to the time of its disappearance. In Yarrell's "British Fishes," p. 269, experiments in trout rearing in Germany are referred to, where the time from impregnation to the eye appearing was 21 days, to the hatching out of the fish five weeks or 35 days; and from hatching out to the absorption of the umbilical sac three or four weeks or 28 days. Thus it would appear that the trout reared at the Opoho ponds take as nearly as possible twice as long as fish in Germany to pass through the same stages from impregnation to absorption of the bag. Some tables at the end of this paper may be found useful, giving a few details of temperature and hatching out in Otago. The 1879 fish grew much quicker than those of 1880, which were remarkably backward.

*The young trout.*—After hatching, the young trout (as stated above) are fed with grated raw liver, and this food is continued to them for some time after. They thrive very well on it, and feed, as we believe, on small water insects besides. After hatching the young fry will be ready for turning out into the rivers in from 30 to 50 days, and will carry best whenever they begin to feed, which is from 25 to 28 days after birth. When they are about six weeks old, if well fed, they average $1\frac{1}{2}$ inches in length, and at 100 days three inches. Parr marks or dark bands distinguish the young trout, just as in young salmon and sea trout, and in number I find these to be from 10 to 13; but the same individual does not always have an equal number on either side, just as they seldom or never have been found by me to have equal numbers of spots on the gill-covers on either side of the head. The parr marks disappear when the trout is four to five inches in length.

In transporting these young fish, Mr. Deans prefers to do so when they are from three-quarters to an inch long. He used to put water-cress into the water in the cans, but more recently he has not used anything but water, and has conveyed the young trout just as successfully the one way as the other. The great objects to be kept in mind in this operation are coldness and thorough aeration of the water, and also avoidance of crowding too many fish into one can. The cans used are conical in shape, the base being from 12 to 15 inches in diameter, and the top or mouth about 6 or 7 inches in diameter, and furnished with a lid which fits exactly. The height of each can is about 15 inches, and it has a perforated false bottom fixed in about one inch above true bottom. Aeration is generally found to be secured by the motion of the railway train or other vehicle conveying the fish. At other times a pannikin used occasionally will do as well. A can of the above dimensions will carry about 500 young trout of one inch in length, but that number should not be exceeded.

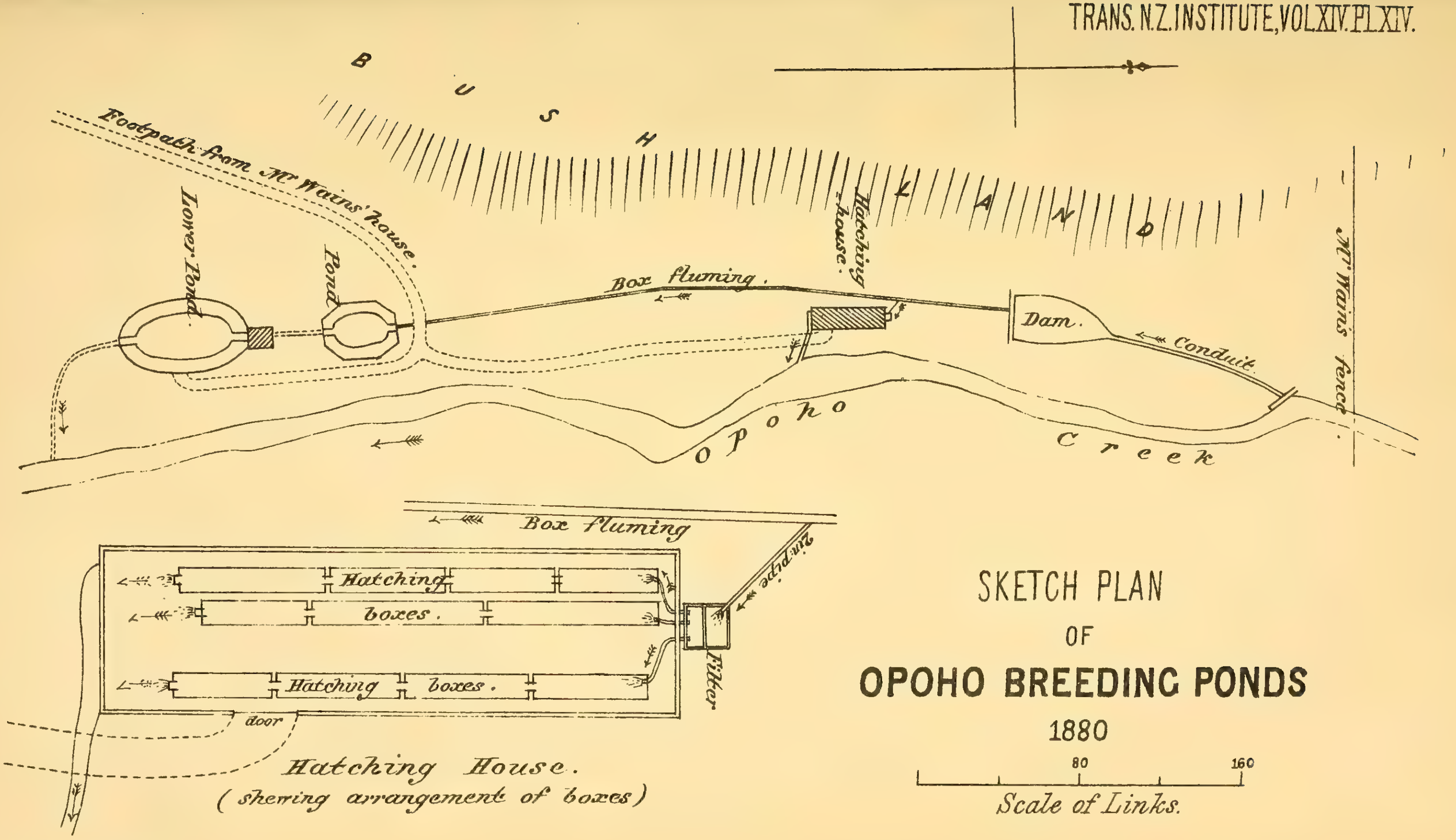
On arrival at the river or stream destined to be the future habitat of the young fry, they are liberated if possible in shallow water, with a coarse gravelly or stony bottom. On their escape from the can to the river, they rest for a time on the bottom, as if fatigued, thereafter going off according as their instinct directs them. On one occasion in January, 1880, I remember in company with Mr. Shennan, of Conical Hills, putting about 500 young trout thus into a shoal part of the Pomahaka River, and on our return in a day and a half, we could not see a single one, not even a dead one, of which there were some dozens at least. The river had been up a little in the interval and was slightly discoloured, so possibly they had shifted their quarters, or been compelled to do so by the action of the water.

It need only be added here, that as it is believed that the stock in any river will decrease (where fishing occurs) from year to year if left to itself, (indeed the experience of Europe and America has demonstrated the fact), the Otago society is very properly spending a large portion of its funds yearly in those operations which I have given now in detail as above. Thus only will the stock of trout in the rivers be maintained.




TROUT HATCHING.

W. Arthur, del.




SKETCH PLAN

OF

**OPOHO BREEDING PONDS**

1880

W. Arthur, del.

## APPENDIX A.

### TABLE showing time of Trout-hatching at Opoho Ponds for 1879.

| Ova when impregnated. | | First fish hatched. | Last fish hatched. | Total time. |
|---|---|---|---|---|
| Box 5 and 6 | July 28 | October 11 | October 24 | 88 days |
| " 9 | " 31 | " 6 | " 17 | 79 " |
| " 10 | " 31 | " 6 | " 18 | 80 " |
| " 11 | August 7 | " 10 | " 23 | 78 " |
| Or a mean duration or period of incubation of | | | | 81 " |

Boxes 5 and 6 were in hatching house; 9, 10 and 11 in open air at lower pond.

One stripping in 1880 took from June 20th to September 8th, and another from July 27th to October 30th, to hatch out. Mean time of hatching, 87 days.

## APPENDIX B.

### TABLE showing Salmon, Trout, etc., distributed in rivers, etc., by Acclimatization Societies.

| NAME. | 1868 | 1869 | 1870 | 1871 | 1872 | 1873 | 1874 | 1875 | 1876 | 1877 | 1878 | 1879 | 1880 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Auckland Society—* | | | | | | | | | | | | | | |
| Californian Salmon | ... | ... | ... | ... | ... | ... | ... | 500 | 36,000 | 90,000 | 80,000 | ... | ... | 206,500 |
| Brown Trout ... ... | ... | ... | 60 | 100 | 1000 | 1000 | 1800 | 200 | ... | 75 | 100 | 2,000 | 8,000 | 14,335 |
| Tahoe Trout ... ... | ... | .. | ... | ... | ... | ... | ... | ... | ... | ... | 1,000 | ... | ... | 1,000 |
| American Brook Trout ... ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 400 | ... | ... | 400 |
| Prussian Carp (1867) | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 114 |
| Catfish ... ... ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 140 | ... | ... | 140 |
| *Hawke's Bay Society—* | | | | | | | | | | | | | | |
| Californian Salmon | ... | ... | ... | ... | ... | ... | ... | ... | 19,545 | 24,300 | ... | ... | ... | 43,845 |
| Brown Trout ... ... | ... | ... | ... | ... | ... | ... | ... | ... | 700 | 1,200 | ... | 4,280 | ... | 6,180 |
| *Wanganui Society—* | | | | | | | | | | | | | | |
| Californian Salmon | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3,500 | ... | ... | ... | 3,500 |
| Brown Trout ... ... | ... | ... | ... | ... | ... | .. | ... | ... | 300 | 1,500 | 1,500 | 3,600 | 9,000 | 15,900 |
| Perch ... ... ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 600 | ... | ... | ... | 600 |
| *Marlborough Society—* | | | | | | | | | | | | | | |
| Californian Salmon | ... | ... | ... | ... | .. | ... | ... | ... | ... | ... | 500 | ... | ... | 500 |
| Brown Trout ... .. | ... | ... | .. | ... | ... | ... | ... | ... | 200 | ... | 700 | 7,100 | 5,000 | 13,000 |
| *Canterbury Society—* | | | | | | | | | | | | | | |
| British Salmon ... | .. | ... | ... | ... | .. | ... | .. | ... | .. | .. | 175 | .. | ... | 175 |
| Californian Salmon | ... | ... | ... | ... | ... | ... | ... | ... | 25,000 | 40,000 | ... | ... | ... | 65,000 |
| American Whitefish | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 8 | ... | 25,000 | 25,008 |
| Brown Trout ... ... | 433 | 450 | 292 | 1823 | 1493 | 434 | 888 | 1,960 | 16,313 | 7,850 | 21,150 | 36,825 | 37,450 | 127,361 |
| Tench ... ... ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 20 | ... | 20 |
| Perch ... .. ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 14 | ... | ... | 14 |
| Goldfish (Carp) ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1 | 26 | ... | 27 |
| *Otago Society—* | | | | | | | | | | | | | | |
| British Salmon (by Government | ... | 250 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 250 |
| Californian Salmon | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 13,000 | ... | ... | 13,000 |
| American Whitefish | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1,000 | 1,000 |
| Salmon Trout ... | ... | ... | ... | 100 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 100 |
| Brown Trout ... | 720 | 1085 | 1000 | 2000 | ... | 4842 | 6227 | 19,797 | 14,326 | 14,321 | 26,531 | 17,250 | 45,450 | 153,549 |
| Charr ... ... .. | ... | ... | ... | ... | ... | ... | ... | 12 | ... | ... | ... | ... | ... | 12 |
| Perch ... ... ... | 21 | ... | ... | ... | ... | 30 | 100 | 108 | ... | ... | 30 | 60 | 730 | 1,079 |
| Tench ... ... ... | 18 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 60 | 78 |
| *Southland Society and Mr. Howard—* | | | | | | | | | | | | | | |
| British Salmon ... | ... | ... | ... | ... | ... | ... | 96 | ... | 1,400 | ... | ... | 2,500 | ... | 3,996 |
| Californian Salmon | ... | ... | ... | ... | ... | ... | ... | ... | ... | 17,600 | 63,000 | ... | ... | 80,600 |
| American Whitefish | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3,000 | 3,000 |
| Salmon Trout ... | ... | ... | ... | ... | ... | ... | ... | ... | 1,100 | ... | ... | ... | ... | 1,100 |
| Brown Trout ... ... | ... | ... | 814 | 242 | 460 | 1042 | 2450 | 3,925 | 3,673 | 111 | ... | ... | ... | 12,717 |

NOTE.—Some of above numbers are approximate, or given by estimation not by actual enumeration.

## Appendix C.

Table of Temperature of Water used in Trout-hatching at Opoho Ponds, in 1879.

| Date. | In upper boxes in house. | In lower boxes at lower pond. | Date. | In upper boxes in house. | In lower boxes at lower pond. |
|---|---|---|---|---|---|
| | Fahr. | Fahr. | | Fahr. | Fahr. |
| August 20 | 44 deg. | 45½ deg. | September 29 | 46 deg. | 48 deg. |
| " 21 | 46 " | 48 " | October 3 | 48 " | 49½ " |
| " 22 | 42 " | 43½ " | " 9 | 49 " | 50½ " |
| " 26 | 40 " | 41 " | " 11 | 50 " | 52 " |
| " 30 | 46 " | 47½ " | " 12 | 50 " | 52 " |
| September 4 | 46 " | 48 " | " 14 | 48 " | 48 " |
| " 8 | 42 " | 44 " | " 15 | 48 " | 48 " |
| " 17 | 45 " | 47 " | " 21 | 48 " | 48 " |
| " 23 | 44 " | 46 " | " 23 | 51½ " | 51½ " |

Table of Temperature of Water used in American Whitefish-hatching, at Opoho, 1878.

| Date. | Hour. | Fahr. | Hour. | Fahr. | Date. | Hour. | Fahr. | Hour. | Fahr. |
|---|---|---|---|---|---|---|---|---|---|
| Feb. 22 | 7 a.m. | 50 deg. | 2 p.m. | 54 deg. | Mar. 6 | 9 a.m. | 50 deg. | 6.30 p.m. | 49 deg. |
| " 23 | 9 " | 52 " | 6 " | 57 " | " 7 | 7.30 " | 50 " | 6.30 " | 50 " |
| " 24 | 9 " | 53 " | 6.30 " | 59 " | " 8 | 8.30 " | 51 " | 6.30 " | 50 " |
| " 25 | 9.30 " | 54 " | .. | .. | " 9 | 8.30 " | 51 " | 4 " | 54 " |
| " 26 | 11 " | 54 " | 6.30 " | 54 " | " 10 | 10 " | 49 " | 4.30 " | 51 " |
| " 27 | 10 " | 51½ " | 12.30 " | 53 " | " 11 | 7.30 " | 50 " | 6 " | 49 " |
| " 28 | 9.30 " | 53 " | 6 " | 54 " | " 12 | 7 " | 50 " | 6.30 " | 49½ " |
| Mar. 1 | 9 " | 52 " | 7 " | 53 " | " 13 | 7.30 " | 52 " | 6 " | 53 " |
| " 2 | 8.30 " | 51 " | 6 " | 53 " | " 14 | 12 noon | 54 " | 7 " | 55 " |
| " 3 | 11 " | 51 " | 9 " | 51½ " | " 15 | 8.30 a.m. | 52 " | 6.30 " | 52 " |
| " 4 | 6.30 " | 50½ " | 6 " | 50½ " | " 16 | 8 " | 53 " | 7 " | 54 " |
| " 5 | 10.30 " | 49 " | 4.30 " | 50 " | " 17 | 12 noon | 54 " | 5.30 " | 55 " |

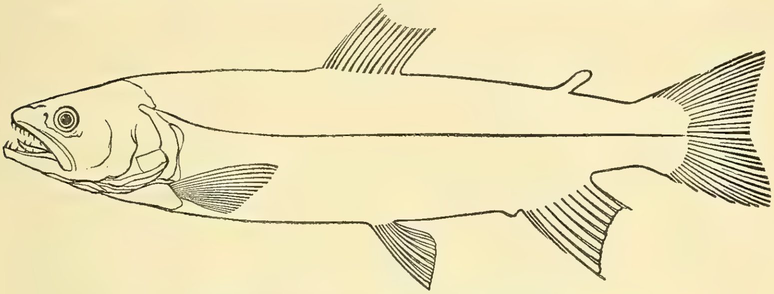
The American whitefish were received February 21st, 1878. First box opened all were dead. Second box yielded some good eggs, which began to hatch at once, on being put into the boxes, as already mentioned. All the hatching was over in about one day; so that above table shows the time during which the fish remained in the boxes, as well as the daily thermal readings.

Note.—Clark's Patent American Hatching-box has layers of trays of brass wire gauze, one above the other, enclosed in a box watertight except at the bottom. The water flows downwards through these, out at bottom and rising to the top of an outer box, flows over into the next set of boxes, and so on. This seems likely to remove all sediment.

## ART. XXVII.—*On the Occurrence of the Salmon Trout in Nelson Harbour.*

By JAMES HECTOR, M.D.

[*Read before the Wellington Philosophical Society, 17th September,* 1881.]



*Salmo trutta*, L. Nelson Harbour.
*Female after spawning.*

B. 11. D. 13. A. 11. P. 13. V. 9.
L.L. 120. L. transv. $\frac{26}{36}$; above V. $\frac{}{22}$.
Vert. 58. *Cæc. Pyl.* 40 +.

| | Inches. |
|---|---|
| Total length .. .. .. .. .. .. | 25 |
| Greatest depth .. .. .. .. .. .. | 5 |
| Length of head .. .. .. .. .. .. | 5 |
| Least depth of tail .. .. .. .. .. | 2 |
| Distance between end of snout and eye .. .. | 1·2 |
| Length of maxillary bone .. .. .. .. | 2 |
| Distance between eye and angle of operculum .. | 3 |
| Distance between occiput and origin of dorsal fin .. | 7 |
| End of dorsal to root of caudal .. .. .. .. | 7·5 |
| Length of base of dorsal .. .. .. .. .. | 2·8 |
| Greatest height of dorsal .. .. .. .. | 2 |
| Length of pectoral .. .. .. .. .. | 3·6 |
| Root of pectoral to ventral .. .. .. .. | 7·4 |
| Length of ventral .. .. .. .. .. | 2·5 |
| Ventral to anal .. .. .. .. .. .. | 5 |
| Length of anal .. .. .. .. .. .. | 3·3 |
| Greatest depth of anal .. .. .. .. .. | 2·9 |
| Length of longest caudal, say .. .. .. .. | 3·2 |
| „ middle „ .. .. .. .. | 1·9 |

Weight, 64 ounces.

The greatest depth of the body is beneath the middle of the dorsal fin, and is equal to the extreme length of the head and one-fifth of the total length. The snout is conical, but compressed vertically. Mouth terminal, the jaws fitting evenly when shut. Maxillary bone dilated and extending slightly beyond the posterior vertical of the eye. Diameter of the eye is one-third the length of the snout. Tip of snout to occiput two-fifths the total length of the head measured to the hinder angle of the operculum. The interorbital space is only slightly convex. Opercles are thin, with concentric striæ. The posterior margin of the operculum is almost straight, oblique, the sub-opercular suture being at right-angles, and only slightly sinuated. The sub-opercular is three times as long as broad. The ratio of the length of the fins to the total length is as follows:—The length being 1·00; D. ·125; P. ·069; V. ·100; A. ·076; least depth of tail ·125. The caudal fin is slightly emarginate. The dentition is complete and powerful, the intermaxillary mandibular and front vomerine teeth being the largest. The maxillary teeth are arranged in pairs. The head of the vomer has a group of three teeth, and three on each side of the body. The tongue is armed with teeth arranged in the same manner and number as on the vomer.

There are 120 perforated scales on the lateral line, which is prominent. From the front origin of the dorsal to the lateral line there are 26 scales, and from between the origin of the ventral and the lateral line there are eighteen rows of scales. The scales are thin and rounded in posterior outline. Immersed nacreous scales occur along the back from the nape to beyond the dorsal.

The snout and muzzle are olivaceous black. The crown and occiput honey yellow. On the cheek and above the eye is a triangular patch of brown. The gill-covers are silvery white with a dusky hue, and have five dark spots, four on the operculum, and one on the pre-operculum. The under parts as far as the vent are pure white.

The nape and back dark blue-black, and the flanks bright silvery with a purple shade. Diffuse and X-shaped black spots on the back and sides, but only a few below the lateral line. Dorsal fin dusky brown with numerous dark spots. Pectoral darkened toward the tip on the inner side. Ventrals and anal white. Adipose and caudal dark coloured.

The fish which is now exhibited was sent to me yesterday by Mr. Greenfield, Secretary to the Acclimatization Society, Nelson, as being, probably, a specimen of the Californian salmon (*Salmo quinnat*). It was captured in Nelson Harbour, near to the mouth of the Maitai Stream, a similar, but smaller, specimen of the same fish having been caught there a few days previously.

Californian salmon having been turned out, three years ago, in various rivers entering Cook Straits and in the Nelson District, while no other migratory salmonoid had ever been liberated, so far as is known, north of Otago, it was not unnatural to suppose that this might be a harbinger of the shoals of American salmon that are expected sometime to reappear on our coasts.

A careful examination of the fish shows, however, that it must be classed as a true sea or salmon trout, although, as has been found invariably to be the case in Otago specimens, it presents a certain admixture of the characters of the many species into which the sea trouts from the various rivers in Europe have been subdivided.

The specimen proves to be a female that has just spawned. For the length of twenty-five inches its weight, four pounds, is small, but it is evidently lanky and out of condition, as otherwise it would have been a six pound fish. The stomach contained half-digested remains of a young barracouta (*Thyrsites atun*) and a sea mullet (*Agonostoma forsteri*), each about nine inches long, proving that it must have been feeding voraciously in salt water. The importance of this determination is due to the fact that the only salmon trout ever introduced to New Zealand were bred from a small lot of ova that came from Tasmania, in 1870, and of which the original stock, turned out in Shag River, Otago, did not exceed seventy or eighty fish. What are supposed to be the progeny of these now abound on the Otago coast, and this discovery might seem to point to its having spread in its migration round the coast as far as Blind Bay. On the other hand, it might be suggested that what we know as brown trout in the rivers are of the large fast-growing variety known as the Thames trout, but which, in New Zealand, enter the sea and acquire the characters of the true sea trout.

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## Art. XXVIII.—*On two Species of* Nudibranchiate Mollusca.

By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 5th September*, 1881.]

*Doris luctuosa*, n.sp.

Length 1–2 inches. Body oblong or linear-oblong, back moderately rounded. Mantle small, rather narrow and hardly concealing the sides of the foot, smooth and soft to the touch, of a dirty flesh-brown more or less spotted or streaked with reddish-brown; occasionally dirty white with a few reddish-brown markings. Towards the sides of the mantle the reddish-brown markings are often arranged in more or less interrupted lines. Dorsal tentacles (rhinophores) stout, clavate, completely retractile within raised sheaths, strongly laminate, laminæ over 20 in number. The laminæ are blotched with dark purple and greenish-yellow, the tips of the sheaths are usually greenish-yellow. Branchiæ 5, rarely 6, forming an incomplete circle round the tubular anus, bipinnate or tripinnate, rounded at the apex, flatly spreading; colour dark-purplish, sometimes mingled with greenish-yellow. The branchiæ are capable of complete retraction within a common cavity, the edges of which have usually a greenish-yellow tinge. Foot large, with thick and high sides, sole uniform flesh colour. Mouth large, tubular. Oral tentacles unusually long, slender, linear, cylindrical, often protruding beyond the edge of the mantle when the animal is crawling. Odontophore broad, of about 28 rows of teeth. No central teeth, lateral about 60 on each side, smooth, strongly arched, all similar in shape.

I have obtained several specimens of this species on rocky ground in Auckland Harbour.

*Doridopsis mammosa*, Abraham, P.Z.S. 1877, p. 266, pl. XXIX., figs. 20, 21.

Mr. Abraham states that this species was collected by the Antarctic Expedition, but its native country appears to be unknown to him. I have no doubt, however, that it is identical with a species found abundantly on *Zostera* beds from Mongonui to the East Cape, and perhaps further south. The Antarctic Expedition probably obtained it at the Bay of Islands, where it is not uncommon. The following description, drawn up from fresh specimens, will afford some information on certain points, such as colour, etc., which could not be made out from the alcoholic specimens described by Mr. Abraham.

Body 2–4 inches long, broadly elliptical, back moderately elevated. Mantle large, usually extending on all sides beyond the foot, margins thin and semi-transparent, much undulated. On each side of the back is a row of 3 or 4 large conical or clavate erect processes; two similar ones are placed close together between the dorsal tentacles. Numerous much smaller tubercles are scattered irregularly over the back and sides. Along the back, between the processes, is a median row of three (rarely two) large lozenge-shaped smooth areas, free from tubercles or projections of any kind. On each side, a similar row of four or five smooth areas extends from the dorsal tentacles to the branchiæ, on the outside of the row of processes. These areas are coloured a deep velvety brown-black, and each contains a central spot and a few lateral specks or streaks of an intense greenish-blue, of almost metallic lustre. The remainder of the mantle is a light brown or fawn colour, always marked (especially towards the margins), with numerous delicate whitish or greyish parallel longitudinal lines, which are more or less continuous towards the margins, but are irregular and broken on the back. Dorsal tentacles (rhinophores) rather small, clavate, the upper portion bent and diagonally laminated, tip thickened and rounded; the whole retractile into cavities that have raised sheath-like edges. Branchiæ 5, large, copiously branched, tripinnate, set round the anus in a circle interrupted behind, retractile within a common cavity; this cavity has its opening irregularly 5-lobed, the lobes more or less tubercled. The pinnules of the branchiæ are lineated and tipped with black, the remainder being a waxy white. Foot rounded in front and behind, margin thin and undulated. There is a narrow notch in front, giving passage to the tubular proboscis; and immediately above it, in the groove between the foot and the mantle, are two minute flap-like projections. No odontophore, or buccal armature of any description.

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## ART. XXIX.—*Further Notes on* Coccidæ *in New Zealand, with Descriptions of new Species.* By W. M. MASKELL, Fel. Roy. Micros. Soc.

[*Read before the Philosophical Institute of Canterbury, 1st September,* 1881.]

Plates XV. and XVI.

### 1st Group.—DIASPIDÆ.

(Trans., vol. xi., p. 189).

### 1st Genus, **Mytilaspis**, Linn.

(Trans., vol. xi., p. 192).

#### 1. *Mytilaspis pyriformis*, mihi.

(Trans., vol. xi., p. 194).

I HAVE lately succeeded in hatching out a male of this species. The insect (fig. 1) is orange-coloured, about $\frac{1}{30}$ inch long, of the normal form, generally, of the Diaspidæ; the abdominal spike is of considerable length. Antennæ (fig. 2) 10-jointed; foot (fig. 3) with four long fine digitules. Haltere (fig. 4) normal.

As remarked in a former paper (Trans. vol. xii., p. 294), the males of the Diaspidæ are not easily distinguishable. There is little certainty to be obtained except by hatching from the puparia, and even then, as the puparia are often similar, it is easy to make mistakes.

#### 2. *Mytilaspis leptospermi*, sp. nov.

Puparium irregularly pyriform, flat, light-brown, formed (besides the two pellicles) chiefly of the bark-cells of the tree arranged longitudinally. The pellicle of the second stage is comparatively small.

Young insect normal.

Adult female greyish-green, generally resembling *M. pyriformis.* Abdomen ending in six lobes, of which the two median are conspicuous and somewhat large and floriated, the rest very small. Five distinct groups of spinnerets, the upper group with about 15 openings, the others with from 25 to 35. Single spinnerets none, or very few.

From bark of manuka (*Leptospermum*).

I am not sure that this is not perhaps a variety of *M. pyriformis*. At the same time the differences are considerable. The two median abdominal lobes of *M. leptospermi* are much more conspicuous than those of *M. pyriformis*; the groups of spinnerets are always distinct, and the single spinnerets usually wanting. The structure of the puparium is also different, but I would scarcely lay specific stress on this. In *M. pyriformis*, which I have hitherto found only on leaves or bark of soft-wooded plants, the whole secretion from the spinnerets is built up into the puparium in *transverse* fibrous layers, apparently without direct admixture of the vegetable substance of the plant. The bark of the manuka probably lends itself more readily to the purposes of *M. leptospermi*, which seems only to cement together with its secretion a number of the bark-cells scaling off the tree; and the fibrous secretion may be made out intermixed with these cells, which are always arranged *longitudinally*.

2nd Genus, **Chionaspis**, Signoret.

This genus has been separated from *Mytilaspis* on account of the form of the male puparium. In *Mytilaspis* the male and female puparia are alike; in *Chionaspis* the female has a broad and pyriform, the male a narrow and usually carinated, puparium.

1. *Chionaspis dubia*, sp. nov.

Puparium of female white, flat, very thin, pyriform, the two pellicles comparatively small.

Adult female generally resembling *Mytilaspis*, but with somewhat deeper corrugations towards the abdominal end. Abdomen ending with a median depression as in *Diaspis rosæ* (Trans., vol. xi., p. 201): no terminal lobes. Five groups of spinnerets; upper group with 6–10 orifices, the rest 10–15.

Male puparium white, elongated, irregularly oval, flat above, but with two keels on the under side, enclosing a longitudinal semi-cylindrical groove as in *Fiorinia asteliæ*, mihi.

Adult male reddish colour, generally normal form of Diaspidæ. Antennæ hairy, 10-jointed, the first two joints very short. Feet normal, with four long fine digitules. At the base of the abdominal spike is a somewhat large tubercle. Haltere of the general form of *Mytilaspis* (see fig. 4), but the terminal seta is very long, four times as long as the thick basal portion, and has no terminal knob. Thoracic band conspicuous. The thorax is somewhat long, so that there is a considerable distance between the first and second pairs of legs.

Common on many plants, *Coprosma*, *Rubus*, *Asplenium*, etc.

The species of *Chionaspis* seems to be by no means clearly differentiated. The present insect resembles in some particulars *C. aspidistræ*, Signoret, *C.*

*populi*, Bärensprung, and others, but differs so much that I can refer it absolutely to none, and am forced to consider it as new. Still it may be only a variety.

### 3rd Genus, **Aspidiotus**, Bouché.

1. *Aspidiotus aurantii*, mihi.

(Trans., vol. xi., p. 199).

I learn from Mr. Comstock, entomologist to the Department of Agriculture, Washington, that this species abounds, and does very great damage, on orange and lemon trees in California and Florida. I do not gather from him, however, that any description of it was published previous to my paper of 1878, so that, I presume, my name for it will be retained.

While in Melbourne last year, I observed this insect in great numbers on orange trees there. But the fruit which has been sold in the shops here during the last few months seems to have been comparatively free from it. Probably, as in other countries, the pest has cycles of maximum and minimum frequency.

2. *Aspidiotus nerii*, Bouché.

I have lately found, on *Coprosma*, in the North Island, this species, which is exceedingly common in Europe, but seems to have hitherto not spread in this country. Its favourite habitat is the *Nerium oleander*, and in France and Northern Italy it does very great damage to that and several other plants. In Melbourne I noticed many plants terribly infested with it. The puparium is whitish, and, as in all *Aspidioti*, round and flat. The species may be recognized by the four anal lobes of the young insect (of which two are somewhat prominent) and by the form of the scaly hairs at the anal extremity of the adult female: these hairs have, some a rectangular, some a serrated tip.

### 4th Genus, **Fiorinia**, Targioni.

1. *Fiorinia asteliæ*, mihi.

Trans., vol. xi., p. 201, under the name *Diaspis gigas*, corrected in vol. xii., p. 292.

It is to be noted that the *larval* form of the male of this species, that is, the stage succeeding the young insect, resembles not a little an adult female of *Mytilaspis drimydis*, showing the four anal lobes extending some way into the body, as in pl. v., fig. 5a, Trans., vol. xi.: but it is somewhat more deeply corrugated, and of a greyish yellow colour instead of red. The form of the puparium, which is quite distinct in the two species, will prevent mistake. In *F. asteliæ* the puparium of the male is long, narrow, thin, and on the under side bi-carinated. The puparium of *M. drimydis* more nearly resembles that of *M. pomorum*, and has no keels.

Amongst the type slides of Coccidæ deposited by me with the Institute, is one showing the male larva of *Fiorinia* in the act of changing into the pupa.

When, as often happens, a leaf or a twig is covered with individuals belonging to two or three different species, it is not always easy to distinguish between them. If practicable, the males should be hatched out from their puparia: but in the great majority of cases this cannot well be done. It is still more difficult, if not impossible, to follow out and watch the development of the females, a process requiring a regular supply of food during many months.

## 2nd Group.—LECANIDÆ.

(Trans., vol. xi., p. 203.)

### Subsection Lecanio-diaspidæ.

(Trans., vol. xi., p. 207.)

### 1st Genus, **Ctenochiton**, mihi.

(Trans., vol. xi., p. 208.)

#### 1. *Ctenochiton spinosus*, mihi.

(Trans., vol. xi., p. 212.)

The young insects, which may be found beneath the mother in autumn in great numbers, show the marginal spines very prominently. The abdominal lobes are comparatively large, and if it were not for other circumstances, I should be almost inclined to consider the species as allied somewhat to *Kermes*, a genus in which the young insect has the anal tubercles of the Coccidæ, whilst the adult has the lobes of *Lecanium*. The antennæ of the young *C. spinosus* have five joints. The upper digitules are long fine hairs: I cannot make out the lower pair. The body is convex above, flat beneath: colour red: length about $\frac{1}{50}$ inch.

The peculiarly fringed test of this species is not easily made out on the adult female; indeed it is easy to mistake the insect then for one of the semi-globular naked Lecanieæ.

#### 2. *Ctenochiton piperis*, sp. nov.

Figs. 5–8.

Young insect of generally normal form of Lecanidæ, but the edges have a great number of minute wrinkles, giving them a crenate appearance: the crenations are very apparent on the cephalic portion. The antennæ are somewhat thick, with six joints; on the last joint some hairs. Feet normal; upper digitules long, fine; lower pair somewhat broader. The usual setæ on the abdominal lobes.

In the next stage the form generally resembles that of *C. perforatus*, but the cephalic end is narrower (fig. 5), giving a roughly triangular shape. The edge has the wavy appearance spoken of in Trans., vol. xi., p. 209. Stigmatic spines somewhat stout: there are a few minute spines on the edge. Antennæ rather thick, 6-jointed: on the last joint several hairs. Feet normal of the genus. From the abdominal lobes two setæ. The test begins to be apparent in this stage as in *C. perforatus:* it is waxy and very thin, and vanishes in balsam. The fringe, as shown in fig. 5, has rather wider and shallower segments than in *C. perforatus*, and I have not seen any of the peculiar markings, or pits, characterizing that species. The body is very thin in this stage. Length about $\frac{1}{30}$ inch.

Adult female (fig. 6) circular, convex above, flat beneath; colour generally greenish, but under the central divisions of the test deep purple, covered with a white, glassy or waxy, test of some consistence, which extends a little beyond the edge in an irregular fringe; but the fringe is often broken or absent, leaving the edge a continuous circle as in fig. 6. The test is regularly tessellated, the tessellations corresponding to those of the body: a row of pretty regular hexagons, the largest being in the centre, runs along the middle, having on each side another row of hexagons somewhat wider, and beyond that a third row of hexagons: a fourth row, of which the outer angles are cut off by the edge, completes the circle. The middle row and the row on each side of it cover the purple patches of the body. Under each of the hexagons, between these and the outermost row, is a small swelling, or tubercle: if the insect be macerated in potash and rendered transparent, these tubercles are seen placed in a ring round the whole body about half way between the centre and the edge. I have failed to make out what is their function: under certain lights they have some slight resemblance to spiracles, but they are much too large, and moreover the Lecanidæ have but four spiracles, whereas there are twenty-four of these tubercles.

The insect fills the whole test, and in its last stage is slightly hollow underneath: the young, as in *Lecanium depressum*, are to be found in the cavity thus formed. The antennæ (fig. 7) of the adult have seven joints, the third joint being the longest. The second, third, fourth, and fifth joints have each one hair, the seventh several hairs. Feet (fig. 8) normal of the genus: the lower digitules rather broad.

The average diameter of the adult insect is about $\frac{1}{15}$ inch.

Not uncommon in the North Island on *Piper excelsum*: sometimes on other trees. I have not found it in the South.

The almost regularly circular form and the colour, green with purple patches, of this species readily distinguish it from others of the genus. It forms a handsome opaque object for the microscope.

### 2nd Genus, **Inglisia**, mihi.

(Trans., vol. xi., p. 213.)

#### 1. *Inglisia patella*, mihi.

(Trans., vol. xi., p. 213).

I have succeeded lately in procuring both the young insect and the adult male of this species.

The young insect has no general peculiarities of form calling for remark, but is readily recognized by its edge, along which is a row of the curious club-shaped spines visible in the adult, and figured in vol. xi., pl. vii., fig. 16d. But whereas in the adult insect these club-shaped spines are alternated with sharp ones, in the young the sharp spines are absent. The length of the body is about $\frac{1}{50}$ inch.

The male insect undergoes its transformations in a test similar to that of the female. At least my specimen was hatched from a leaf of *Drimys* from Lyttelton on which there were a number of tests (perhaps fifty), and I was unable to find any difference to show which were tests of males. The insect is about $\frac{1}{24}$ inch long, exclusive of the abdominal spike ; greenish in colour : form generally normal. Antennæ 10-jointed : the first two joints very short, the rest to the seventh much longer and equal, the three last somewhat shorter and equal. All the joints have several hairs. Foot normal ; four digitules, all fine knobbed hairs. Wings rather long, hyaline. Abdominal spike about half the length of the abdomen. From the last segment of the abdomen spring two very long white setæ.

This species is more common than I imagined when first describing it. I have seen plants of *Drimys* on the hills over the town of Lyttelton with every leaf covered thickly with the tests of *I. patella*, so thickly indeed, as to make the whole under surface of the leaves look white.

2. *Inglisia leptospermi*, sp. nov.

Figs. 9–17.

Test white, glassy or waxy, elongated, convex above, flat and open beneath, formed of several agglutinated segments, each segment more or less convex or conical, median segments usually five in number ; at the edge an irregular fringe, as in *C. perforatus*, but the fringe is often absent. Average length of test $\frac{1}{10}$ inch.

The test, though preserving the same general form, is subject to minor variations, as shown in figs. 9 and 10.* I rather think that fig. 9 is a younger form than fig. 10, and that the little secondary tests shown in the former become more closely agglutinated with age.

Each segment of the test is marked with grooves and striæ radiating from the centre, as in the single test of *I. patella*. The striæ, which widen from the apex to the base, are composed, as in the former species, of perforations containing air.

The female insect (figs. 11, 12, 13) fills the test in the adult stage, but, as in most of the Lecanio-diaspidæ, becomes when old, and after propaga-

* Fig. 10 is slightly incorrect : the segments of the marginal fringe are shown too small and regular.

tion, shrivelled up at one end of the test. The insect is flat beneath, convex above, of elongated oval shape, brown in colour. The two abdominal lobes, which are yellowish, are conspicuous over the anal cleft (fig. 11). The underside is smooth, but the upper is divided by several large corrugations, and I think each corrugation corresponds to one of the primary segments of the test.

The mentum is, I think, bi-articulate, but I have not been able to make this out with certainty.

Antennæ (fig. 14) of seven joints, of which the third is the longest, the fourth, fifth and sixth, the shortest; a few hairs, especially on the last joint. In some specimens I have seen the third joint as if divided into two; but this was probably only due to a folding of the integument.

Feet (fig. 15) normal; the tibia is somewhat thin, and has one spine or hair at its tip. Digitules, of which two are shown in fig. 16, normal; upper pair long knobbed hairs, lower pair very broad.

The female in the second stage is also convex above, flat below, but is less thick than the adult, and has not the corrugations. General form elongated oval, with the anal cleft and lobes of Lecanidæ, but the lobes are not, as usual, smooth, but approach by irregularity the anal tubercles of the Coccidæ, and like them bear a few hairs. I think the anal ring has eight hairs. Antennæ of six joints. Feet normal, digitules as in adult. On the skin are several scattered, circular, very minute, spinnerets; the stigmatic spines are long and conspicuous, and along the edge runs a row of conical hairs or spines, which may, as in *Acanthococcus*, act also as spinnerets. These details are shown in fig. 17.

Like the other Lecanio-diaspidæ here, *I. leptospermi* is much subject to attacks from parasitic Hymenoptera.

Not uncommon throughout the Islands on the manuka, *Leptospermum scoparium*. I have found the twigs of this tree covered with the little white tests of this insect near Christchurch, Kaiapoi, Wellington and Auckand. I have not seen it on any other plant. It does not appear to attack the leaves, but prefers the young twigs.

I had some doubt, when describing in 1878 *Inglisia patella*, as to the propriety of erecting a new genus to fit a single species. *I. leptospermi* has come to remove the doubt: the nearest European genus seems to be *Fairmairia*, Signoret: but the 7-jointed antenna of *Inglisia* and the form of the test remove it from that genus.

3rd Genus, **Lecanochiton**, gen. nov.

Adult female covered by a test formed partly of the pellicle of the second stage, partly by a hard, apparently chitinous, secretion. Other characters of Lecanidæ: apodous in adult stage.

The admixture of the second pellicle with secretion to form the test approaches this genus more nearly to the Diaspidæ than any others of the group. But there can be no mistaking its affinities, for the abdominal cleft and lobes of *Lecanium* at once define its position.

1. *Lecanochiton metrosideri*, sp. nov.

Figs. 18–21.

The young insect, extremely minute, has the general form of *Lecanium hesperidum*: it is flat, oval, brown, or rather reddish, usually found at the tips of young shoots. The antennæ have six joints (fig. 18); on the last joint are several hairs, amongst which is one excessively long, slightly knobbed. Foot (fig. 19) normal; the joints hairy; upper digitules fine knobbed hairs, lower pair a little broader.

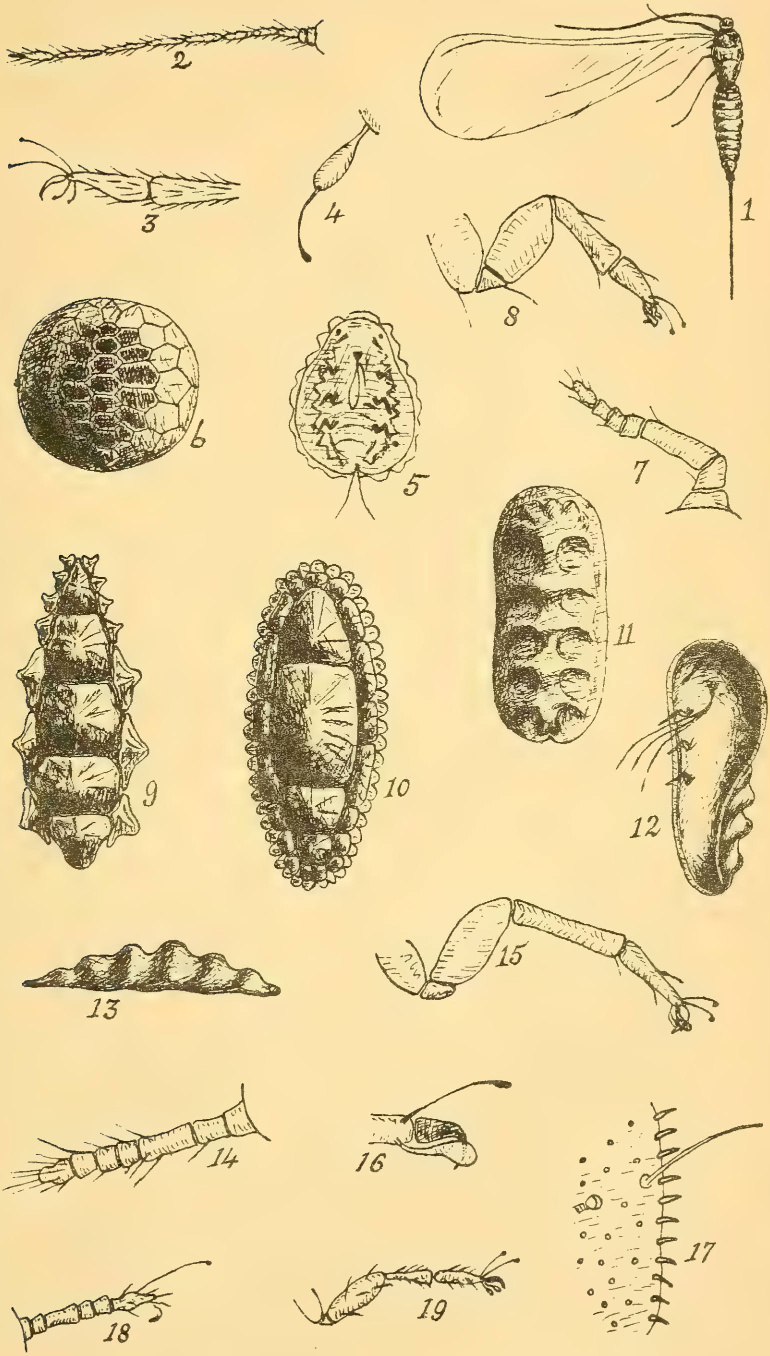
In the second stage the insect is scarcely altered: the antennæ and feet remain as before: but there is a test, white, waxy, very thin, covering the dorsal surface, and extending a little beyond the edge in an irregular fringe somewhat resembling that of *Ctenochiton elongatus* (Trans., vol. xi., p. 212, pl. vii., fig. 14d). On the edge, also, are a number of protruding spinneret tubes, glassy, white, cylindrical, either curved or straight: a few of these tubes protrude on the surface of the back. The under side of this stage is shown in fig. 20.

The adult female is covered by a hard, brown test (fig. 21, dorsal view), having the general appearance of an overturned basket, the foot of the basket being formed by the pellicle of the second stage. This test, convex or semi-globular above, is open beneath; and as the insect, which entirely fills the test, approaches its last stage it becomes slightly hollowed below as in some other Lecanidæ: in the cavity thus formed the young are hatched.

The female, dark-brown in colour, corresponds to the shape of the test. The rostrum is comparatively large; the mentum, I think, monomerous. Antennæ (fig. 22) short, thick, atrophied; and the seven joints of which they are composed are so compressed as to show apparently only three: it is not easy to make out the divisions. The last joint has a few hairs. The feet are entirely absent, and I have not been able to see maculæ in place of them, as is usual in some other apodous Lecanidæ.

On the pellicle at the top of the test may be seen remains of the test of the second stage. From this pellicle radiate to the edge four rows of rather large spinnerets secreting the test, each row starting from a point opposite the stigmata of the pellicle: and on turning over the test there are seen on the underside four corresponding lines of white cotton.

The skin of the insect is smooth and not tessellated.




COCCIDÆ.

W. M. Maskell, del.

I obtained my specimens from the *rata* tree *(Metrosideros)* at Milford Sound. Being in the Sound only a few hours on my way from Melbourne, I was unable to make as full a collection as I should wish, nor could I find a male.

*Lecanochiton* is the only genus of Lecanidæ, as far as I know, which makes use of the pellicle of its second stage. In the Diaspidæ the pellicles always form part of the test. This new genus supplies an extra link between the two groups, as the genus *Kermes*, where the young insect has the anal tubercles whilst the adult has the abdominal lobes, is the link between the groups Lecanidæ and Coccidæ. As mentioned by me (Trans. vol. xii., p. 291) there is a very close gradation between all the genera of the Homoptera, at least as far as concerns the Monomera.

### 3rd Group.—COCCIDÆ.

(Trans., vol. xi., p. 216.)

### 1st Subsection.—LECANO-COCCIDÆ, sec. nov.

Insect possessing the anal tubercles of *Coccus* in all stages; covered by a test; mentum monomerous.

As observed in my first paper (Trans., vol. xi., p. 217), the general characteristics of the group Coccidæ are, a pair of anal tubercles, and a mentum bi- or tri-articulate. I have, however, lately met one of those puzzling forms which possess characters apparently of two groups. The articulations of the mentum are in most cases very difficult of detection; and, as it seems to me, the only sure guide to the grouping of a species is the presence of *anal tubercles* (in which case it is a Coccid), or of *abdominal lobes* (in which case it is a Lecanid). As a rule, a Lecanid has not more than eight, and almost always seven, joints in the antennæ. But in cases where, as in the following species, the antennæ are lost in the adult stage, this can clearly not be made a guide.

In the genus *Kermes* the young insect has the anal tubercles of *Coccus*, the adult the abdominal lobes of *Lecanium:* and this genus has been, in late works on the Homoptera, considered as a link between the two groups on that account. The insect which I have to describe has the anal tubercles in all stages, and if the mentum were not uni-articulate I should have placed it amongst the group Coccidæ, in the subsection Coccidæ proper. As it is, I am compelled to create a new subsection for it.

### Genus **Planchonia**, Signoret.

Insect enclosed in a hard, smooth, test, completely surrounding it; test convex above, flat below. Adult female apodous. Anal tubercles present in all stages. Test surrounded by long fringe.

M. Signoret, following Professor Targioni-Tozzetti, includes the genus *Planchonia* amongst the Lecanio-diaspidæ, but himself remarks that on account of the tubercles it ought to be removed thence. I see no reason for perpetuating the error here, and have therefore placed it in its proper place.

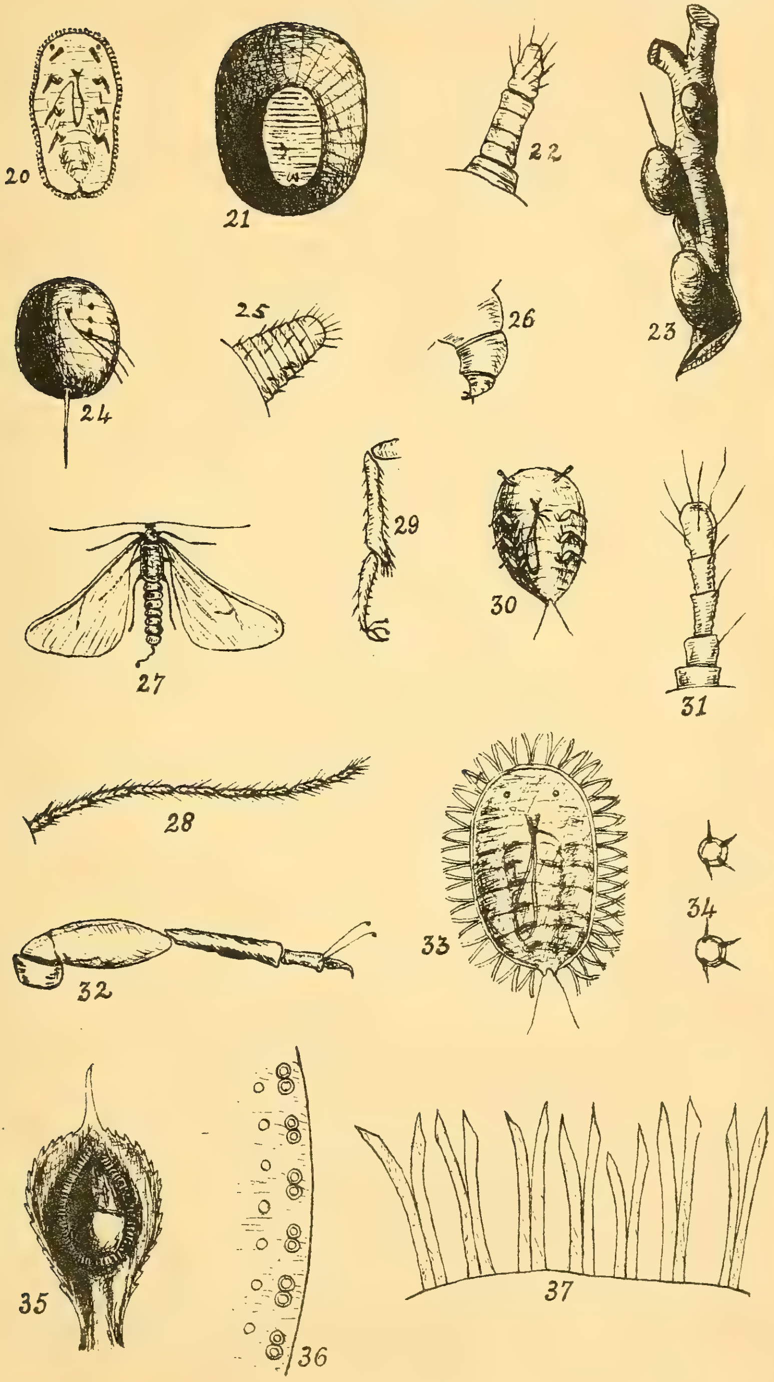
*Planchonia epacridis*, sp. nov. (?)

Figs. 30–37.

Young insect about $\frac{1}{40}$ inch in length, outline oval, body flat, tapering somewhat towards the anal tubercles (fig. 30). Antennæ (fig. 31) of five joints, but as these are crossed by numerous, closely placed, transverse lines, they seem to have more joints. The last joint is slightly clavate and has several long hairs. Feet (fig. 32) with well developed coxa, trochanter and femur; tibia and tarsus thin. I can make out only two digitules, which are fine hairs. From the anal tubercles spring two long setæ. The mentum is uni-articulate. General colour reddish brown. All over the dorsal surface and round the edge of the body are scattered spinneret orifices in the form of the figure 8, from which spring long, curling, white, glassy tubes.

Second stage of female with general outline resembling the young; body somewhat flatter, marked with several transverse corrugations. Average length about $\frac{1}{20}$ of an inch (fig. 33). Antennæ completely atrophied, indeed quite lost, their place being occupied only by circular rings with four hairs (fig. 34). Feet likewise absent. Mentum uni-articulate. Anal tubercles not very prominent, each bearing a long seta. The anal ring has, I think, six hairs. On the dorsal surface there are only a very few spinneret orifices, but round the edge of the body is a row of the figure-of-8 spinnerets, and from these springs a long silvery fringe, which is double. In fig. 33 I have tried to represent this fringe, but have only been able to show one row of it. It is necessary to imagine another row above the one shown, as if there were two fringes, one over the other. As the colour of the insect at this stage is reddish brown, as is also the surface of the leaf on which it feeds, the effect of this double glassy fringe of silver is of great beauty. The tubes of the fringe are not quite straight. Each pair springs from one of the figure-of-8 orifices, and the tips slightly diverge.

The adult female is covered over with a smooth, hard, semi-transparent test, convex above, flat beneath, and on the underside this test is also almost closed, leaving only an orifice for the rostral setæ, so that the insect is really enclosed: but at the extreme end of the abdomen the upper and lower portions of the test are slightly parted, leaving an opening. The test (fig. 35) is oval, but tapers towards the anal extremity, and in all the specimens which I have seen this anal end was turned towards the tip of the leaf. I should imagine that the reason for this is to facilitate the work of the male (though I have not as yet found any male insects). The leaves of *Leuco-*




COCCIDÆ.

W. M. Maskell, del.

*pogon fraseri*, on which *Planchonia epacridis* is found, are often pretty closely imbricated, and there would be considerable difficulty for the male to impregnate the female if the abdomen of the latter were turned towards the stem of the plant. By turning the abdomen towards the tip of the leaf the male may with ease reach the female through the opening, just mentioned, between the portions of the test. Accordingly, in several scores of specimens which I have examined, the abdominal extremity of the test is directed to the tip of the leaf.

The test, in all cases which I have seen, is of two colours: one half, at the cephalic end, is dark green, the other, or abdominal half, is bright yellow. All round the edge runs, as in the second stage, a long silver fringe in double row, one row over the other. The contrast of these colours with the dark reddish-brown of the leaf is extremely beautiful. Average length of the test $\frac{1}{15}$ to $\frac{1}{20}$ inch, exclusive of fringe.

The insect fills the whole test until gestation, after which it shrivels up, as in the *Lecanio-diaspidæ*, towards the cephalic end. It is, therefore, convex above, flat below. Antennæ, as in the second stage, reduced to rings with hairs (fig. 34). Feet entirely absent. The four spiracles are somewhat large: there are no spiracular spines as in *Lecanium*. Anal tubercles small, each bearing a seta: anal ring with six hairs. Along the edge of the body is a row of the figure-of-8 spinnerets, as shown in fig. 36: and all over the dorsal surface are a large number of simple circular spinneret orifices from which the test is secreted. Also a number of protruding tubes which stand out irregularly over the body like minute fingers, each cylindrical with a slight expansion at the tip. The mentum is uni-articulate, globular: the rostral setæ are short.

On *Leucopogon fraseri*, as yet only from Amberley, where it seems to be pretty abundant in one locality.

Having been obliged to send back to France my copy of M. Signoret's work on the Homoptera (the only work of reference available for the order at present), I am unable to say positively that *Planchonia epacridis* is a new species. It is possible too that I may have been mistaken in assigning its generic position, for I am not clear that the European *Planchonia* has not a felted, instead of a waxy or glassy test. Of course such a difference would be radical, because the secretion of wax and the secretion of felted matter would mean a different description of organs. However, the occurrence of the insect in a locality far removed from imported plants would seem to point to its being, at least, indigenous. I found it always on *Leucopogon*, growing amongst the tussacks and native plants, with only here and there a rare specimen of English grass or clover, from neither of which was it likely to have come. Whether it is a new species, or identical with one in Europe, it seems probable that it has not been *introduced* here first in the out-of-the-way locality where I found it.

*Planchonia* would seem to link the Lecanidæ to the Coccidæ even better than *Kermes*.

### 2nd Subsection.—Monophlebidæ.

(Trans., vol. xii., p. 294).

Antennæ of eleven joints in the adult female.

### 1st Genus, **Icerya**, Signoret.

(Trans., vol. xi., p. 220).

Mr. Comstock informs me that a species, which he takes to be my *Icerya purchasi* (Trans., vol. xi., p. 221), is committing great ravages in California, on limes, oranges, etc., and he has some suspicion that it arrived there from Australia. This, I think, is not at all unlikely. In describing the species in 1878 I mentioned that it had only lately appeared in Auckland, and I found it on an Australian plant, the kangaroo acacia. When in Australia a few months ago, I observed at Ballaarat an insect certainly an *Icerya*, but I think not *I. purchasi*: but I had no opportunity of bringing away a single specimen. As mentioned in my first paper, the Mauritian *Icerya* differs in some particulars from ours: probably also in Australia the genus may have several representatives, of which one has travelled to California and New Zealand.*

### 2nd Genus, **Cœlostoma**, mihi.

*Cœlostoma zealandicum*, mihi.

(Trans., vol. xii., p. 294.)

The young insect, adult female and adult male of this species, is correctly described in my paper in vol. xii.; but the second stage of the female is incorrect. At p. 297 of that volume I mention that *Cœlostoma* was found at Lyttelton "interspersed with another curious Coccid:" this other turns out to be the second stage of the female *Cœlostoma*. If, however, I had not actually extracted a fullgrown *Cœlostoma* from this stage, seen it, that is, actually emerge, I should not have imagined the possibility that the two were really one and the same insect at different ages, so much do they differ from each other.

In the second stage, the female is torpid, stationary, enclosed in a solid, hard, round test or shell of thick yellow wax. Some of these tests (fig. 23), attain the size of a large pea; they are very strong and thick; the wax is not soluble in alcohol. Often from an orifice at one end a long white seta

* Since writing this paper I have received from Dr. Hector specimens of *I. purchasi* from Napier. It had evidently travelled thither either from Auckland or Australia. It was greatly damaging *Acacia decurrens*.

protrudes (fig. 23); this springs from the anal extremity of the insect. The tests almost wholly enclose the insect, only a little space being left on the underside.

The insect itself completely fills its waxy shell. It is deep red in colour, almost spherical, quite smooth and hard, but the skin is somewhat thin, so that in detaching it from the test it is easy to wound it. The outline is smooth and free from corrugations (fig. 24), except that a few fine line-like grooves traverse it; in general appearance it is like a round, hard, red ball. No hairs are visible, but from the anal extremity, which is darker in colour than the rest, springs a long white seta protruding through the test. This seta is tubular, glassy, and at the point where it leaves the body there is a short tuft of white cotton.

At first sight there seem to be no organs—feet, antennæ, or rostrum; but closer inspection reveals them all, of very small size. The mentum is tri-articulate, and has a few hairs at its tip. The rostral setæ are short.

The antennæ (fig. 25) are very short, and can be of little use, shut up as the insect is in its shell. They are broad at the base, tapering in a somewhat regular cone, with eight joints, of which the first seven are very short, the eighth a little longer and rounded at the tip. On all the joints a few hairs.

The feet (fig. 26) are completely atrophied, and I can only make out three joints besides the claw: there seems to be no trochanter: digitules, I think, only two, both extremely minute. The whole leg has a fat, bloated appearance.

On maceration in potash, to get rid of the interior substance, it is seen that the skin is marked with a great number of spinneret orifices, of two sizes. They are all circular; the larger seem to be simple; the smaller have an inner tube made up of several circles. The tracheæ are enormous, with conspicuous spiral markings; they abut in sixteen large circular spiracles. The spiracles and the tracheæ for a short distance form brown tubes having, a little way within the body, a kind of crown of beads, so that they look like brown goblets receiving the ends of the tracheæ. Towards the anal extremity is a large patch coloured brown, of which the anal orifice is the centre; in this the spinnerets are much more numerous, and their tubes seem to converge towards the anus.

The anal orifice itself forms the extremity of a large tube, exactly resembling that which, in my description of the adult female, I termed the oviduct. From this tube, which is never itself exserted, springs the seta spoken of above. I fail to make out the use of this tube and seta in this stage.

The insect at this stage emits a strong and fetid odour, peculiarly unpleasant, which clings for some time to the fingers after handling it or its tests.

I append figures (figs. 27, 28, 29) of the male and its organs, to illustrate the description given in vol. xii., p. 297.

The tests of this second stage were found by me very common on *Muhlenbeckia*, growing amongst the rocks on the Sumner road, Lyttelton, chiefly on the roots and the underground portions of the stems. Often a stem was covered with hundreds of the waxy shells, some of them as large as a small marble. I have since found them on various trees in the forests, where the adult form of *Cœlostoma* may be commonly found in late summer crawling about the pines and other trees. In February and the beginning of March it is not uncommon to find a female almost covered by a cluster of the large males, which present an elegant appearance with their purple bodies and blue wings with red nervures. This is certainly the largest Coccid known to me, and I think it not unlikely to be the one mentioned by Westwood (Int. to Mod. Class. of Ins., vol. ii., p. 450), as sent to him from New Holland :—" A gigantic female, which has much the appearance and size of a full grown larva of *Œstrus bovis*."

I know of no species undergoing transformations like those of *Cœlostoma*. In many species the young insect is free and the later stages torpid, whether naked or enclosed in tests. But there is usually some indication, at least, in the second stage of the appearance of the adult insect. Thus, in the Diaspidæ, the legs and antennæ gradually disappear, the test or puparium increasing with age. In *Ctenochiton* the test makes its appearance early but preserves the same general character to the last stage. In *Icerya* the growth of the cotton is progressive, and the various distinguishing marks can be traced throughout the life of the insect. But in *Cœlostoma* the changes are almost radical. The young insect, hatched in soft white cotton, secretes a white, scanty and thin, meal : in the next stage it secretes a very thick, hard wax ; and again in its adult state it secretes meal which gradually produces a close web of white cotton. The young insect is free and active : the second stage is torpid, enclosed, with atrophied limbs : the adult again is active and free until gestation. To be sure, there are characters found almost alike in all stages. Thus, the spinneret orifices are much the same all through, with the exception of those round the anal orifice in the second stage, which may perhaps be those specially used for secreting the wax. And the organ which I have called the oviduct may be traced through all the stages, from the newly hatched young to the old female : with the exception, however, of the second stage of the male, which nearly resembles the adult female, but has antennæ of nine joints, no "oviduct," and only very few spinnerets.

It appears to me clear that *Cœlostoma*, with all the characters which I have described, is certainly new.

## EXPLANATION OF PLATES XV. AND XVI.

| | | |
|---|---|---|
| Fig. 1. | *Mytilaspis pyriformis*, male .. .. .. .. .. | × 25 |
| Fig. 2. | ,, ,, ,, antenna .. .. .. .. | × 60 |
| Fig. 3. | ,, ,, ,, foot .. .. .. .. .. | × 200 |
| Fig. 4. | ,, ,, ,, haltere .. .. .. .. | × 200 |
| Fig. 5. | *Ctenochiton piperis*, female, 2nd stage .. .. .. .. | × 50 |
| Fig. 6. | ,, ,, ,, in test, dorsal view .. .. .. | × 20 |
| Fig. 7. | ,, ,, ,, antenna .. .. .. .. | × 90 |
| Fig. 8. | ,, ,, ,, foot .. .. .. .. .. | × 90 |
| Fig. 9. | *Inglisia leptospermi*, test .. .. .. .. .. .. | × 15 |
| Fig. 10. | ,, ,, ,, .. .. .. .. .. .. | × 15 |
| Fig. 11. | ,, ,, female, dorsal view .. .. .. | × 15 |
| Fig. 12. | ,, ,, ,, under view .. .. .. | × 15 |
| Fig. 13. | ,, ,, ,, side view .. .. .. .. | × 15 |
| Fig. 14. | ,, ,, ,, antenna .. .. .. .. | × 90 |
| Fig. 15. | ,, ,, ,, foot.. .. .. .. .. | × 90 |
| Fig. 16. | ,, ,, ,, claw .. .. .. .. | × 200 |
| Fig. 17. | ,, ,, ,, 2nd stage, skin with spines .. | × 200 |
| Fig. 18. | *Lecanochiton metrosideri*, young insect, antenna .. .. | × 90 |
| Fig. 19. | ,, ,, ,, ,, foot .. .. .. | × 90 |
| Fig. 20. | ,, ,, female, 2nd stage .. .. .. | × 30 |
| Fig. 21. | ,, ,, ,, test, dorsal view .. .. | × 30 |
| Fig. 22. | ,, ,, ,, 3rd stage, antenna .. .. | × 200 |
| Fig. 23. | *Cœlostoma zœlandicum*, tests of 2nd stage .. .. | natural size. |
| Fig. 24. | ,, ,, female, 2nd stage, under view .. | × 2 |
| Fig. 25. | ,, ,, ,, ,, antenna .. .. | × 60 |
| Fig. 26. | ,, ,, ,, ,, foot .. .. | × 60 |
| Fig. 27. | ,, ,, male .. .. .. .. .. | × 4 |
| Fig. 28. | ,, ,, ,, antenna .. .. .. .. | × 10 |
| Fig. 29. | ,, ,, ,, foot .. .. .. .. | × 10 |
| Fig. 30. | *Planchonia epacridis*, young insect .. .. .. .. | × 60 |
| Fig. 31. | ,, ,, ,, ,, antenna .. .. .. | × 200 |
| Fig. 32. | ,, ,, ,, ,, foot .. .. .. | × 200 |
| Fig. 33. | ,, ,, female, 2nd stage, under view .. | × 20 |
| Fig. 34. | ,, ,, ,, remains of antennæ .. .. | × 350 |
| Fig. 35. | ,, ,, ,, test of adult on leaf .. .. | × 10 |
| Fig. 36. | ,, ,, ,, edge with spinnerets .. .. | × 350 |
| Fig. 37. | ,, ,, ,, fringe of adult .. .. | × 200 |

## Art. XXX.—*Additions to the Crustacean Fauna of New Zealand.*

By George M. Thomson, F.L.S.

[*Read before the Otago Institute, 22nd November*, 1881.]

Plates XVII. and XVIII.

### Stomapoda.

### Genus **Squilla**, Fabricius.

1. *S. tridentata*, n. sp.

Carapace quite smooth, broadening posteriorly; its front transverse and unarmed, as are its smooth lower margins. Rostral plate triangular, about as long as broad, sub-acute. Large prehensile limbs, with the terminal joint as long as the hand and furnished with *three spines;* palm of the hand finely serrate. Terminal segment of the abdomen with a very short central ridge terminating in a spine, and two lateral ridges similarly spined but very imperfectly developed; posterior border with six short spines, the two central ones being articulated and moveable.

Colour yellowish, with a few minute black dots on the carapace and frontal organs. Length, 0·75 inch.

*Hab.* Only one specimen was obtained by the dredge in Port Pegasus, and apparently—to judge by its small size—it was a very young one. In general appearance and in the majority of its characters this agrees with *S. indefensa*, T. W. Kirk; but that species has *nine* teeth on the fingers of the large prehensile limb, and this feature seems to be very characteristic of species, and very persistent.

### Isopoda Aberrantia.

### Fam. ANTHURIDÆ.

### Genus **Paranthura,** Bate and Westwood.

(Brit. Sessile-eyed Crust., vol. 2, p. 163).

Body long and slender. Head distinct from the first segment of the pereion. Antennæ short, subequal. First pair of legs large and subchelate, six succeeding pairs subequal. All the segments of the pleon distinct, and carrying six pairs of pleopoda. Middle tail-piece ovate, obtuse.

1. *P. costana*, Bate and Westwood (*l.c.*, p. 165, figured).

Cylindrical; segments of the pereion subequal in length. Hand of the first pair of legs very large, smooth, and bearing a small tubercle on its inner and under surface. The middle tail-piece is smooth and rounded at the extremity. All six pairs of pleopoda two-branched; last pair with the outer branch one-jointed and foliaceous, inner branch two-jointed and placed horizontally.

Colour pale-yellowish, covered with small black spots. Length about 0·25 inch.

*Hab.* One specimen of this interesting Crustacean was obtained among some seaweed washed up on the beach near the mouth of the Taieri river. It differs from the figure (given in Brit. Sess.-eyed Crust.) in having more slender limbs with the exception of the first pair; otherwise it agrees perfectly. This species has hitherto only been recorded from the English and French coasts, and from the Mediterranean.

### Amphipoda Normalia.

### Sub-fam. Lysianassides.

### Genus **Anonyx**, Kröyer.

Superior antennæ short, the peduncle very large at the base, and furnished with a secondary appendage. Mandibles with a smooth incisive margin, and no secondary plate, and having an appendage. First pair of gnathopoda subchelate; second pair long, slender, feeble, rudimentary, subchelate. Telson single, squamiform, entire or cleft.

(The characters on which this genus is separated from *Lysianassa* are very insufficient, being mainly subchelate nature of the first pair of gnathopoda, and secondly the cleft telson. The first species following is an *Anonyx* in all respects, except that its telson is entire, which is the case also with *A. plautus*, Kröyer, an European species.)

1. *A. corpulentus*, n. sp.

Pl. XVII., fig. 1.

Cephalon rounded in front, hiding the antennæ. Pereion greatly distended, so as to give the animal a very corpulent appearance; coxæ very deep. Eyes not appreciable. Superior antennæ short and very thick; basal joint cylindrical, hardly longer than it is thick, two following very short; secondary appendage minute, 2-jointed; flabellum slightly longer than peduncle, tapering, 4-jointed, first joint as long as or longer than the next three, setose below. Inferior antennæ slender, subequal with the superior; second and third joints of peduncle long, and subequal with the 6–7-jointed flagellum. Gnathopoda small; first pair densely fringed below with simple hairs; propodos narrowing to the extremity, lower margin without a distinct palm; dactylos curved; second pair very slender, with tufted setæ on the lower margin, propodos about three times as long as broad, with a small curved dactylos. Four anterior pairs of pereiopoda subequal, slender, naked, with narrow basa; fifth pair short, setose, and with the basa dilated into wide, rounded, squamiform plates. Three posterior pairs of pleopoda terminating subequally, naked. Telson short, entire, rounded. Length 0·23 inch. Colour yellowish.

*Hab.* Dredged in Paterson Inlet, in 8 fathoms.

2. *A. exiguus*, Stimpson.

Pl. XVIII., fig. 2.

This species is most imperfectly described in the Brit. Mus. Cat., p. 75, so that it is not easy to identify, as even the figure—unless accompanied by drawings of separate parts—is not complete enough in its detail. The following is all the description given:—"Pleon having the third segment tumid posteriorly, and curved down towards the fourth; the posterior margin deeply concave; the infero-posterior angle produced and directed upwards; fourth segment having a deep dorsal sinus. Pereiopoda having the dactylos long and slender; basos of the three posterior margins deeply serrated along the posterior margin."

To which I add the following as descriptive of specimens obtained by me:—Eyes very inconspicuous. Superior antennæ with a 5-jointed flagellum; secondary appendage 3-jointed, half as long as the flagellum. Inferior antennæ twice as long as superior. Mandibles with rows of strong teeth on the cutting edge. First gnathopoda having the carpus and propodos subequal, the latter slightly ciliated, and with a well-defined palm. Second gnathopoda having the propodos shorter than the carpus, oval, densely ciliated, destitute of a palm, and having a very small dactylos. Third pereiopoda the shortest; fifth pair with broad basa. Length, 0·25 inch.

*Hab.* Dredged in Paterson Inlet, in 8 fathoms.

The type specimens were obtained by Stimpson "on sandy bottoms in 8–15 fathoms" off the east coast of North America.

Sub-fam. PHOXIDES.

Genus **Phoxus,** Kröyer.

Superior antennæ with a secondary appendage, inferior pair as long as the superior. Mandibles with an appendage. Maxillipeds subpediform. Both pairs of gnathopoda subchelate. Coxæ deeper thon the respective segments. Posterior pair of pereiopoda shorter than the preceding. Telson double.*

1. *P. batei*, W. A. Haswell (Proc. Linn. Soc. N.S.W., vol. iv., p. 259).

Cephalon produced into a long obtuse hood, extending almost to the end of the peduncle of the superior antennæ. Eyes ovate-reniform, black, conspicuous. Antennæ short: flagellum of superior pair longer than the base; secondary appendage about two-thirds as long as flagellum: inferior pair rather exceeding the superior; peduncle much exceeding the flagellum, joints flattened, bearing numerous short obtuse spines on their upper surface, and long setæ on their outer margins. Gnathopoda subequal and

* In the generic character given in the Brit. Mus. Cat., p. 97, it is said:—"Eyes not appreciable," a footnote pointing out that the diagnosis is doubtful. In some of my specimens the eyes had lost most or all of their pigment, but in others they were very black.


NEW ZEALAND CRUSTACEA.

C. M. Thomson, del.

similar; propodos subquadrate, about twice as long as broad, palm nearly transverse, slightly oblique, with a double row of numerous, close-set, short spines, and its point of impingement defined by a tuft of long spines and setæ. Coxæ of both pairs of gnathopoda and of the first two pairs of pereiopoda fringed with 10-12 simple hairs on their inferior margins. All the pereiopoda more or less fringed with intermingled spines and setæ; fourth pair the longest; third and fourth pairs with the basa slightly dilated; fifth pair short, with the basa dilated into large squamiform plates, which are serrated on their posterior margins. Pleopoda terminating subequally, their bases longer than the rami, and furnished with rows of short spines; posterior pair with the rami unequal, the outer branch being 3-jointed, the inner simple, narrow, and acute. Telson deeply 2-cleft, the divisions rounded at their extremity, and with about three short subapical spines.

Length about ·35 inch. Colour yellowish; carapace of a thick, somewhat horny consistence.

*Hab.* Dredged in Paterson Inlet, 7 fathoms.

This species was first described by Mr. Haswell, who obtained it by the dredge in Port Jackson; the figure given of it in the journal quoted above is, however, not very satisfactory. In the original description the only points of difference between the Australian form and ours are immaterial; the flagellum of the appendage to the superior antennæ being 6-jointed. The species is quite distinct from any other described, its nearest ally being the European *P. holbölli*, Kröyer, from which it differs in several respects.

Genus **Polycheria**, W. A. Haswell.

(Linn. Soc. N.S.W. Proc., vol. iv., p. 345).

"Pereion broad; pleon compressed, more or less carinate. Antennæ subequal; superior pair without an appendage. Mandibles without an appendage. Maxillipedes with well-developed squamiform process. Gnathopoda small, subchelate. Pereiopoda all prehensile, with narrow basa. Posterior pleopoda biramous with equal rami. Telson double."

Before Mr. Haswell's description was published, I had obtained a species of this genus, and by a remarkable coincidence drew out a generic description, giving it the name *Polychelia*, from its many claws. Mr. Haswell says of this very distinct genus, "*genus incertæ sedis.*" In the present confused arrangement of the genera of the sub-class Gammarides, it is certainly most difficult to assign it a correct position. It appears to me, however, to be most near *Dexamine.*

1. *P. obtusa*, n. sp.

Pl. XVII., fig. 3.

Body tumid, not compressed. Eyes large and prominent. Superior antennæ about two-thirds as long as the body; first joint of peduncle short and stout, second slender and twice as long, third not distinguishable from the first joint of the flagellum, which is multi-articulate, twice as long as peduncle, with long setæ on its lower margin. Inferior antennæ rather shorter than superior; first joint of peduncle very short, second and third long and slender, flagellum slightly longer than peduncle, sparingly setose. Gnathopoda similar, second pair rather the longest, with numerous setæ; propodos oblong, with a narrow base, furnished with four or five rows of setæ on the back; dactylos slender, curved. Pereiopoda slender, subequal, sparingly spinose; ischium very short; meros as long as carpus and propodos together; latter with a transverse palm, which has a long tooth in the middle, and two or three shorter ones at the point of impingement of the curved dactylos. Telson acute, each division bearing six short spines on its outer margin, and a small tooth near its extremity.

Colour yellowish. Length 0·3 inch.

*Hab.* Dredged in Paterson Inlet, in about 10 fathoms.

This species is very near *P. tenuipes*, Haswell, an Australian form, but differs in having over twenty joints in the flagella of both pairs of antennæ, in the length of the inferior antennæ, and in the spinous palms of the pereiopoda. It is questionable whether such characters are sufficient to establish the specific rank of the differing forms, but the relative values of varying parts is not yet well understood in the Amphipoda, nor are sexual differences and those due to the age of the specimens duly taken into consideration.

### Sub-fam. Gammarides.

### Genus **Leucothoë**, Leach.

Body long, compressed. Antennæ simple, subequal. Maxillipeds subpediform, unguiculate. Mandibles having an appendage. Four anterior pairs of coxæ as deep as their respective segments. First pair of gnathopoda having the carpus inferiorily produced to the extremity of the propodos; propodos slender; dactylos short: second pair having the carpus inferiorly produced to half the length of the propodos; propodos ovate; dactylos long. Pereiopoda subequal, slender. Posterior pair of pleopoda having two long lanceolate rami. Telson single, squamiform.

1. *L. traillii*, n. sp.

Pl. XVIII., fig. 1.

Body rather slender. Cephalon slightly produced between the bases of the superior antennæ. Eyes rounded, large. Superior antennæ one-fourth the length of the body; first joint of the peduncle stout; second subequal with it, but slender; third very short, flagellum few-jointed (about 4?) shorter than the basal joint of the peduncle. Inferior antennæ arising at some distance behind and below the superior, subequal with them, but more slender; peduncle slightly exceeding that of the superior; flagellum about

5-jointed, shorter than the last joint of the peduncle. Mandibular appendage very slender, 3-jointed. First gnathopoda with the basal joints slender; meros very small; proximal end of the carpus flattened into a circular disc, distal end tapering to an acute point, produced to about two-thirds the length of the propodos, which is elongated and without any distinct palm; dactylos curved, about one-third as long as the propodos, finely serrated on its inner margin. Second gnathopoda with the carpus produced to two-thirds the length of the propodos, ending in a curved spine and bearing numerous hairs; propodos large, oval, its lower margin with numerous dentations, a tuft of hairs at its upper extremity; dactylos curved, half as long as the propodos. Pereiopoda slender; three last pairs with wide basa, which are crenated on their posterior margins. Three posterior pairs of pleopoda with narrow-lanceolate, nearly smooth rami. Telson narrow, tapering to a sub-acute, entire apex. Integument rather thin, semi-transparent. Length 0·35 inch.

*Hab.* Two specimens were obtained, one from Port Pegasus (5 fathoms), and a smaller one in Paterson Inlet (in about 10 fathoms).

I have named this species after Mr. Charles Traill, of Cooper Island, Paterson Inlet, a gentleman who has aided much in the investigation of the Fauna and Flora of Stewart Island.

Genus **Moera**, Leach.

Long and slender. Superior antennæ appendiculate, much longer than the inferior. Inferior antennæ a little posterior to the superior, having the peduncle much longer than the flagellum, and not reaching to the extremity of the peduncle of the superior. Oral appendages receding. Mandibles having an appendage. Four anterior coxæ not so deep as their respective segments; three posterior not much shorter than the preceding. Gnathopoda unequal; second pair much the larger. Pereiopoda slender, subequal. Posterior pair of pleopoda biramous, subfoliaceous. Telson double.

1. *M. quadrimanus*, Sp. Bate (Brit. Mus. Cat., p. 194).

"Slender; coxæ narrow. Superior antennæ half as long as the body; base a little longer than the flagellum; first and second joints long, subequal, third very short; flagellum pubescent; setæ longer than articuli, and hardly divaricate; secondary appendage rather longer than half the flagellum. Inferior antennæ shorter; base shorter than base of superior pair; flagellum very short. First pair of gnathopoda quite small; propodos oblong, hirsute below, narrower at base; propodos of second pair equal, very large, subquadrate; apex transverse, defined by a spiniform acute immoveable tooth; palm tri-dentate, teeth prominent; dactylos hardly longer than palm. Two posterior pairs of pereiopoda subequal, the fifth a little the shorter, the joints at their posterior apices densely hirsute; other setæ short."

This species was obtained by Dana from coral-reefs at the Fijis, and described as above.

Numerous specimens of a form almost identical with Dana's species were obtained by me in Paterson Inlet with the dredge. They differ in having the palm of the second pair of gnathopoda rather oblique and furnished with irregular dentations (see pl. XVII., fig. 4A), and in the fifth pair of pereiopoda being rather longer than the fourth. The length varied from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch, and all were of a uniform yellowish-white colour.

Another form of the same—apparently variable—species was obtained under stones, between tide-marks, from the same locality. Besides being of slightly larger size, it was of a dirty green colour, and had the teeth of the palm of the second gnathopod more sharply defined, in this respect resembling the typical form (see pl. XVII., fig. 4B).

A third form, with a more sharply defined palm still than the last, and with longer spines and numerous hairs on the propoda of the second gnathopoda, was taken by the dredge in Port Pegasus from a depth of 5 fathoms.

(Originally described by Dana from Fiji specimens).

2. *M. petriei*, n.sp.

Pl. XVIII., fig. 3.

Coxæ not so deep as their respective segments. Fourth segment of pleon produced into two acute spines on its postero-dorsal margin, and having its postero-inferior angles also acutely pointed. Eyes oblong, black. *Superior antennæ as long as the body*; peduncle having its first joint as long as the second, but twice as broad, third short; secondary appendage shorter than last joint of peduncle, about 6-jointed; flagellum subequal with peduncle, very many-jointed (about 50–60), joints at first more than twice as long as broad, all setose. Inferior antennæ less than half as long as superior; flagellum about 14-jointed, half as long as the peduncle. First pair of gnathopoda having the carpus and propodos subequal, the latter oblong, with an ill-defined oblique convex palm and a slender curved dactylos; dense rows of hairs occur on the extremity of the meros, and transversely on the lower side of the carpus and margins of the propodos, while the latter also bears numerous oblique or transverse rows of short spine-like hairs. Second pair of gnathopoda very large; basos deeply hollowed out in front, so as to form a groove for the propodos; ischium, meros, and carpos very short, the latter about three times as broad as long; propodos large, ovate, distally produced into a large curved tooth on each side of the articulation of the dactylos, terminal half of the lower surface with a deep groove to receive the dactylos, whole lower surface very densely fringed with two rows of long simple hairs; dactylos strong, arcuate, sinuously toothed on its inner margin, blunt. First and second pairs of pereiopoda slender, three


NEW ZEALAND CRUSTACEA.

C.M.Thomson. del.

posterior pairs broader and more hirsute; third pair shortest. Posterior pleopoda having the rami subequal and densely fringed with hairs at their extremity. Telson having each division slightly hollowed out at the apex, with the inner edge acutely toothed, and two setæ springing from the hollow.

The integument is of a remarkably horny consistence.

Colour yellowish. Length 0·5 inch.

*Hab.* Only two specimens of this very distinct species were taken in the dredge in Port Pegasus. I have named it in honour of my fellow-worker and companion on the cruise, Mr. D. Petrie.

### Fam. COROPHIIDÆ.

### Genus **Iphigenia**, n. gen.

Pl. XVIII., fig. 4.

Body much depressed and flattened. Antennæ short and thick, subequal. Coxæ of the first four segments of the pereion very large, those of the succeeding segments small. Basa of the three pairs of posterior pereiopoda dilated. Gnathopoda simple, unguiculate. Three posterior pairs of pleopoda very small, curved inwards, with minute simple rami. Telson single, entire.

The very remarkable Crustacean (Amphipod) for which this genus has been formed, appears on first inspection to be an Isopod. It is only after closer examination that it is seen to be allied to *Icillius*, Dana, one of the most anomalous forms of the Corophiides. From this genus it is, however, at once distinguished by the very large coxæ of the four anterior segments of the pereion, and by its short, thick, subequal antennæ.

1. *I. typica*, n. sp.

Segments of the pereion and part of the pleon slightly ridged on the dorsal median line, and produced upwards into tubercles. Cephalon produced forward laterally into acute lobes in the angles of which the eyes are placed. Coxæ of first four segments of the pereion quadrangular, much deeper than their respective segments, apparently projecting horizontally. Antennæ hardly more than one-sixth as long as body: superior pair with the basal joint broad, flagellum very short, about 4-jointed, and furnished with long setæ; inferior pair terminated by a short 5-jointed flagellum, and bearing numerous short setæ. Gnathopoda subequal; propodos without a palm, dactylos simply unguiculate, and bearing a curved spine on its inner margin. First and second pereiopoda similar to the gnathopoda. Basa of the third pair very broad, of the succeeding pairs narrower. Pleon narrowing posteriorly. Three last pairs of pleopoda with thick, styliform rami; ultimate pair with a row of tooth-like spines on its upper surface. Telson about as broad as long, nearly semicircular, quite entire.

Length 0·12 inch.

*Hab.* Two specimens were obtained by the dredge in Otago Harbour.

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EXPLANATION OF PLATES XVII. AND XVIII.

PLATE XVII.

Fig. 1. *Anonyx corpulentus* × 7; *a*, sup. antenna × 20; *b*, inf. antenna × 20; *c*, 1st gnathopod × 20; *d*, 2nd gnathopod × 20; *e*, 5th pereiopod × 20; *f*, telson and posterior pleopoda × 20.

Fig. 2. *Phoxus batei*, *a*, head and antennæ, seen from above, × 26; *b*, 2nd gnathopod × 20; *c*, 3rd pereiopod × 20; *d*, 5th pereiopod × 20; *e*, telson and posterior pleopoda × 20.

Fig. 3. *Polycheria obtusa* × 13; *a*, mandible × 50; *b*, 2nd pereiopod × 20; *c*, extremity of 4th pereiopod, showing prehensile fingers, × 75; *d*, telson and posterior pleopoda × 20.

Fig. 4. *Moera quadrimanus*, *a*, hand of second gnathopod × 13, taken from dredged specimens; *b*, same taken from littoral specimen.

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PLATE XVIII.

Fig. 1. *Leucothoe traillii*, *a*, cephalon and antennæ × 20; *b*, 1st gnathopod × 20; *c*, 2nd gnathopod × 20; *d*, telson × 20.

Fig. 2. *Anonyx exiguus*, *a*, mandibles × 75; *b*, 1st gnathopod × 44; *c*, 2nd gnathopod × 44; *d*, 5th pereiopod × 44; *e*, telson and posterior pleopoda × 75.

Fig. 3. *Moera petriei* × 5; *a*, 1st gnathopod × 20; *b*, 2nd gnathopod × 13, with dactylos separate; *c*, telson and posterior pair of pleopoda × 20.

Fig. 4. *Iphigenia typica* × 13: *a*, superior antennæ; *b*, inf. ant.; *c*, maxillipeds; *d*, 1st gnathopod; *e*, dactylos of same; *f*, penult. pleopoda; *g*, telson and last pair of pleopoda;—all these parts × 44, except *e* × 75.

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## ART. XXXI.—*On the* Notornis.

By WALTER L. BULLER, C.M.G., Sc.D., F.R.S.

[*Read before the Wellington Philosophical Society, 3rd September*, 1881.]

THE capture of a specimen of the rare *Notornis mantelli* in the South Island, is an event of sufficient importance to warrant a special memoir in our "Transactions," and I have therefore much pleasure, at the request of our president, in bringing before you this evening all the information I have been able to collect on the subject.

I may here mention—and I do so with regret—that the specimen which I am about to describe is no longer in the colony, having been despatched by the Waitangi about three weeks ago for sale in England.

Every effort was made by Dr. Hector and others to retain possession of it for one of our local Museums, and immediately before its departure from our shores I wrote myself to the owner offering him fifty pounds for the skin, but to no purpose.

It will be interesting to watch its ultimate fate; but as there are already two fine examples in the National Collection, it will most probably find its way into one of the Continental or American Museums. Although we have failed to detain the prize, there is every reason to believe that the species still survives in the land, and that it will yet be added to the type collection in the Colonial Museum. It is a curious fact, illustrating the wide range of a bird supposed to be nearly extinct, that the three known examples have been obtained at localities nearly a hundred miles apart from each other, and over an interval of thirty-five years. As the species belongs to a gregarious family, and as the general character of its habitat is rough and inaccessible in the extreme, I think it may be fairly inferred that many yet survive to reward the future search of the Southern naturalist.

The two fine specimens now in the British Museum (supposed to be male and female) were obtained through the exertions of our former president, the Hon. Walter Mantell, after whom the bird was named. The first of these was captured alive in 1849 by a party of sealers at Duck Cove, on Resolution Island, Dusky Sound. "Perceiving the trail of a large and unknown bird on the snow, with which the ground was covered, they followed the footprints till they obtained a sight of the *Notornis*, which their dogs instantly pursued, and after a long chase caught alive. It ran with great speed, and upon being captured uttered loud screams, and fought and struggled violently. It was kept alive three or four days on board the schooner and then killed, and the body roasted and eaten by the crew, each partaking of the dainty, which was declared to be delicious." The second of Mr. Mantell's specimens was caught by the Maoris on Secretary Island, opposite to Deas Cove, Thompson Sound. This also was eaten, but fortunately the skin was preserved and sent to England to join the other, and (as already mentioned in my "Birds of New Zealand") these members of an expiring race, "having been carefully mounted by Mr. Bartlett, now stand side by side in the National Collection of Great Britain, and, like the remains of the Dodo in the adjoining case, daily attract the attention of thousands of eager visitors."

The third specimen to which I have specially to refer this evening, was obtained last year, on what are called the "Bare-patch Plains," on the eastern side of Te Anau Lake. The circumstances of the capture were thus narrated to me by Captain Hankinson, on whose property it occurred. A man who was engaged "rabbiting" on the run, had camped on the

Maruroa Flat, not far from the homestead. One day his dogs ran down a large bird, and on coming up he found it alive and unharmed. Taking the bird from the dogs he deliberately killed it, took it to his tent and hung it up to the ridge pole. On the following day the station manager (Mr. J. Connor), in making his customary round, visited the camp. The rabbiter had just struck his tent, and calling the manager's attention to the dead bird, still suspended to the ridge pole, told him he might have it. Mr. Connor, who was intelligent enough to suspect that he had found a *Notornis*, at once accepted the offer and took the bird home to the station, where he carefully and very successfully skinned it, preserving also all the bones of the body.

The weather had been exceptionally severe, and it is supposed that this was how the *Notornis* came to be found on the flats, having been driven down from the high country. The man who caught it said that it seemed quite tame, whereas Mantell's bird (as already mentioned) made a vigorous resistance on being taken.

Professor Parker having undertaken to describe the skeleton for our "Transactions," Dr. Hector invited me to undertake the same duty in regard to the skin, in order that, in default of the specimen itself, we might have on record in the colony as complete a monograph as possible of this interesting bird. I cheerfully undertook the task, and made a visit to Dunedin specially for this purpose.

On being introduced to this *rara avis* I experienced again the old charm that always came over me when gazing upon the two examples in the British Museum—the lingering representatives of a race co-existent in this land with the colossal Moa! Then, retiring to the Museum Library, I shut myself in with *Notornis*, handled my specimen with the loving tenderness of a true naturalist, sketched and measured its various parts, and made a minute description of its plumage.

Like many other New Zealand forms of an earlier period, the *Notornis* is the gigantic prototype of a well known genus of Swamp Hens. It is, in fact, to all appearance a huge Pukeko *(Porphyrio)*, with feeble or aborted wings, and abbreviated toes, the feet resembling those of *Tribonyx*—a bird incapable of flight, but admirably adapted for running. Similar, no doubt, was the relation borne by the powerful *Aptornis* to our present Woodhen *(Ocydromus)* ; but in that case the prototype has disappeared, leaving only its fossil bones for the study of the scientist, and its place in nature to be filled by its existing diminutive representatives.

The interest attaching to *Notornis* has been greatly enhanced by the discovery that the white Swamp Hen, of Norfolk Island, belongs to the same genus, as this has an important bearing on the study of geographic distribution.

The characters of the genus *Notornis* were first determined by Professor Owen, in 1848, from certain fossil remains collected by Mr. Mantell in the North Island of New Zealand, and consisting of the skull, beaks, humerus, sternum, and other parts of the skeleton of a large brevipennate Rail. The sagacity with which the learned professor had interpreted these bones, and the absolute correctness of his prevision, were exemplified in the discovery which enabled Mr. Gould, in 1850, to communicate to the Zoological Society the complete generic characters of the bird, already known to science as *Notornis mantelli*, Owen. In illustration of these, Mr. Gould furnished to the society a coloured sketch of the head of *Notornis*, in his usual artistic style; and at a later period he published, in the supplement to his "Birds of Australia," a full-sized drawing of the bird. These plates are very beautiful, but on a close comparison with the specimen to which these notes more especially refer, I find that some of the minor features have been overlooked by the artist, or sacrificed to pictorial effect. In the following descriptive notes, I have, therefore, deemed it best to record the characters (generic as well as specific) with some minuteness of detail.

The bill is somewhat shorter than the head, greatly compressed on the sides, and much arched above, the culmen having a convex or rounded aspect, with a uniform width of $\frac{3}{8}$ of an inch from above the nostrils to within half an inch of the tip, when it rapidly diminishes, terminating in a rounded point. Where it merges into the frontal shield, the culmen is $\frac{5}{8}$ of an inch in width. Gould has somewhat exaggerated in his drawings the angle of declination towards the corners of the mouth, also the serrated edge of the upper mandible. In this specimen there is only the slightest indication of pectination. The cutting edges of both mandibles are sharp to the touch. The horny covering of the bill rises on the forehead to a line with the posterior angle of the eye, forming a depressed frontal shield (not arched as in the drawing). Nostrils oval, placed in a depression near the base of the bill, and forming an oblique opening, nearly twice as large as shown in Gould's sketch of the head (Proc. Zool. Soc.). Wings short, rounded, and slightly concave; ample in appearance, but useless for purposes of flight; first quill shortest, second half an inch shorter than third; third fourth and fifth longest and about equal; sixth scarcely shorter than fifth. On examining the wing-feathers they are found to be feeble and pliant, the outer webs being almost as broad as the inner. The tail-feathers are likewise soft and pliant, with disunited filaments, much worn at the tips. The tarsi are long, strong, and well proportioned to the bird; longer than the toes (exclusive of claws), rounded in form, and armed in front with fourteen more or less broad, regular, transverse scutellæ, forming an effective shield; on the middle toe there are twenty-three transverse scales, all very regular, but narrowed at the joints; on the inner toe fifteen, and on the outer toe twenty-one. On the hind toe there are five scales. The claws are strong, thick, not much arched, rather sharp on the edges, but with blunted points, especially on the hind toe. The palate is deeply grooved.

Head and upper part of neck very dark blue, changing according to the light into brownish-black on the crown and nape, brighter on the cheeks and sides, and passing into dark purplish blue on the lower part of the neck; the whole of the back, rump, and upper tail-coverts rich olive-green, varied more or less, and particularly on the shoulders, with dull verditer green, the feathers shading off into that colour at the tips, the general olive hue, however, predominating towards the sides of the body; foreneck, breast, sides of the body, and inner portion of flanks beautiful purplish-blue; the lengthened pectoral plumes which overlap the sides and the outer portion of flanks vivid purplish-blue, mixed and varied, especially on the former, with verditer green; abdomen, thighs, and vent dull indigo or bluish-black, more or less mixed with brown; under tail-coverts pure white. The general upper surface of the wings is a rich mixture of blue and verditer green, very difficult to express exactly in words, the combination having something of the effect, in certain lights, of *lapis lazuli*.

On a close examination of the larger coverts it is found that they are marked transversely with numerous delicate rays of a darker purplish blue, adding much to the beauty of the plumage. On the lesser coverts this rayed character although present is less conspicuous, and the olive hue is more pronounced, while on the scapulars it becomes predominant, resembling the plumage of the back. The outer edges of the wings and the tertial plumes very rich purplish-blue or obscurely rayed with green. The outer primaries are blue on their outer webs, but this rapidly changes to dull sea-green, which colour prevails on both webs of the secondaries, only washed with a brighter tint on the outer vane. This colour deepens again into olive on the inner secondaries and their coverts, thus harmonizing with the plumage of the back. The under surface of the quills is uniform blackish-brown, and the shafts are white towards the base; the axillary plumes and the larger inner coverts are of the same colour tipped on their outer aspect with blue, and the smaller coverts, which are of very soft texture, are entirely blue. The tail-feathers are dark olive mixed with verditer green on the upper surface and changing to dull olive-brown, with lighter shafts, on their under surface.

The bill has lost its original colour through being dried. On the frontal plate and along the basal edges of both mandibles it appears to have been dark red, fading outwards. The culmen still has traces of its original pinky colour; but the sides of both mandibles, in the present condition of the specimen, are reddish horn colour, fading to whitish horn along the cutting edges. The tarsi and toes appear to have been originally light-red, having now faded to a transparent reddish-brown, paler on the toes. Claws dull brown, lighter towards the tips.

The texture and general appearance of the plumage on the head, neck, and under parts generally, is very similar to that of the Pukeko *(Porphyrio melanotus)*, although the latter bird lacks the produced bright-coloured pectoral plumes which overlap the sides of the body, under the wings, in *Notornis*. The plumage of the back is very long and thick, but at the same time soft and somewhat silky to the touch, being evidently adapted to haunts where the bird is constantly subject to drippings from wet herbage. On moving this plumage with the hand it is found that the basal portion, comprising more than two-thirds of the feathers, is of a uniform blackish-brown, whereas the basal plumage on the other parts of the body is dark grey. The plumage of the head and neck is short and close, as in *Porphyrio*, the feathers having a soft texture. The whole of the upper surface has a slight sheen upon it (amounting almost to a glint on the tips of the shoulder-plumage), and the bright hues of colour on the back and wings change slightly under different lights. The plumage covering the flanks and overlapping the thighs is dense and long, while its brilliant blue and green colours contrast strongly with the olive plumage of the back and rump. When looked at in front, with the wings closed in against the body, the purplish vivid blue already described is very conspicuous. The carpal spur is shaped like the claw of the hind toe, but is less arched. It is nearly one-eighth of an inch thick at the base, and is dark brown, fading into horn-colour at the tip.

*Measurements.*—Approximate length (measuring from tip of bill, following its curvature, and from the forehead to the end of the tail) 24·5 inches wing, from flexure, 10 ; from humerus to flexure 3·75 ; carpal spur ·4 ; tail (to extreme tips) 4·75 ; bare part of tibia 1 ; tarsus 3·5 ; middle toe 3, its claw 1·1 ; inner toe 2·2, its claw 1 ; outer toe 2·4, its claw ·8 ; hind toe ·75, its claw ·75. Bill, from posterior edge of frontal plate to tip of upper mandible, 3·4 ; from gape along edge of upper mandible 2·5 ; along edge of lower mandible 2·25 ; greatest width of bill, measuring across from the summit of the arch, or culmen, to the junction of the rami, 2.

*Observations.*—Taken altogether, the specimen is a very fine one—probably an adult female. The plumage is somewhat worn, the primaries and tail-feathers having their webs more or less abraded on their outer edges and tips. The edges and sides of the mandibles are considerably worn, indicating a fully adult state. The claws of the toes, and particularly that of the hind toe, appear to be much blunted by use. The colours of the plumage generally are brighter than in the supposed female specimen in the British Museum, but they are, I think, less brilliant on the whole than in the British Museum male: notably there is an entire absence of the well defined terminal margins of verditer green on the wing-coverts which form crescentic bands in the type specimen. There are, however, as mentioned above, different blending shades of green and blue on the plumage of the wings, which impart to it a very beautiful appearance. My recollection of the ♀ specimen in the British Museum collection is that it has these crescentic markings far less conspicuous than in the male.

*Note.*—There appears to have been originally very little colour in the beak except on and below the frontal shield and along the basal edges of both mandibles. The legs are in much the same condition as that presented by the legs in a dried Pukeko skin, the colours having faded out. But there is enough colour left in the tarsi to show that the legs and feet were originally, as described above, a light (probably pinkish) red. The skin is much stretched by unskilful treatment after being removed from the body; but I have allowed for the stretching in taking the measurements given above.

I remarked to Professor Parker, on first taking up the specimen, that the legs appeared to be more attenuated than in the British Museum examples, and the measurements which I afterwards made, as given above, prove that the toes are somewhat longer proportionately to the size of the bird, which is altogether slightly larger than the type specimen described in my "Birds of New Zealand." The frontal shield is, however, somewhat smaller, being just one inch across in its widest part, and ascending barely half an inch from the base of the culmen. It has a corrugated, shrivelled appearance in the dried specimen, and from the sides of the bill, at its base, the cuticle is inclined to peel off. The skin (in the dried state) is very tough, having the appearance and consistency of fine leather.

*Hab.*—South-west portion of South Island. As already mentioned the first recorded specimen (in 1849) was obtained on Resolution Island, the second, nearly three years later, on Secretary Island, in Thompson Sound, and the third, which has formed the subject of this paper (in December, 1879), on the eastern side of Te Anau Lake. Taking these three localities as marking the points of a triangle describing the ascertained limits of its occurrence, we have before us the present range of *Notornis* over a considerable area of very broken and rugged country. As its fossil remains testify, its ancient range was far more extensive, including the North Island, and in prehistoric times probably reaching much further.

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ART XXXII.—*On the Skeleton of* Notornis mantelli. By T. JEFFERY PARKER, B.Sc.London; Professor of Biology in the University of Otago.

[*Read before the Otago Institute, 21st September,* 1881.*]

Plates XIX—XXI.

*Introductory.*

THE genus *Notornis* was founded by Professor Owen in the year 1848, upon portions of the skull sent to him from the North Island by the Hon. Walter Mantell. The skull was fully described in the Transactions of the Zoological Society, and the genus was referred to the family *Rallidæ*, as a close ally of *Porphyrio*. Shortly afterwards the same distinguished osteologist received a femur, a tibia, and a tarso-metatarse of the same bird, as well as a sternum, which he at first erroneously referred to *Notornis*, but afterwards (in 1871) recognized as belonging to *Aptornis otidiformis*. Professor Owen's description of these bones, published originally in the Proceedings and Transactions of the Zoological Society, are republished at pp. 173 and 199 of his great work, "The Extinct Birds of New Zealand": the account of the sternum referred to is on p. 198, and the correction of the position at first assigned to it on p. 340. The memoir on the "Restoration of *Notornis*" (p. 436) contains nothing new as to the osteology of the genus, and, as far as I am aware, no other descriptions of the skeleton have been published up to the present time.

The fossil bones of *Notornis* mentioned above were all found in the North Island, and the bird was at first supposed to be extinct, but in 1849 the first recorded living specimen was captured on Resolution Island, on the West Coast of Otago, and shortly afterwards a second example on Secretary Island. Both were secured by Mr. Mantell, and are now in the British Museum. Unfortunately in neither case were any of the bones preserved. For thirty years nothing more was seen of *Notornis*, and it was very generally supposed to have become wholly extinct. But about two years ago, the third known specimen was taken on Captain Hankinson's run on the eastern shore of Lake Te Anau; being run down by dogs in the course of a rabbiting expedition. The captor, Mr. J. Connor, fortunately preserved not only the skin of the bird, but also the dried trunk, and last year forwarded both of them to Dunedin for transmission to England for sale. Through the kindness of Mr. E. J. Spence I was allowed to have the specimens at

* When this paper was read I had no skeleton of *Tribonyx*: I have since, however, received two specimens of that bird from Mr. Robbins, of the Hobart Museum, whom I desire to thank for his promptitude in supplying my wants in this respect. The paper has been recast to admit of the necessary comparisons with *Tribonyx*. January 24, 1882.

the Museum for several weeks, and the notes and sketches of the skeleton then made I am now enabled, by the courtesy of Mr. Connor, to publish. As to the external characters, it happened, most opportunely, that Dr. Buller visited Dunedin while the specimen was in my keeping, and made notes of the skin.*

It was much to be regretted that the funds of the Museum did not allow of the purchase of these relics, as the desirability of a specimen of this rare example of the New Zealand avifauna being retained in the colony, is obvious. I have, however, through the kindness of two ladies, Miss F. M. Wimperis and Miss Maud McLaren, been fortunate enough to secure for the Museum the next best thing to the actual specimen, namely, two life-sized oil paintings, one outlined from Mr. Gould's figure in Owen's "Extinct Birds," the other from Dr. Buller's figure, and both coloured from the actual specimen with a fidelity and artistic skill which leave nothing to be desired. As the colouring of the Te Anau specimen differs in some details from that of the British Museum examples, it is a matter of considerable interest to have accurately coloured paintings of it. The latter will not lose their value even if an actual specimen should at some future time be secured.

*General Description and Measurements.*

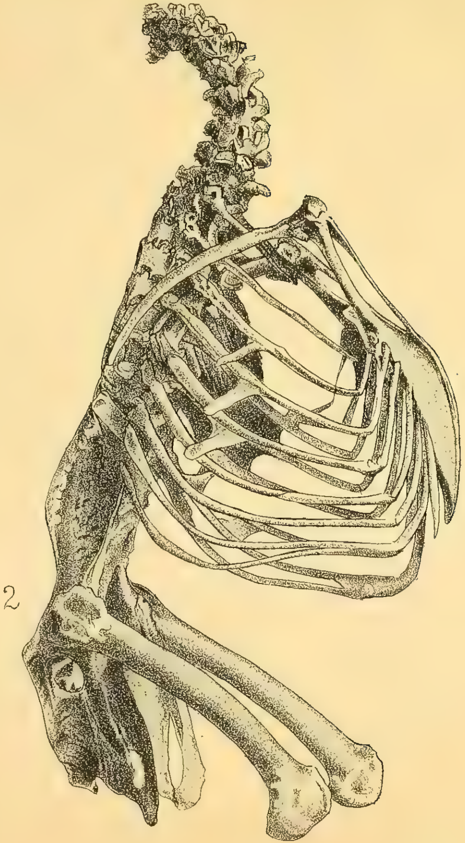
The skeleton consisting, as it does, of the parts saved after skinning (pl. XIX., figs. 1 and 2) is *minus* the head and the anterior cervical vertebræ, the wing-bones, the bones of the legs with the exception of the femora, and the posterior caudal vertebræ. It is in very good preservation with the exception of the ribs and the femur on the left side, which are shattered, probably by shot, and the right side of the middle xiphoid process of the sternum, which is slightly cut, apparently during skinning.

The more important measurements are as follows :—

| | | |
|---|---|---|
| Length of trunk, measured from anterior (dorsal) ends of coracoids to posterior extremity of pelvis .. .. | 18·5 | cm. |
| Length of scapula .. .. .. .. .. .. | 8·0 | ,, |
| ,, coracoid .. .. .. .. .. .. | 4·2 | ,, |
| ,, sternum .. .. .. .. .. .. | 6·8 | ,, |
| Width of ,, (measured just posterior to coracoid grooves) .. .. .. .. .. .. .. | 4·3 | ,, |
| Depth of keel of sternum .. .. .. .. .. | 0·9 | ,, |
| Length of ilium .. .. .. .. .. .. .. | 10·4 | ,, |
| Width of pelvis at posterior border of acetabula .. .. | 5·6 | ,, |
| Length of femur .. .. .. .. .. .. .. | 10·3 | ,, |

For purposes of comparison, however, the absolute dimensions of the parts are of less importance than their proportional dimensions as compared with the corresponding parts in allied genera. I therefore give in

* See above, Art. XXXI.



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1

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NOTORNIS.

the following table the comparative dimensions of the same bones in *Notornis*, *Ocydromus*, *Tribonyx*, and *Porphyrio*, taking as a standard the length of the trunk as measured from the centre of a line joining the anterior or dorsal ends of the coracoids to the centre of a line joining the posterior boundaries of the pelvis. This, I think, bears a fairly correct relation to the bulk of the bird, and is independent of the length of either neck or legs. Taking this line as equal to 100, the remaining dimensions may be taken as percentages of the length of trunk, and thus the proportional size of sternum, pelvis, etc., clearly brought out:—

LENGTH OF TRUNK=100.

| —— | Notornis. | Ocydromus. | Tribonyx. | Porphyrio. |
|---|---|---|---|---|
| Length of sternum .. .. | 36 | 28 | 35 | 40 |
| Width ,, .. .. | 24 | 14 | 17·5 | 17 |
| Depth of carina sterni .. | 4·8 | 4·7 | 7 | 13 |
| Length of scapula .. .. | 43 | 35 | 39 | 49 |
| ,, coracoid .. .. | 22 | 20 | 22·5 | 28 |
| ,, ilium.. .. .. | 56 | 49 | 52 | 43 |
| Width of ,, .. .. .. | 29 | 21 | 22·5 | 21 |
| Length of femur .. .. | 57 | 51 | 49 | 51 |
| Coraco-scapular angle .. .. | 97° | 100° | 92° | 86° |
| Transverse sternal angle .. | 132° | 141° | 122° | 96° |

Pl. XX. represents outline drawings to scale of the four skeletons, that of *Notornis* being two-thirds natural size.

*Vertebral Column.*

In the vertebral column, the nine posterior cervical vertebræ are left: as in *Porphyrio* and *Ocydromus* the total number is fifteen and in *Tribonyx* fourteen,* it is probable that the five or six anterior vertebræ are missing. The last cervical vertebra bears on each side a moveable rib, 3 cm. in length, this being proportionally shorter than the corresponding bone in *Ocydromus*, *Tribonyx*, and *Porphyrio*. The penultimate cervical rib is also moveable, but is short and stout, approaching in form to the anterior (ankylosed) cervical ribs. In this particular *Notornis* agrees closely with *Ocydromus*. In *Porphyrio* and *Tribonyx* the homologous rib is slender, pointed at its distal end, and fully one-fourth the length of its successor.

* That is, in the single specimen of each at my disposal.

Defining, as usual, the first thoracic vertebra as the first in which the ribs articulate with the sternum, there are seen to be seven præsacral thoracic vertebræ, free save for a union of their spines by ossified ligaments. The last, or eighth, thoracic vertebra is ankylosed with the compound sacrum. The same number is found in *Ocydromus* and *Porphyrio*, in *Tribonyx* there are nine thoracic vertebræ. These vertebræ do not differ in any important respect from those of the allied genera ; and even if it were necessary I could not describe them in detail, as it was not possible for me to have the skeleton disarticulated.

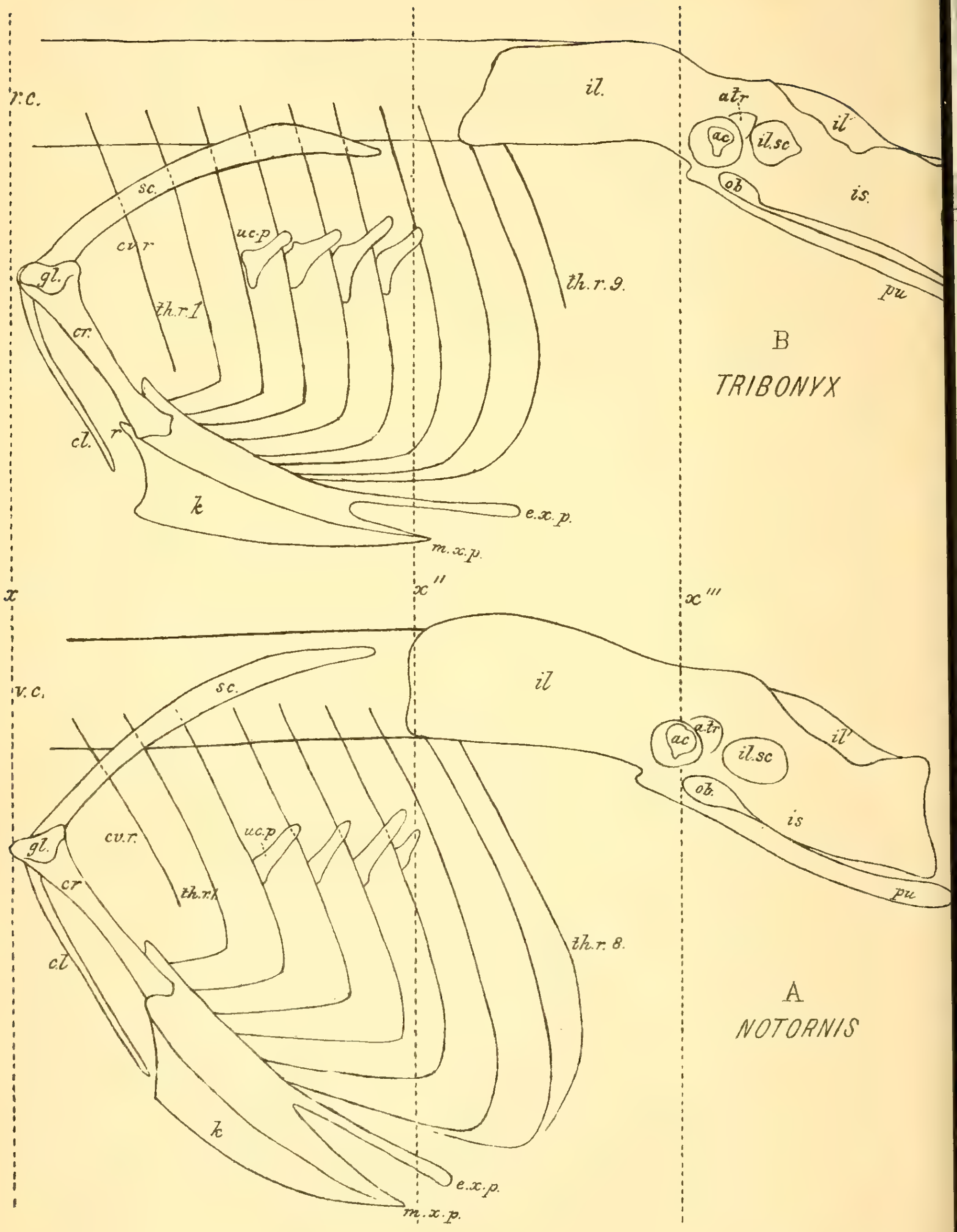
It is to be noted, however, that the entire thoracic region is proportionally shorter in *Notornis* than in either of its three allies. This is shown in fig. 3, in which the line $xy$ corresponds pretty nearly with the anterior boundary of the thorax in all four figures, while the line $x''y''$, which is taken through the anterior end of the pelvis in *Notornis*, and consequently a little in front of the hinder extremity of the thoracic region, passes in the other three figures well in front of the pelvis.

The eight thoracic ribs of each side are flattened bones, divided, as usual, into sternal and vertebral portions; five of the sternal ribs articulate with the sternum, their ventral ends being less crowded together—owing to the greater length of the costal edge of the sternum—than in *Ocydromus*, but more so than in *Porphyrio*. Four of the vertebral ribs, the second to the fifth inclusive, have uncinate processes, as in *Tribonyx* and *Porphyrio* ; in *Ocydromus* there is an uncinate process also on the first thoracic rib. The position of the uncinate processes in *Notornis* is similar to that in *Ocydromus* ; they are situated nearer the sternal ends of the ribs than in *Porphyrio;* in *Tribonyx* their position is about intermediate.

The compound " sacrum " contains one thoracic, five lumbar, apparently four true sacral, and six caudal vertebræ. As far as I can make out these numbers hold good for the other three genera, but in adult specimens it is not easy to decide the exact number of true sacrals. Behind the last ankylosed caudal vertebra come four free caudals; from the analogy of the allied genera these were probably followed by two or three ordinary vertebræ and a pygostyle.

### *Sternum and Shoulder-girdle.*

The sternum of *Notornis*, as shown by the above table of comparative measurements, and by pl. XX., is as nearly as possible of the same proportional length as that of *Tribonyx*, while it is considerably longer than that of *Ocydromus*, and shorter than that of *Porphyrio*. Its breadth, proportionally to length of trunk, is considerably greater than in either of the three allied genera. The proportions of the sternum are, however, best seen by reducing it in all four genera to the same absolute length ; this is done in figs. 4

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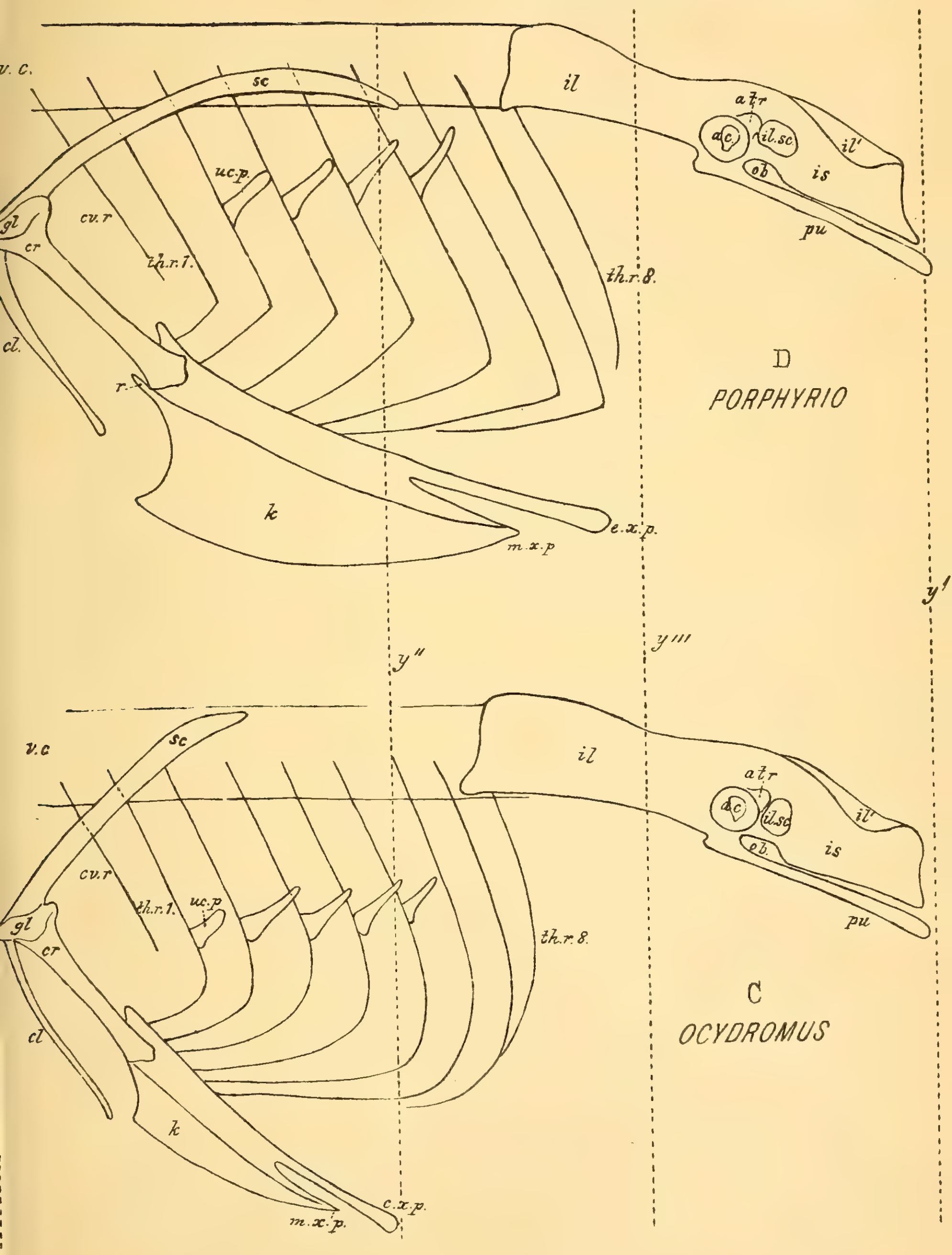


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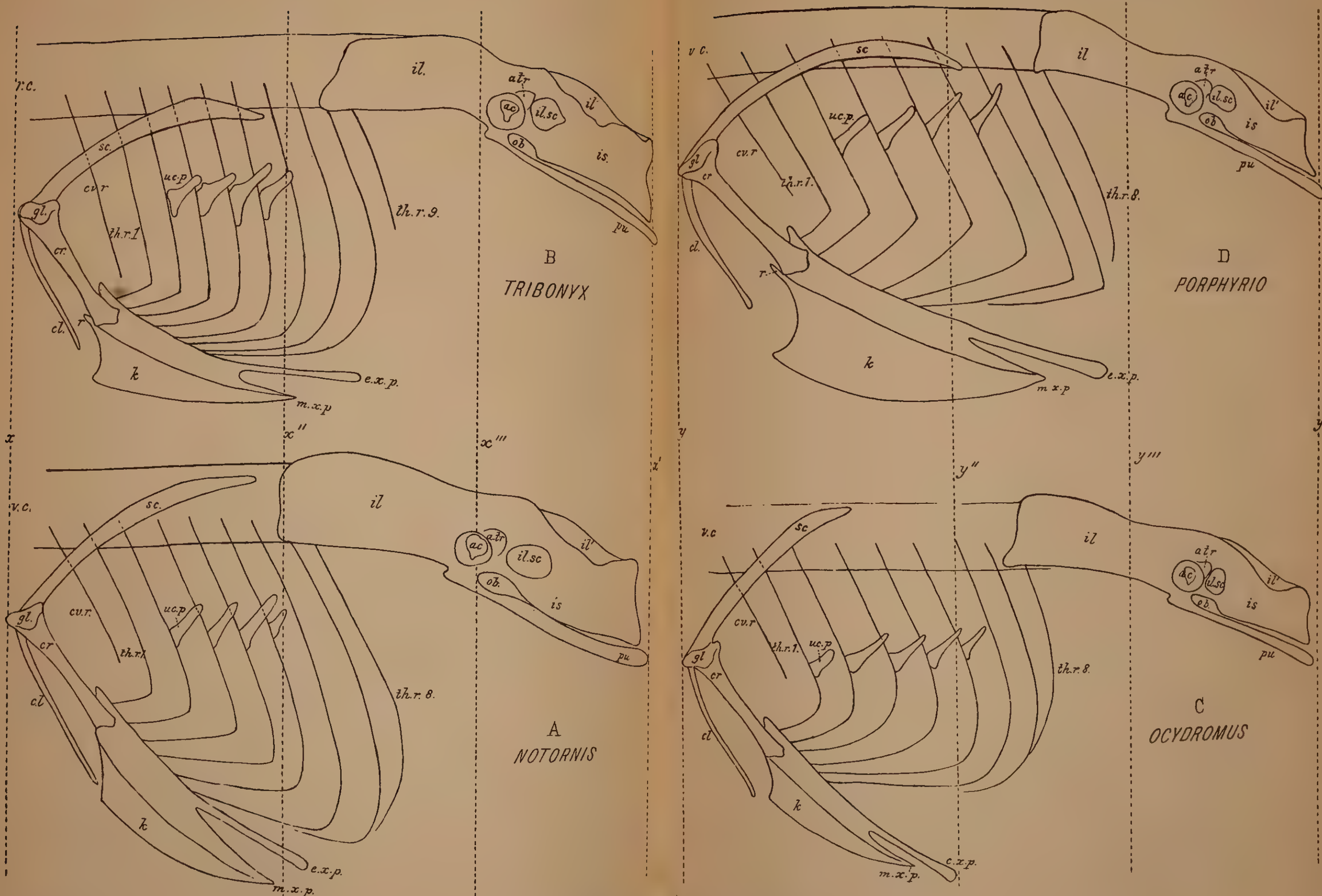


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TO ILLUSTRATE PAPER ON NOTORNIS.

and 4A (pl. XXI.), the former showing the outline of the sternum of *Notornis* from the ventral face with that of *Ocydromus* superposed in dotted outline on the left side, and that of *Porphyrio* in broken outline on the right; while fig. 4A shows the right half of the sternum of *Notornis* with that of *Tribonyx* superposed in dotted outline.

The sternum of *Notornis* is broad and flat; its anterior edge is somewhat emarginate, as in *Ocydromus*, and is devoid of all trace of the manubrium or rostrum (fig. 4, 4A, *r*) found in *Porphyrio*, and to a less degree in *Tribonyx*. The coracoid grooves are even more widely separated than in *Ocydromus*, instead of having merely the width of the rostrum between them, as in the other genera. The diminution in width of the sternum from its anterior to its posterior end is very gradual; in this respect *Notornis* most nearly approaches *Tribonyx*. The external xiphoid processes (*e. x. p.*) are divergent, not expanded at their distal ends, and are proportionally shorter than in either of the allied genera; the middle xiphoid process is blunt and unossified, the bone terminating in a straight transverse edge, about six mm. from the actual extremity of the process. In this again the resemblance between *Notornis* and *Tribonyx* is of the closest kind: the middle xiphoid both in *Porphyrio* and *Ocydromus* is completely ossified, terminating in the former by a truncated edge, while it is deeply emarginate in the latter.

The keel of the sternum is feebly developed, being hardly deeper, proportionally to length of trunk, than that of *Ocydromus*. Its anterior edge has nothing of the strong forward convexity found in *Porphyrio*, but passes almost insensibly into the ventral edge; in this respect the resemblance to *Ocydromus* would be great, but for the fact that in the latter a strong bifid thickening (fig. 4, *k*) is formed at the junction of the anterior and ventral borders, whereas the corresponding thickening in *Notornis* is less marked and shows no tendency to division; the resemblance to *Tribonyx* is here very marked.

Another point connected with the flightlessness of *Notornis* is the very slight lateral curvature of the sternum; its two sides enclose a dihedral angle (fig. 5 B.) which is nearly as open as that of *Ocydromus* (A) and considerably greater than in *Tribonyx* or *Porphyrio* (C and D). This *transverse sternal angle* as it may be called, seems to be pretty constantly more open in flightless birds than in the normal members of the same group; its increase, and the correlated diminution of the keel, cause the sternum to approach to the ratite type, as is especially well seen in *Didus*, *Cnemiornis*, *Stringops*, and *Aptornis*, and to a less extent in *Nesonetta*, *Ocydromus* and *Notornis*.

On the whole the sternum of *Notornis* differs from that of *Tribonyx* in much the same way as the latter from that of *Porphyrio*. *Tribonyx* is, in all important respects a mean between the two extremes furnished by *Porphyrio* and *Notornis*. *Ocydromus*, on the other hand is, in some respects, intermediate between *Tribonyx* and *Notornis*, while in others it is in advance of *Notornis*, in just the same way as the latter is in advance of *Tribonyx*, *i.e.*, deviates more from normal carinate characters.

In the shoulder-girdle the four genera form a very interesting series: this is shown in fig. 6 (pl. XXI.), in which all four shoulder-girdles are reduced to a common length of trunk, and the coracoids are superposed upon one another, so as to coincide in direction. As regards relative length of coracoid and scapula, *Notornis* is seen to intermediate between *Ocydromus* and *Porphyrio*, *Tribonyx* having the coracoid a little longer than that of *Notornis*, the scapula somewhat shorter. The same series is observable in the curvature of the scapula; this is greatest in *Porphyrio*, next comes *Tribonyx*, then *Notornis*, and finally *Ocydromus* with a scapula nearly straight save at its distal end.

A similar gradation is seen in a more important point, namely, in the angle enclosed between the adjacent portions of the coracoid and scapula. As was first pointed out by Professors Huxley and Newton*, one of the most marked features of the *Carinatæ* is the fact that the coraco-scapular angle never approaches 180° as in *Ratitæ*, and is usually less than 90°; the only exceptions mentioned by either author being *Didus* and *Ocydromus*, in which the angle is slightly over 90°. This, then, is another morphological character which has a definite relation to the power of flight, the coraco-scapular angle, like the transverse sternal angle, being found, speaking generally, to increase *pari passu* with diminution of that power. It would, however, be a mistake to suppose that there is anything like a constant relation between flightlessness and increase of the coraco-scapular angle. I find, for instance, that it is less in *Tetrao* than in *Vultur*, and that of the two skeletons of *Stringops* in the University Museum, one has the angle less than 90° on both sides, while in the other the angle on the left side is just over a right angle, that on the right being the same as in the other skeleton: so that the angle has undergone little or no increase in a bird in which the carina sterni is practically obsolete, and the furcula rudimentary. But the strangest exception to the rule that the coraco-scapular angle in the *Carinatæ* is less than 90°, is furnished by that paragon of flying birds, the albatross, in which the angle is fully 100°; the same, though to a less degree, is the case in the Nelly *(Ossifraga)*.† Thus *Diomedea* and *Ossifraga* must be added to the above list of exceptions, as well as *Stringops (?)*, *Cnemiornis*, *Aptornis*, *Tribonyx*, and *Notornis*. As a very general

* Huxley, "On the Classification of Birds," Proc. Zool. Soc., 1867, pp. 418 and 425: Newton, "On the Osteology of the Solitaire," Phil. Trans., 1869, p. 341, note.

† That is, measuring by the adjacent portions of the bones only, as in the definition of this angle by Huxley and Newton. Of course if the general direction of the scapula be taken, the angle will be greatly diminished. I may mention, in passing, that the most convenient way to take the coraco-scapular angle, is to trace the outlines of the two bones on a sheet of glass held parallel to the median vertical plane of the body.

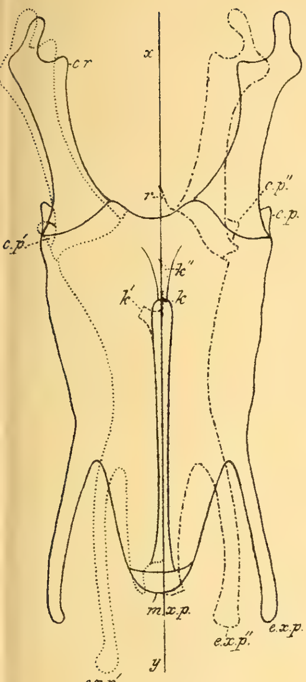


Fig. 4.

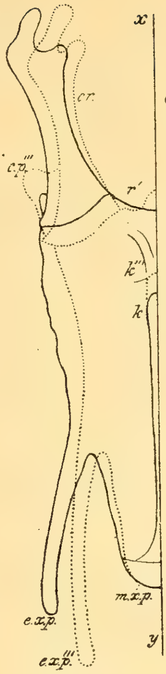


Fig. 4.a.

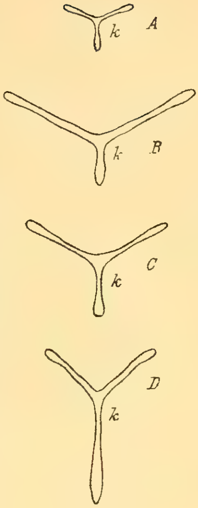


Fig. 5.

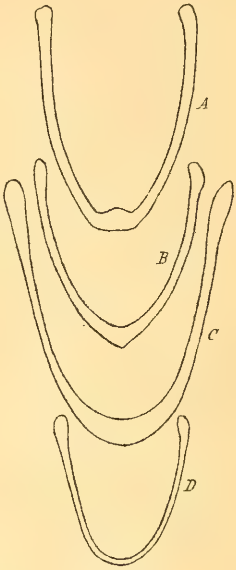


Fig. 7.

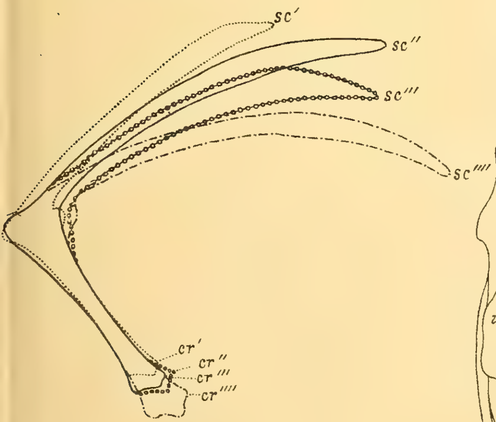


Fig. 6.

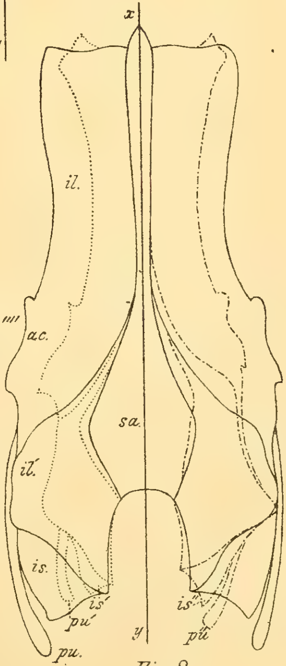


Fig. 8.

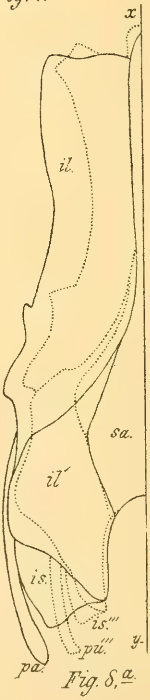


Fig. 8.a.

TO ILLUSTRATE PAPER ON NOTORNIS.

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rule, however, a large coraco-scapular angle seems to be correlated with a small carina sterni and large transverse sternal angle, and, taking birds of the same order, there is a tolerably close relation between these structural peculiarities and adaptation to a cursorial life.

The table of comparative measurements given above shows* that, arranged according to depth of carina sterni, or to size of transverse sternal angle, the four genera of *Rallidæ* under consideration must be placed in the following order:—1. *Porphyrio*, 2. *Tribonyx*, 3. *Notornis*, 4. *Ocydromus*. Fig. 6 shows that the same order is maintained if they are arranged by the coraco-scapular angle, which is least (86°) in *Porphyrio*, and greatest (100°) in *Ocydromus*, and it will be seen that the list begins with a good flier (*Porphyrio*), and ends with a bird of purely cursorial habits (*Ocydromus*). Similar series may be obtained by turning to other orders; in *Anseres*, for instance, we have 1. *Anser*, 2. *Nesonetta*, 3. *Cnemiornis;* in *Columbæ*, 1. *Columba*, 2. *Didus;* and in *Psittacinæ*, 1. *Ara*, and 2. *Stringops*. In all cases loss of the power of flight is associated with the ratite characteristics of increase of transverse sternal and coraco-scapular angles, and decrease of carina.

There is still one other point to be observed in connection with the shoulder girdle: if the extremes of our ralline series be compared, *i.e.*, *Notornis* or *Ocydromus* with *Porphyrio*, it will be found that the forward inclination of the coracoid from its sternal articulation is much less in the flightless forms than in *Porphyrio*, in other words, that the angle enclosed between the coracoid and a fore-and-aft line drawn through the coraco-scapular articulation parallel to the long axis of the body is greater in *Notornis* and *Ocydromus* than in *Porphyrio*. Such an angle will, of course, vary according to the position of the sternum in respiration, so that its exact size is of no importance and it can only be of use in the comparison of extreme forms.

The furcula of *Notornis* is slender and flattened from before backwards in its median portion; this latter part is, however, very thin, so that the apparent thickness of the bone in a ventral view is deceptive, and as a matter of fact it is nearly as slender as in *Ocydromus*. As to the form of the furcula, fig. 7 shows that, as in preceding cases, the four genera form an almost perfect gradation, *Porphyrio* having the thickest and most V-shaped furcula, *Ocydromus* the slenderest and most U-shaped.

### *Pelvis.*

In the characters of the pelvis the four genera no longer fall into the same order, the heavy cursorial *Notornis* having a pelvis of considerably greater dimensions than either of its three allies (pl. XX.): in length, in breadth, and in height the pelvis of *Notornis* is markedly larger than that of *Ocydromus*, and very considerably larger than those of *Tribonyx* and

* See p. 247.

*Porphyrio.* In the general form of the ilium and in the relative proportion of præ- and post-acetabular regions, *Notornis* approaches most nearly to *Tribonyx*, while it deviates, on the whole, in the greatest degree, from *Ocydromus.* The excess in size of the pelvis is most marked in its transverse dimensions. This is well shown in figs. 8 and 8A (pl. XXI.), in which the four pelves are drawn of the same absolute length.

The ischia and pubes of *Notornis* are widely divergent ; so much so that the pubes can be seen throughout nearly their whole length in a dorsal view. In the other three genera they fall well within the outer boundary of the ilia. This is most pronounced in *Ocydromus*, in which the obturator notch *(ob.)* is not seen in a ventral view, being completely hidden by the pubis. In the other three genera, it is well seen internal to the pubis.

Thus, arranged according to the characters of the pelvis, the four genera under consideration no longer fall into the same order as when arranged by the shoulder-girdle and sternum. As before, *Tribonyx* is intermediate between *Porphyrio* and *Notornis*, but *Ocydromus* can no longer be placed in a direct series with the others, since, by the size of its pelvis, it comes between *Porphyrio* and *Tribonyx*, while in many of its pelvic characters it goes off on a special line of its own.

*Summary and Conclusions.*

To sum up: an examination of the four Rails under consideration shows that flightlessness is accompanied by the following structural peculiarities:—

*a.* The *carina sterni* is diminished.

*b.* The sternum is widened, and the transverse sternal angle is increased.

*c.* The manubrium, or *rostrum sterni*, disappears.

*d.* The coracoid grooves recede from the middle line.

*e.* The coracoid becomes more nearly vertical in position.

*f.* The coraco-scapular angle is increased.

*g.* The coracoid and scapula decrease in all dimensions, and the furcula decreases in thickness.

*h.* The pelvis increases in size, and the acetabulum is relatively thrown forward.

Professor Owen, from the examination of the fossil bones referred to above, considered *Notornis* to be intermediate in characters between *Porphyrio* and *Ocydromus.* Nothing could have been nearer the truth than this, if we were unacquainted with *Tribonyx*, to which bird Mr. Gould, from a consideration of external characters, considered *Notornis* to be most nearly allied.

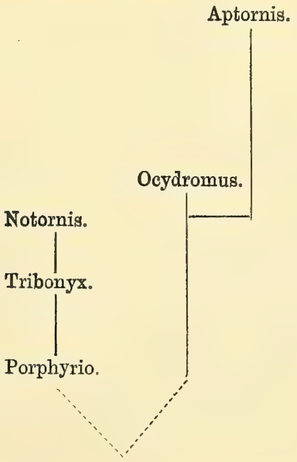
An examination of the skeletons shows that Mr. Gould's sagacity was not at fault. In nearly every respect, *Tribonyx* is intermediate between *Porphyrio* and *Notornis*, approaching more nearly to the latter; the only exceptions of any importance to this rule are in respect of the length of the scapula and of the sternum, both of which are proportionally longer in *Notornis* than in *Tribonyx*, instead of shorter, as they would be if the rule held good throughout. As regards the sternum and shoulder-girdle, *Notornis* is intermediate between *Porphyrio*—or rather *Tribonyx*—and *Ocydromus*, but in the character of the pelvis it differs far more from the normal ralline type than does *Ocydromus*.

It has always been acknowledged that *Notornis* is a degenerate rail, its special and aberrant characteristics being due to structural modification connected with the disuse of the wings and the assumption of purely cursorial habits. And I think it is impossible to avoid the conclusion that we have in *Porphyrio* the nearest living representative of the typical ralline ancestor of *Notornis*, and in *Tribonyx* the nearest living representative of an important intermediate stage in the process of degeneration.

The degenerate character of *Ocydromus* is equally evident, but this genus must be looked upon as descended from a strictly ralline, not from a porphyrionine ancestor; in other words, as having come along an entirely different line of descent from *Notornis*, with which it must have, therefore, only a collateral relationship.

I regret that the absence of specimens in this Museum prevents my instituting a comparison with *Aptornis*, but judging from Professor Owen's figures, it seems to me that this largest of rails is a further development, by degeneration, of an ocydromine type. For instance, the short sternum, narrowing posteriorly, seems a sort of exaggeration of that of *Ocydromus*, and the pelvis approaches in its proportions to the same genus, having a far less proportional breadth than in *Notornis*.

These conclusions are expressed in the following diagram :—



### *General Remarks.*

The study of *Notornis* suggests certain questions of interest as to flightless birds in general, and especially as tō that group of preeminently flightless birds, the *Ratitæ*, and their relations on the one hand to the *Carinatæ*, and on the other to the reptilian ancestors of the class.

The *Ratitæ* are usually regarded, from certain undoubted reptilian characteristics, as being nearer the reptilian stock from which birds sprang, than the *Carinatæ*, and there seems to be a general opinion that large ratite birds of some sort formed the actual connecting link between reptiles of a dinosaurian type and the *Carinatæ*.

But it appears to me that there are serious difficulties in the way of this view. The *Ratitæ*, in many of the most distinctive avian characteristics, approach no nearer to reptiles than do the *Carinatæ*. For instance, in the characters of the vertebræ, the femur, the tibio-tarsus, the tarso-metatarsus, the pelvis and sacrum, and, in the case of *Dinornis* and *Apteryx*, of the small, backwardly-directed hallux.

The chief skeletal characters, except those of the skull, in which the *Ratitæ* differ from the *Carinatæ*, are:—

*a.* The absence of a keel to the sternum:
*b.* The great width, and, except in *Rhea*, the extreme flatness of the sternum, *i.e.* the openness of the transverse sternal angle.
*c.* The comparatively small size of the scapula and coracoid.
*d.* The coraco-scapular angle is equal to two right-angles.
*e.* The axis of the coracoid is vertical or inclined backwards.
*f.* The furcula is rudimentary or absent.

If the *Ratitæ* are to be looked upon as in any way an ancestral group, these characters must be considered of primary importance, that is, as having a true phylogenetic significance. But in all these points, the *Ratitæ* merely exaggerate what we find in the flightless members of the Carinate order. There is no more keel to the sternum in *Stringops* or *Cnemiornis* than in *Struthio*, and the transverse sternal angle of *Rhea* is very considerably less than in the flightless *Carinatæ*. In these, also, there is a progressive diminution in size of the coracoid and scapula in passing from good fliers to flightless members of the same class, and at the same time a gradual rotation backwards of the dorsal end of the coracoid, and increase of the coraco-scapular angle. In fact, with the exception of the foramen in the coracoid of the ostrich, I know of no character in the shoulder-girdle of *Ratitæ* which can be pointed out as distinctively reptilian. One important distinction between the shoulder-girdle of reptiles and that of birds, is the position of the bones. In reptiles the coracoid passes from its sternal articulation outwards and slightly upwards, and the scapula (including the supra-scapula), from its coracoid articulation upwards and somewhat inwards, so that the two pairs of bones form, with the adjacent portions of the sternum and vertebral column, a transverse arch or true shoulder "girdle": in *Carinatæ*, on the other hand, the coracoid passes from the sternum forwards, upwards, and outwards, and the scapula, from its coracoid end, backwards and upwards. In the *Ratitæ* the bones make no closer an approach to reptiles in this than in other characters, the coracoid is still directed upwards and slightly outwards, the chief alteration in its position being that it has a slight backward inclination, this being, however, only an extreme development of what occurs in *Notornis* and *Ocydromus:* the scapula also passes upwards and backwards, and not inwards. Finally, a diminution of the furcula occurs in all birds with functionless wings.

In a suggestive paper on the phylogeny of Mammals,* Professor Huxley has brought out the fact that it gives a wholly erroneous notion of the pedigree of that class to suppose that either the Marsupials or the Monotremes lie in the direct line of descent of the *Monodelphia.* He points out that the ancestors of the *Monodelphia*—the *Metatheria*—were probably didelphous but not marsupial, and that the *Marsupialia* are to be looked upon as an offshoot of the *Metatheria*, which, while retaining the lower characters of brain and urinogenitals, and the large præ-pubes, have undergone great specialization in other directions. In the same way Professor Huxley supposes the *Monotremata* to be a specially modified offshoot of the *Prototheria*, the forerunners of the *Metatheria.*

It appears to me that a far juster view of the affinities of the *Ratitæ* than that alluded to above, is to be had by considering them as the greatly specialized but degenerate (using that word in the sense in which I have applied it to *Notornis* and other flightless birds) descendants of Carinate birds. Professor Huxley remarks† that "in all probability the existing *Ratitæ* are but the waifs and strays of what was once a very large and important group." What I wish to insist upon is that this hypothetical group, like the mammalian *Metatheria*, gave rise to two races of descendants: one continuing the direct line of descent—the *Carinatæ*—the other arising by a gradual modification of structure correlated with disuse of the wings—the *Ratitæ.* Just as the *Metatheria* gave rise to marsupial descendants which exist now only in the Austro-Columbian and Australian regions, so we may suppose that a widely distributed group of primitive typical birds—*Proto-Carinatæ*—gave rise to Ratite descendants, now confined to the Austro-Columbian, African, and Australian regions. The fact that such

* "Nature," vol. xxiii., p. 227.

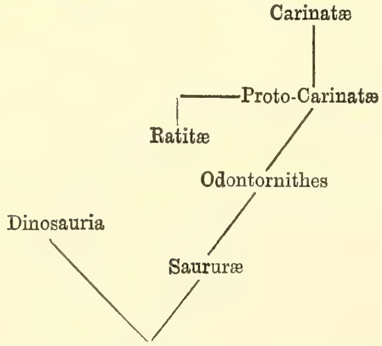
† Proc. Zool. Soc., 1867, p. 419.

a group must have been intermediate between *Odontornithes** and *Carinatæ* is quite sufficient to account for all the reptilian affinities of the *Ratitæ*: the assumption that they had acquired the distinctive characteristics of shoulder-girdle and sternum, pelvis, vertebral column, and fore and hind limbs, and had lost all trace of teeth, will account for the fact that in these points the *Ratitæ* make no approach whatever to reptiles. The same hypothesis also explains the fact that while the *Ratitæ* agree in certain common characters, some because they are of ancestral importance, others because they have been acquired by the same law of degeneration, they differ in the most remarkable way in other points. For instance, while *Dinornis* retains such ancestral structures as the hallux, large external xiphoid processes, and free ischium and pubis, it has undergone the greatest amount of degeneration of the shoulder-girdle and forelimb. *Struthio*, in the same way, shows the extreme of modification in the foot, *Struthio* and *Rhea* in the pelvis, and so on.

Probably the great size of the *Ratitæ* is also connected with their cursorial life, and is, like so many points in the skeleton, merely an exaggeration of what is found in *Notornis*, *Cnemiornis* and *Didus*. The *Proto-Carinatæ* being, by the hypothesis, good fliers, were presumably not of gigantic size; moreover they probably possessed feathers with connected barbs, so that the special characters of the Ratite plumage should be looked upon as a secondary or degenerate, not as an ancestral, character.

Finally, if we look upon the typical *Odontornithes* and *Archæopteryx* as approximately linear types in the ancestry of birds, we must assume that the latter arose from ornithoscelidan reptiles of comparatively small size, the gigantic *Dinosauria* being a special development of the same type.

The following diagram expresses the results to which a consideration of the above facts seems to lead:—




* I mean such *Odontornithes* as *Ichthyornis*: *Hesperornis* is another instance of degeneration induced by disuse of the wings.

## DESCRIPTION OF PLATES XIX—XXI.

### PLATE XIX.

Fig. 1. The Te Anau skeleton of *Notornis mantelli*, from the ventral aspect (½ nat. size).
Fig. 2. ,, ,, ,, ,, ,, ,, from the right side ( ,, ,, ).
(Figs. 1 and 2 from photographs by Burton Bros., Dunedin.)

### PLATE XX.

Fig. 3. Comparative views of the trunk skeleton of

A. *Notornis mantelli.*
B. *Tribonyx gouldi.*
C. *Ocydromus australis.*
D. *Porphyrio melanotus.*

All drawn to the same absolute length.

*xy*, line drawn through anterior boundary of trunk.
*x′y′* ,, ,, ,, posterior ,, ,, ,,
*x″y″* ,, ,, ,, anterior end of pelvis of *Notornis.*
*x‴y‴* ,, ,, ,, acetabulum of *Notornis.*

*ac*, acetabulum.
*a. tr*, anti-trochanter.
*cl*, clavicle.
*cr*, coracoid.
*cv.r*, last cervical rib.
*e.x.p*, external xiphoid process.
*il*, ilium (præ-acetabular portion).
*il′*, ,, (post-acetabular portion).
*il. sc*, ilio-sciatic foramen.
*is*, ischium.
*k*, keel of sternum.
*m.x.p*, middle xiphoid process.
*ob*, obturator notch.
*pu*, pubis.
*sc*, scapula.
*th.r.*1, first thoracic rib.
*th.r.*8 (*th.r.*9 in B.), last thoracic rib.
*uc.p*, uncinate process.
*vc*, vertebral column.

### PLATE XXI.

Fig. 4. Outline of sternum and coracoids of *Notornis* (even line), with the same parts in *Ocydromus* superposed on the left side (dotted line), and those of *Porphyrio* on the right (broken line). For reference letters see under 4A.

Fig. 4A. Outlines of right half of sternum and coracoids of *Notornis* (even line) and *Tribonyx* (dotted line).

All drawn to a common length of sternum, and viewed from the ventral aspect.

*xy*, long axis of sternum.

*cr*, coracoid.
*cp*, costal process (*Notornis*).
*cp′* ,, ,, (*Ocydromus*).
*cp″* ,, ,, (*Porphyrio*).
*cp‴* ,, ,, (*Tribonyx*).
*k*, *k′*, *k″*, *k‴*, anterior end of keel of sternum.
*e.x.p.*, *e.x.p′.*, *e.x.p″.*, *e.x.p‴.*, external xiphoid process.
*m.x.p.*, *m.x.p′.*, *m.x.p″.*, *m.x.p‴.*, middle xiphoid process.
*r*, rostrum or manubrium (*Porphyrio*).
*r′*, ,, ,, ,, (*Tribonyx*).

Fig. 5. Transverse sections of sternum of

A. *Ocydromus.*
B. *Notornis.*
C. *Tribonyx.*
D. *Porphyrio.*

All two-thirds natural size.

*k*, keel of sternum.

Fig. 6. Shoulder-girdles of

*Notornis* (thick even line).
*Tribonyx* (thin „ „ ).
*Ocydromus* (dotted line).
*Porphyrio* (broken „ ).

All drawn to a common length of trunk.

*cr*, *cr′*, *cr″*, *cr‴*, ventral ends of coracoids.
*sc*, *sc′*, *sc″*, *sc‴*, distal ends of scapulæ.

Fig. 7. Furculæ of

A. *Porphyrio.*
B. *Tribonyx.*
C. *Notornis.*
D. *Ocydromus.*

All two-thirds natural size.

Fig. 8. Outline of pelvis of *Notornis* (even line) with that of *Ocydromus* superposed on the left side (dotted line), and that of *Porphyrio* on the right (broken line).

Fig. 8A. Outline of left half of pelvis of *Notornis* (even line) and *Tribonyx* (dotted line).

All drawn to a common length of sacrum and viewed from the dorsal aspect.

*xy*, long axis of sacrum.
*il*, ilium (præ-acetabular portion).
*il′*, „ (post- „ „ ).
*is*, *is′*, *is″*, *is‴*, ischium.
*pu*, *pu′*, *pu″*, *pu‴*, pubis.
*sa*, sacrum.

(Figs. 3 to 8 from drawings by the author.)

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## Art. XXXIII.—*On a new Method of preserving Cartilaginous Skeletons and other soft Animal Structures.* By T. Jeffery Parker, B.Sc. London, Professor of Biology in the University of Otago.

[*Read before the Otago Institute, 21st June,* 1881.*]

On reading Professor Miall's account of his method of employing glycerine jelly instead of alcohol for the preservation of anatomical specimens,† it occurred to me that the more solid and less complicated structures might be preserved by thoroughly impregnating them with glycerine jelly and then allowing them to dry. The advantages of such a mode of preservation are obvious, since it allows of the handling of the specimens, and does away with the necessity for containing vessels, and the optical disadvantages of a surrounding medium.

I was able to make very few experiments on the subject before leaving England, but during the whole of the past year I have tested the method

* I have partly re-written this paper so as to include additions and corrections up to the present time, February 18th, 1882.—T.J.P.

† "Nature," vol. xviii., p. 312.

about to be described enough to make me feel tolerably confident in recommending it as of special value in the case of cartilaginous skeletons, and useful for hollow viscera, the exoskeletons of Crustacea and Echinodermata, etc.

It will be advisable to describe separately the chief applications of the method.

1. *Cartilaginous skeletons.* I find the best way to clean the skeletons of fresh Elasmobranchs is to clear away the flesh, etc., very roughly, after removal of the skin and viscera, then to dissect away the gill-arches, and then to plunge the body into boiling water for a few seconds. This softens the muscle and connective tissues so much that their removal is rendered quite easy, while, if prepared in the cold, it is almost impossible to remove the tough perichondrium without injury to the cartilage. In the case of even moderate sized specimens it is often necessary after separating the skull, vertebral column, and fins, to dip each part again into boiling water. With very large specimens it is necessary to separate the different regions of the skeleton, and even to cut the vertebral column into segments before plunging them in the water, as otherwise no ordinary vessel will suffice for their immersion. In the case of spirit specimens parboiling is not necessary. The gill-arches should be thoroughly hardened in spirits and then cleaned by ordinary dissection; even a slight application of heat causes the separation of their delicate cartilages. In the same way no heat must be employed in the preparation of persistent notochords, as for instance in the case of *Callorhynchus.*

When thoroughly cleaned, fresh specimens should be placed in strong methylated spirit for two or three weeks. This hardens the cartilage and produces a certain amount of shrinking. In the case of large skeletons (sharks, etc.), this operation may be dispensed with on economical grounds, but without it the results are never so satisfactory.

When thoroughly hardened the specimen is transferred to one of the following fluids:—

GLYCERINE FLUID, A.

| | |
|---|---|
| Glycerine .. .. .. | 1 litre. |
| Water .. .. .. | 1 ,, |
| Corrosive sublimate .. | 10 grams. |
| Alum .. .. .. | 10 ,, |

GLYCERINE FLUID, B.

| | |
|---|---|
| Glycerine .. .. .. | 1 litre. |
| Water .. .. .. | 1 ,, |
| Concentrated solution of Phenol .. .. .. | 5 c.c. |
| Alum .. .. .. | 10 grams. |

Of the two fluids, B seems to give the best results, the colour of its specimens being better than that of those prepared by A. The alum may be omitted if the specimen has been previously hardened in alcohol. It is always advisable to use earthenware vessels; indeed, this is necessary in the case of A, as corrosive sublimate acts upon metals. It is also a good plan to have vessels of various sizes, so as not to use more of the fluid than is absolutely necessary. I find that a small pudding basin, a vegetable dish, a soup tureen, and an earthenware foot-bath, or "tongue pan," form a very useful series of vessels. If earthenware vessels of sufficient size cannot be had, tin, zinc, or galvanized iron may be used; but then fluid B must be employed, and not A.

After remaining in the glycerine fluid for about three to seven days, according to size and density, the specimen is transferred to melted glycerine jelly, made in one of the following ways:—

| Glycerine Jelly, A. | |
|---|---|
| Glycerine .. .. .. | 1 litre. |
| Water .. .. .. | 1 ,, |
| Gelatine .. .. .. | 150 grms. |
| Corrosive sublimate .. | 10 ,, |

| Glycerine Jelly, B. | |
|---|---|
| Glycerine .. .. .. | 1 litre. |
| Water.. .. .. .. | 1 ,, |
| Gelatine .. .. .. | 150 grms. |
| Concentrated solution of Phenol .. .. .. | 5 c.c. |

Either of these fluids may of course be made by removing the specimen from the glycerine fluid, dissolving in the latter the requisite quantity of gelatine, and when the jelly is of the right temperature, replacing the specimen. It is not well to have much alum present, as it tends to stiffen the jelly. I generally use gelatine-glue instead of pure gelatine, for the sake of cheapness. Even common glue will answer the purpose, the chief disadvantage attending its use being the darker colour of the specimens.

The jelly must be kept at a temperature just sufficient to retain it in the fluid condition (about 40° C.); for this purpose it is best to use a water-bath. The specimen is retained in it from two to four days, so as to get it thoroughly permeated with glycerine jelly.

After removal from the jelly the specimen is thoroughly drained and placed in a dry room on a sort of trellis-work tray, made by stretching pieces of tape across a wooden frame; this allows of exposure to the air on all sides. The drying-room should be kept shut up as far as possible, so as to keep dust from the sticky surface of the specimen. Such cartilages as the shoulder-girdles and jaws of Elasmobranchs, which are strongly curved and of considerable thickness, should be fastened in position during drying by strappings of tape, wooden supports, etc., as otherwise the small but inevitable shrinking which takes place will cause a certain amount of distortion, and prevent accurate fitting when the whole skeleton is mounted. The gill-arches should be very carefully fixed out in their natural position before drying.

Of wholly cartilaginous skeletons there have been prepared for the Dunedin Museum *Carcharodon*, a young male about 10 feet long, *Cestracion*, *Raja*, and *Trygon*, as well as skulls of *Petromyzon*, *Alopecias*, and *Acanthias*. The first of these was prepared with an insufficient amount of gelatine and is therefore not a great success; *Raja* was prepared without previous immersion in alcohol, and although a vast improvement on the ordinary skeletons of the same fish, is not so good as one could wish; but *Cestracion* and *Trygon* show, up to the present time, remarkably little alteration, the latter having been removed from glycerine jelly for about six weeks, the former for fully three months.

The success of the method is most marked in purely cartilaginous parts, such as the branchial arches, with their delicate branchial rays, which after many months retain their flexibility and translucence unimpaired. The thicker parts of the skeleton show, naturally, the greatest amount of distortion, and this is particularly marked when there is a thickish superficial layer of calcific matter, as in the jaws, etc., of Elasmobranchs: with these parts, the shrinking of the cartilage always produces a slight cracking of the bony matter, but as a similar though less marked cracking is seen in spirit specimens, I do not see how it is to be altogether obviated, unless, perhaps, by using a larger proportion of glycerine.

It is always advisable to allow the specimens several weeks to dry; when the surface no longer feels sticky they are varnished with a solution of white shellac in rectified spirit, the operation being conducted in a warm dry room, as the slightest damp produces precipitation of the shellac. If properly managed, two or three applications of this varnish produce a dry and smooth but not too glossy surface.*

In mounting skeletons prepared in this way, the best plan is to make a framework of japanned wire, of such a form as to serve as a series of rests, or "cradles," for the several parts; the gills are best supported on a special light wire framework. Unless absolutely necessary, no attempt should be made to fasten parts together with wire as in ordinary articulating, and when this has to be done, neither iron, copper, nor brass wire is admissible; silver or platinum only should be used if "glycerine jelly A" has been employed, with "B," pure tin would probably be safe. The method of mounting recommended has the advantage of allowing each part to be separately removed for examination; this of course adds greatly to the value of the skeleton for teaching purposes.

2. *Partly ossified skeletons.* Of these I have had prepared skeletons of *Ceratodus*, and of fœtal calf and foal, and two skulls of the trout, and hope before long to get examples of the various genera of Ganoids and *Urodela*; the method has also been employed with good results for the mesethmoid

* Some recent experiments seem to show that a better varnish is afforded by a solution of dried Canada balsam in benzol, or by equal parts of undried Canada balsam and solution of gum benzoin in methylated spirit.

of mammalian and other skulls, the sternum and sternal ribs of reptiles and mammals, and other partly or wholly cartilaginous portions of the skeleton of the higher animals.

The skeleton of *Ceratodus* was prepared from a specimen which had been for a long time in alcohol; when cleaned it was put through the process described above, as a whole, the cartiliginous and bony portions being too intimately united to allow of the former being prepared alone. This skeleton has now been prepared for upwards of six months, and shows no signs of deterioration. During the whole process it only lost $\frac{1}{36}$ of its length, and even the notochord is hardly more shrunk than in a spirit specimen.

The trouts' skulls were prepared by plunging in boiling water for a few seconds, and then removing the membrane bones; the chondrocranium, Meckel's cartilages and the branchial arches only being put through the glycerine jelly process. After nearly six months the shrinking of the chondrocranium is so slight that the membrane bones fit into their places with almost perfect accuracy. The chief drawback to this preparation is the bad colour taken by the cartilage bones, which of course have to be put through the preserving process; they assume much the colour of the cartilage and cannot be brought to the same state of whiteness as the membrane bones, which are dried at once.

The same objection applies to such parts of the fœtal skeletons, which were put through the preserving process entire. In the case of long bones, the plan was adopted of macerating until the epiphyses could be easily removed, and then preparing these latter alone, and afterwards wiring them on to the shafts. After several weeks the shrinking in these is quite unnoticeable.

3. *Internal organs.* The method has been tried for the hearts of the skate, dogfish, and leopard-seal, the stomach and intestine of the skate, and brains of the skate and sheep. All such structures are first thoroughly hardened in alcohol or chromic acid, and are then subjected to the same process as the cartilaginous skeletons, care being taken to support them carefully in the desired position while drying: veins, for instance, have to be kept open with cylinders of card-board, and so on. It is best to make any dissection of these organs after their removal from alcohol, they can, however, be trimmed conveniently when thoroughly dry. As a rule the thinner organs are more successful than those of considerable thickness; the intestine of the skate, for instance, with the spiral valve displayed, shows no perceptible shrinking: while the ventricles of the seal's heart are perceptibly thinner than before drying; none of the details of structure, however, being lost. These organs, like the bones, assume a dark colour, and are not very attractive as preparations: they are, however, greatly

improved both in appearance and in usefulness for museum and lecture purposes by being painted and varnished—the hearts, *e.g.*, receive the conventional blue and red hues. Distemper colours mixed with a solution of shellac in methylated spirit seem to answer very well.

For brains, my present experience seems to show that my method is inferior to Giacomini's,* but the number of experiments made is hardly sufficient to justify a very positive opinion. Anyhow, I do not expect to effect much improvement in this particular direction; the series of brains prepared by my colleague Dr. Scott, by Giacomini's method, could not easily be bettered.

4. *Invertebrate exoskeletons.* A modification of the above method appears to be very useful for Crustacea, Echinodermata, and other invertebrates with hard exoskeletons. The internal organs are first, as far as possible, removed, and the specimens are then placed in glycerine fluid for a few days; they are then well drained, and after a few days dipped into thin size, kept as nearly as possible at the ordinary temperature of the air: this is done two or three times, and has the effect of producing a good surface; a coat of varnish may afterwards be applied or not according to circumstances. For the larger Crustacea this method appears to be very successful; the chitinous parts retain their flexibility, so that the risk of injury to the specimen is greatly diminished, and the natural colours are retained, in many cases, perfectly. A female *Halimus hectori*, for instance, with eggs attached to the swimmerets, has the general dark colour of the body unaltered, instead of being nearly colourless as in ordinary dried specimens, and the bright scarlet eggs have merely become a shade or two darker, their form and translucence being unchanged.†

5. *Skins of fishes, amphibia, etc.* From one or two experiments, I think the method described in the preceding paragraph is likely to prove very useful for the preparation of skins of fishes, etc., for stuffing. The glycerine fluid must, however, be of only half the usual strength, *i.e.*, one part of glycerine to two of water. The fish is skinned while perfectly fresh, and the skin prepared as above and then stuffed. Some of the colours appear to be retained very well by this method, but I have not yet succeeded in retaining the more delicate shades, such as the spots of the trout and the pink tints of the red cod (*Lotella bacchus*). There is certainly one great

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* Journ. of Anat. and Phys., Jan., 1879.

† I believe that my friend Professor Haddon, when curator of the Cambridge Museum, employed glycerine for preserving Crustacea, but I know nothing of the way in which it was used. In Dr. Carpenter's fine collection of starfish, the colours are beautifully preserved by means of glycerine, but the specimens are enclosed in glass cells, which are expensive and troublesome.

advantage in the method, namely, that it diminishes greatly the shrinking of the fins and other thin parts: adipose fins, for instance, retain their form very satisfactorily. It is possible that the same method, or some modification of it, may be applicable to the preservation of the wattles and other soft parts of birds.

It will be obvious from what has been said that the glycerine jelly process of preserving animal structures is slow, troublesome, and expensive. It will, therefore, probably never be very widely used, although the simplified modification of it described in section 4 should, I think, quite supersede the ordinary method of merely drying the specimens. But even the more complicated process is well worth the trouble it gives if it provides the museum or the zoological laboratory with a small series of type-skeletons of Elasmobranchs, Ganoids, Amphibia, etc., which can be handled like ordinary skeletons, and at the same time have their form almost unaltered, instead of being either in the form of spirit specimens or in that of the shapeless and brittle abominations which usually do duty for the skeletons of cartilaginous fishes.

In conclusion it is only right to mention that the success of my experiments is largely due to the skill and intelligence of my assistants, Messrs. Jennings and Bourne.

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## Art. XXXIV.—*Notice of the Occurrence of the Eastern Golden Plover* (Charadrius fulvus) *in the Auckland District.* By T. F. Cheeseman, F.L.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 13th June,* 1881.]

Few birds have a wider geographical range than the Eastern Golden Plover *(Charadrius fulvus)*. Drs. Finsch and Hartlaub, in their work on the avifauna of Central Polynesia, give an excellent sketch of its distribution. According to them, it ranges along the whole of the eastern shores of Asia, from Northern Siberia and Kamtschatka through Japan and China to the Malay Archipelago and India. Eastwards and southwards, it extends to New Guinea, Australia, and Tasmania, and has been recorded from almost every group of islands in Polynesia. Its breeding quarters, however, are confined to Northern Asia, and it thus exists as a migrant only in countries to the south of China.

The Golden Plover was first recorded from New Zealand by the late Mr. G. R. Gray (under the name of *C. xanthocheilus*, Wagl.), in his catalogue of the birds of New Zealand, printed in vol. ii. of Dieffenbach's "New Zealand," published in 1843. The only specimen known to Mr. Gray appears to have been one presented to the British Museum by Miss R. Stone. From Gray's list the species was copied into all subsequent catalogues; but I cannot ascertain that any further examples found their way to Europe, with the exception of one stated by Finsch and Hartlaub, in their work already quoted, to exist in the Bremen Museum. With the history of this specimen I am not acquainted.* Dr. Buller, in his "Birds of New Zealand" avowedly bases his description upon Miss Stone's specimen. As far back as 1856 there existed in the old Auckland Museum a single specimen said to have been obtained somewhere in the Auckland district; but this was forwarded to Dr. Finsch for examination some ten or twelve years ago, and has not been returned. None of the other museums in the colony have ever contained specimens; and although New Zealand ornithologists have often searched for the bird during the last twelve or fifteen years, no further examples were procured; and doubts have even been expressed as to whether any of the specimens mentioned above were really killed in this country.

The two examples now exhibited were shot by Mr. E. A. Plumley near Penrose, on the Manukau Harbour, early in December, 1880. In all, ten or twelve individuals were observed, three of which were killed, but one proved to be unfit for skinning. Mr. Plumley was kind enough to immediately forward the birds to the museum, so that I was able to examine them in a fresh condition. They proved to be male and female respectively. Like all the specimens hitherto obtained in New Zealand, they are in winter plumage, but show signs of being about to put on their summer dress. It is not improbable that birds in summer plumage may sometimes occur here; indeed, I have had particulars given me by Mr. Plumley which seem to show that this is the case.

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## Art. XXXV.—*Notice of the Occurrence of the Australian Roller* (Eurystomus pacificus) *in New Zealand.* By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 14th November,* 1881.]

The Auckland Museum has lately received a specimen of the Australian Roller (or Dollar Bird, as it is often called in New South Wales), obtained under circumstances which clearly prove it to be a straggler from the Australian continent. The bird was shot by Mr. Charles Cowan, at Piha, a

* Dr. Finsch has since informed me that he is by no means certain that this specimen actually came from New Zealand.

secluded little bay about eight miles to the north of the Manukau Heads, and on the west side of the Waitakerei Range. When first observed by Mr. Cowan it was feeding on the outskirts of the forest, and on being disturbed flew noisily away. Later in the day it returned to the same locality, and was then secured by Mr. Cowan. Mr. J. McElwaine, who happened to be on the west coast at the time, kindly offered to deliver the bird to me, and I thus received it in a fresh condition. It proved to be an adult male, in full plumage. From the state of the long feathers of the wings and tail, which are quite entire and unworn, even at the extremities, it is obvious that the bird has never been kept in confinement, and cannot therefore have been brought over in some vessel. The bird possesses considerable powers of flight, and there is no great improbability in supposing that it has crossed the 1300 miles of ocean separating the two countries, a passage that is made every year by our little cuckoo (*Chrysococcyx lucidus*).

Mr. Gould, in his "Handbook to the Birds of Australia," observes that the Roller is a local species, and is chiefly confined to New South Wales. He makes the following remarks respecting its habits: "It appears to be most active about sunrise and sunset; in sultry weather it generally perches upon some dead branch in a state of quietude. It is a very bold bird at all times, but particularly so during the breeding season, when it attacks with the utmost fury any intruder that may venture to approach the hole in the tree in which its eggs are deposited."

"When intent upon the capture of insects, it usually perches upon the dead upright branch of a tree overhanging the water, where it sits very erect, until a passing insect attracts its notice, when it suddenly darts off, secures its victim, and returns to the same branch. At other times it may constantly be seen on the wing, mostly in pairs, flying just above the tops of the trees, diving and rising again with many rapid turns. During flight the silvery spot in the centre of each wing shows very distinctly, and hence the name of 'Dollar Bird' bestowed upon it by the colonists."

The species appears to be purely an insect feeder. Mr. Gould remarks that the stomachs of all the specimens dissected by him contained *Coleoptera* only. This agrees exactly with the specimen now under notice, its crop being distended in a wonderful manner with these insects.

For further particulars respecting this interesting bird, reference may be made to Gould's work quoted above. The plumage differs in no respect from that of Australian specimens contained in our museum.

## Art. XXXVI.—*On some new Marine Planarians.* By T. W. Kirk, Assistant in the Colonial Museum.

[*Read before the Wellington Philosophical Society, 20th August,* 1881.]

The animals comprising this group are exceedingly interesting. They are usually thin, soft, and delicate; their varied colours, beautiful leaf-like forms and graceful movements render them attractive alike to the naturalist and the novice. They are, however, somewhat small, and adhere so closely to the sea-weed and stones amongst which they live as to require not only a sharp but an experienced eye to detect them.

Most of the members of this section are furnished with a pair of tentacles. In some species these are mere folds or ear-like projections, in others they assume the form of true tentacles, situate either occipitally or dorsally.

The mouth is situate on the under surface, in the median line, but may be either sub-central, pre-central, or post-central.

The ova may often be mistaken for those of nudibranch molluscs, being usually deposited in flakes on sea-weed, etc.

It is to be regretted that no preparation has yet been devised for preserving these animals without destroying the colouring, which is their chief beauty.

The two species now described were obtained in the neighbourhood of Wellington, and kept alive for several weeks. The shores of Cook Strait and Wellington Harbour appear particularly suited to them, and will, when thoroughly examined, probably yield many new and beautiful forms.

### Thysanozoon.

*Thysanozoon huttoni*, sp. nov.

Body oblong, very thin, margin extremely irregular and puckered.

*Upper surface* uniform dirty yellow, irregularly blotched with brown, and having a broad, chocolate-coloured border.

*Under surface* steel grey, bordered with black; a broad, somewhat irregular patch of brown extends along the central two-thirds of the median line.

*Head* with two long tentacles of chocolate colour, but tipped with yellow.

Length, 2 inches.

Lyall Bay.

### Eurylepta.

*Eurylepta herberti*, sp. nov.

Body moderate, veined dendritically, margin much crenated and puckered.

*Upper surface* pale cream colour, with a darker brown median stripe running the whole length; margin white, with an inner border of bright red, and another and narrower one of deep brown, *Under surface* pale grey, with darker along the median line.

Tentacles short, pale cream colour tipped with red.

Eyes numerous at the base of the tentacles.

Length, 1½ inch.

Evans Bay.

Named after Mr. W. H. Herbert, to whom I am indebted for specimens of this beautiful species.

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## Art. XXXVII.—*Additions to the List of New Zealand Shells.*

By T. W. Kirk, Assistant in the Colonial Museum.

[*Read before the Wellington Philosophical Society, 20th August*, 1881.]

*Buccinulus gracilis*, sp. nov.

Whorls 8, finely and closely spirally grooved. Body whorl rather constricted in the middle; the spiral grooves are much finer at the anterior end of this whorl, and as they approach the lip, which is very thin and sharp. White.

Length ·85 inch. Breadth ·37 inch.

Wellington: collected by Mr. C. Holdsworth.

This shell is easily distinguished from *Buccinulus kirki*, Hutton, (the type of which is in the Colonial Museum), by the greater number of whorls, its more elongate and less robust appearance, and by the greater number and closer proximity of the spiral grooves.

*Buccinulus huttoni*, sp. nov.

Whorls six, with numerous fine spiral grooves. Columella with double fold, but more prominent than in the preceding species. Spire very short, giving a decidedly robust appearance to the shell. Ground colour, white with longitudinal brown wavy lines.

Waikanae.

*Neritina fluviatilis*, Linn.

*Neritina fluviatilis*, Jeffreys, Brit. Conch., i. p. 53.

Shell convex above, slightly compressed towards the spire, and almost concave below, solid, moderately glossy, yellowish or brown, with often brown or white zigzag streaks, spots, or bands, which run lengthwise or in a spiral direction, and marked with fine but distinct transverse striæ or plaits, which are more conspicuous towards the suture; epidermis thin: whorls three, rather convex, the last or lowermost exceeding two-thirds of the whole shell, increasing very rapidly and disproportionately in size; spire very short and oblique; suture rather deep; mouth of aperture semilunar; outer lip sharp; pillar-lip exceedingly broad, polished and flat, with a sharp and plain edge.

The only other species of *Neritina* recorded from New Zealand is *N. zealandica*, Reclwz., P.Z.S., 1845, p. 120; but it appears doubtful if the specimens were actually procured in this country.

Those now under consideration were found among the debris brought down by the Waikanae River; probably if the stream were carefully examined further up living examples might be procured, and it is important that this should be done, in order that the animal may be described as well as the shell. A considerable number of specimens were obtained, and submitted to careful examination, yet although there are minor points of difference, the general characters agree so well with the description of *N. fluviatilis* that I am obliged to refer it to that species. Probably, however, the animal when discovered will exhibit sufficient distinctive characteristics to warrant the foundation of a new species.

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## ART. XXXVIII.—*On Pseudo-scab and Lung-worm in Sheep.*

By JOHN BUCHANAN, F.L.S.

[*Read before the Wellington Philosophical Society, 6th August,* 1881.]

### *Pseudo-scab in sheep.*

A DISEASE in sheep resembling Acari Scab, having recently attracted attention among flock-owners, several pieces of affected skin were forwarded by the Sheep Department to the Museum for examination and report, but with no definite results, in consequence of the disease in every case having reached its crisis and the wool having again begun to grow, and only in one case was it clear that the skin had been burrowed by worms.

The conclusions arrived at in lung-worm disease, regarding the life-history of the lung-worm *(Strongylus filaria)*, are clearly applicable in the present case, and it is also highly probable that the same species or an allied one produces this eruption on the sheep, the eruption disappearing in autumn, after which the sheep regain their usual health. The conditions most favourable to the selection of the skin as a nidus, are wet seasons, when the sheep are in a continually soaking condition from rain; such weather is also favourable to the movements of the young worms when in search of a host.

It is doubtful whether the worms in every case burrow into the skin, as no doubt the clotted secretions of yolk at the base of the wool offer sufficient shelter in many cases; it is certain, however, that a scab is produced in every case where the worms have selected the body as a nidus, and their leaving in autumn is coincident with the departure of the lung-worm.

Positive proof of the species infesting the skin can only be ascertained by those having opportunities of searching for them at the proper time, when this pseudo-scab is prevalent.

*The lung-worm in sheep.*

The result of an examination of a portion of a sheep's lung forwarded by the Stock Department is as follows:—The sheep was depastured at Marton and was killed in June last. Near the opening of the bronchial tube was found a contorted heap of filiform white worms, which, on examination, proved to be a species of *Strongylus*. All the specimens examined of this travelling detachment, were found to be packed with eggs, each egg showing under the microscope a coiled embryo within, in an advanced stage of development; a large portion of the lung structure was found to be perfectly healthy, and evidently had not been visited by the worm, but in the remaining portion some worms were found which proved under the microscope to be nearly filled with eggs, none of which, however, showed any traces of an embryo, thus no doubt explaining their delay in moving with the others; male worms were also found here. This portion of the lung proved to be in a diseased state, being flabby and white, the worms having evidently burrowed through its body and formed a lodgment there till they should arrive at their normal size and become fertile with ova. It appears that they remain in the lung till the embryos reach the mature stage of bursting their envelopes, when the parent worms commence to evacuate their temporary abode and move towards the damp ground, where they find the conditions best adapted for the first stage of life of the young worms, and where the parents no doubt die.

It is at this travelling stage that the worms become most dangerous to their host, in proportion to their numbers, filling the air passages of the lungs and nostrils, and often when numerous in weak sheep or lambs causing suffocation. The life-history of this nematode clearly shows that it only occupies the lungs of sheep for a few weeks during summer; leaving the ground in spring while yet in an immature condition and scarcely visible to the unassisted eye, and crawling up the nostrils of the sheep, they reach the lungs without causing much annoyance. The period of escape by the same track in autumn, after they have reached their mature condition and become fertile with embryotic ova, may extend over several days, during which time the sheep labour under great annoyance, and if the worms are numerous are in much danger of suffocation; as they advance towards the nostrils in contorted balls and fill up the air passages, if not speedily expelled the sheep must die. From what has been said it is shown that the maturity of the embryo occurs in some worms earlier than in others, thus lengthening the period of annoyance although diminishing the danger of suffocation, as the worms are not all travelling at one time.

Preventative measures with this disease should always be tried in preference to what may be termed a cure, for it is only when the worms are leaving instinctively that any cure is ever tried, and it were better to assist their escape by cleaning out the nostrils of the sheep than killing them in the air passages of the lungs with the fumes of burning sulphur.

Either prevention of access of the worm to the sheep in spring, by their removal to dry ground—or keeping rock-salt in places where the sheep can have access to it, more especially when the young nematode has newly reached the lungs and is of a microscopic size—should be adopted.

When the young worm finds a nidus on the back, and the wool shows the first symptoms of raggedness, an application of a mixture of soft soap in water with a little turpentine or kerosene, if distributed in the opened wool with a groove-corked bottle, would speedily check the evil.

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*Extracts from Reports of Sheep Inspectors and Notes thereon.*

Mr. Foster in a report to the Stock Department describes very correctly the disease in sheep caused by worms in the lungs; but the proper time for administering remedies is not stated, and any treatment which would kill the worms after they have reached an advanced stage of development is more likely to kill the sheep; every means should be used to get the worms out of the nostrils and prevent suffocation of the sheep. It is very probable that sulphur fumes might prove beneficial if applied when the worms are of a microscopic size on their earliest arrival from the wet ground.

Mr. Boyes seems to be on the right track with the sulphur fumes, he says he is sure it will cure the bronchial disease "in its earlier stage," and he means to use it as a preventative; perhaps he expects too much in that, as sulphur fumes are not likely to do much damage to worms before their arrival. Why not put soluble sulphur in the blood through the stomach?

Mr. Reginald Foster points out the main feature of the whole subject:

"Most stock-owners wean their lambs on their best feed, which in summer is usually on the moist low-lying land where these parasites or rather their ova exist. Lambing paddocks should be virgin pasture."

Sheep Inspector Simpson, Marton District, reports as follows: "I forward by mail to-day a package containing portion of a sheep's lung showing a number of worms in its tubes, perhaps you may be able to obtain reliable information if this is the cause of the heavy losses, chiefly in hoggets, for several years past.

"The first symptom is a severe cough, afterwards followed by scouring, which invariably terminates in death. I have very little doubt but the worm is the cause of the cough, and the scouring is an after consequence."

Mr. Reginald Foster, of Amberley, writes to the Christchurch papers in July last, in reference to a mortality among sheep in some districts of Canterbury, supposed to have been caused by worms. He says: "On Friday last, at the farm of Mr. James Guild, of Ohoka, I examined some hoggets which had apparently died from scour. I found that the lungs were in a highly diseased state, and opening the bronchial tubes I discovered several white thread-like worms about one inch in length. I also found a considerable number of these parasites in the air passages of the lungs. With the exception of a little inflammation in the intestines, caused no doubt by the diarrhœa from which all these hoggets had suffered, the rest of the internal organs were perfectly healthy. Mr. Guild has recently lost a considerable number of hoggets, and there is little doubt that these worms were the cause of their death. So far as I can learn, this disease, well known in England, has not as yet been noticed in New Zealand, but I think it is highly probable that it has been one of the causes of the heavy mortality in young stock, especially in hoggets and calves, from which stock-owners have suffered for several seasons past. The remedial treatment recommended is turpentine, in doses of a quarter of an ounce, given in oil. A simple and more direct remedy is to make the sheep inhale fumes of sulphur in a shed. In advanced cases, where diarrhœa has set in, some medicine to act on the stomach would also be necessary."

The remarks of Inspector Reginald Foster, in the concluding part of his report are worthy of notice:

"I think that future investigations should be directed towards noticing the earliest stages of the disease, by watching the young stock on farms known to be infected, at what rate the disease progresses, so as to form an opinion as to when is the best time to use remedial measures. Several breeders of stock who have taken some trouble to investigate this disease agree with me, that when the cough is bad and is accompanied by diarrhœa the malady is in too advanced a stage to hope much from remedial measures. So far as my knowledge of the bronchial disease goes at present, I am strongly of the opinion that breeders of stock in low-lying districts, to which the disease appears to be almost entirely confined, should put their weaners through a course of inhalation of the fumes of sulphur about the month of April; this remedy is known to be effectual and is very inexpensive, two men could put 400 or 500 hoggets through in half a day."

Mr. Charles C. Boyes, in writing to Mr. R. Foster, Amberley, says: "Since writing you I am glad to say my sheep are fast recovering, and I have only one death to record. I have persevered in the sulphur treatment, in which I have great faith, and I am now quite certain that it will cure the bronchial disease in its earlier stage. I tried the oil and turpentine in a few cases, but I fear the sheep were too far gone for any remedy to have effect. In each of these latter cases I found on opening the sheep that the worms had penetrated the lungs, and when this has occurred I am afraid there is no cure. I have made the infected sheep inhale sulphur four times, at intervals of three days, and the flock seem now quite recovered, in good heart and feeding well. The sulphur inhalation is the cheapest and speediest cure, and I am much indebted to you for your suggestion of it; in future I intend putting the sheep through a course of this treatment at the end of each autumn as a preventative, as I have noticed that this is the season when the disease always shows itself first."

Mr. Reginald Foster, writing to the Stock Department, says:—" We must look rather to preventive means. In this, as in the case of most diseases, I think there must be some predisposition to contract disease, and this is most likely to occur soon after weaning, when those lambs which had not weaned themselves, being suddenly deprived of their natural food, are for a time debilitated, and would therefore be the more susceptible to disease.

" Most stock-owners wean their lambs on their best feed, which in summer is usually on the moist low-lying land, where these parasites, or rather their ova, exist. None but adult stock which are able to resist the attacks of the bronchial worms should be put on rich swampy pastures. Lambing paddocks should if possible be virgin pasture, or should have been saved some time for the purpose, and the lambs should always have access to rock-salt, which is the best known preventative for worms of all kinds. The simplest remedies recommended are a dessert-spoonful of turpentine to two of linseed oil, given every other day, about three or four doses; or the sheep should be placed in a close shed and made to inhale the fumes of sulphur. This may be done by sprinkling sulphur on a pan of live coals.

" These remedies have been tried in two or three instances here, but I have not yet heard with what result. I think they would only be effectual in the very earliest stages."

*Extract from Report of the Commissioner of Agriculture, Ohio.*

" We have no knowledge of the cause of the lung-worm—a name given for the want of a better perhaps. It affects young sheep in a greater degree and to a greater extent than matured animals. The worm is a small white one, and is found in considerable numbers in the lungs, or in tubes connecting the windpipe with the lungs. The symptoms are weakness, failure to eat, loss of flesh, and a cough. This disease is but little understood by the wool-grower.

" Stricana or Strichnia is perhaps a very incorrect name for the disease I wish to describe. It is caused by a very small worm, so minute, indeed, that it cannot be seen without the aid of a magnifying-glass. It is believed to cause the sheep to pick or bite the wool from its sides, flank, and other parts, until the fleece becomes more or less ragged and wasted. The skin becomes rough, and shows symptoms of disease. It is not contagious, but attacks sheep of all ages. It is more damaging in flocks that have been closely bred 'in and in' for many years; indeed this is the case with most diseases. As both a preventative and cure, wood and cob ashes with salt are used, with partial success."

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ART. XXXIX.—*Notes on Zoological Researches made on the Chicken Islands, East Coast of the North Island.* By ANDREAS REISCHEK. Communicated by Professor VON HAAST, PH.D., F.R.S.

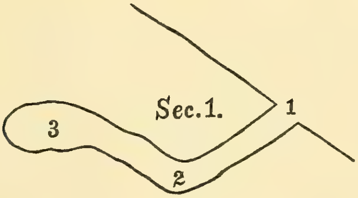
[*Read before the Philosophical Institute of Canterbury, 4th August,* 1881.]

IN December of last year I paid a visit to that cluster of islands called the Chickens, situated east of Wangarei Bay, on the East Coast of the North Island. There are six islands, three of which are of some size, and three are small. The first are covered with bush, with the exception of a few abandoned Maori plantations, now overgrown with flax and scrub. They are hilly and contain copious springs of excellent water. On the large western island two good boat harbours are situated on the southern and western side, and between the islands are good places for small vessels to anchor. In examining the summits of these larger islands I found remains of Maori pahs with numerous cooking places and kitchen middens near them. In excavating amongst them I found only one polished stone axe, but several specimens of chipped flint, together with a quantity of mussel and other marine shells, of which the animals have evidently served as food to the former inhabitants. On the smaller islands the bare rocks show mostly, covered here and there with patches of low scrub. All the islands are uninhabited. The avifauna consisted of

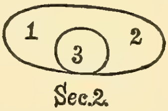
*Hieracidea novæ-zealandiæ*, Lath. Scarce.
*Circus assimilis*, Gray.
*Prosthemadera novæ-zealandiæ*, Gray.
*Anthornis melanura*, Sparrm.
*Zosterops lateralis*, Lath.
*Petroica macrocephala*, Gml. Scarce.
*Gerygone flaviventris*, Lath.
*Rhipidura flabellifera*, Gml.
*Platycercus novæ-zealandiæ*, Sparrm.

*Nestor meridionalis*, Gml. Scarce.
*Chrysococcyx lucidus*, Gml. Scarce.
*Carpophaga novæ-zealandiæ*, Gml. Scarce.
*Larus dominicanus*, Licht. Scarce.
*Procellaria lessoni*, Garnot. Scarce.
,, *gouldii*, Hutton.
,, *cookii*, Gray.
*Puffinus gavius*, Forst.
*Dysporus serrator*, L.
*Graculus varius*, Gml.
*Eudyptula minor*, Forst.

It is evident from an examination of this list that the avifauna is much richer on these comparatively small islands than on the adjoining mainland, where, to give only one instance, *Anthornis melanura* has entirely disappeared, while on these islands it is still of frequent occurrence. Of the birds at least three, namely, *Procellaria gouldii and cookii* and *Puffinus gavius*, live sociably in the holes generally dug out by the tuatara (*Sphenodon punctatum*, Schtz.), and apparently on the best of terms with it. The tuatara excavates its hole mostly on the western slope of the islands. The entrance to the chamber is generally four to five inches in diameter, and the passage leading into the inner chamber is two to three feet long, first descending and then ascending again. The chamber itself is one foot and a-half long, by one foot wide and six inches high, and is lined with grass and leaves. The following rough sketches give (1) a section of the passage and inner chamber, and (2) a section along the greatest diameter of that strange habitation. On both sides of the entrance the two animals have their nests separately, so that they do in no way interfere with each other. On the right side lives generally the tuatara, and on the left the petrel. In one chamber I found one tuatara and one petrel with its eggs, in another one tuatara and one young petrel.




1. Entrance.
2. Passage.
3. Chamber.




1. Tuatara.
2. Petrel.
3. Entrance.

Sometimes two petrels were inhabiting one side and the tuatara the other, but I never found two tuataras living in the same chamber. I am certain that the tuataras excavate, at least in most cases, the holes they inhabit, as I have watched them doing it; and, moreover, I found several of them in holes only half finished, without having a bird with them. In another instance when my dog ran after one of these remarkable lizards it buried itself with great celerity in a sandhill. However, I have no doubt that in some instances the tuataras also inhabit holes dug out by the petrels. The difference between the habitations of the latter compared with those of the former is that the petrels excavate their holes on the mainland and the islands under the roots of trees and scrub in rather loose earth, while the tuataras dig in solid and hard earth, but the form of the passage and of the interior are in both cases nearly alike. As before observed, the petrel is usually on the left side, the tuatara on the right side of the inner chamber; only in two cases did I find the bird on the right hand side. The tuataras lie also in such a manner that their head is placed where the passage enters the chamber, so that they can defend it.

On putting one's hand or a stick into the passage the tuatara bites at them furiously. One of them bit me on the finger, and the wound healed very slowly and was rather painful. During the daytime these lizards are seldom met with outside their hole, or should this be the case, never far from its entrance. As soon as they apprehend danger they re-enter immediately, or should this not be possible, hide amongst the roots or behind a stone. In that case owing to the peculiar colour of their skin it is extremely difficult to detect them; in fact a well-trained dog is wanted for the purpose. They run very fast, and defend themselves with great pluck against dog or man, by biting and scratching. In unearthing them by digging, great care has to be taken, as they very often possess additional passages leading into the inner chamber, by which they are able to save themselves.

As soon as the sun has set the tuatara leaves its hole to seek its food, consisting of worms, beetles, wetas, etc. It also feeds on the remnants of fishes and crustaceans brought by the petrel into the chamber. During the night a peculiar croaking sound is heard emanating from these lizards, not unlike the grunting of a pig when it is tormented or frightened; this is the best time to catch them. I believe that the female of *Sphenodon* lays its eggs in February, as in January I found in one of them eight full-grown eggs. And I may here mention that I obtained about the same time a young one, eight inches long including the tail.

I also searched the Little Barrier Island for tuataras, but in vain. The large quantities of feral pigs living upon that island may easily account for their absence. There are also none on the Hen and the Guano Islands. Most frequently they were found by me on the large western Chicken Island. I believe that they are still more abundant on the smaller islands; however, although I tried repeatedly to land on them, the heavy surf would not allow me to do so.

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## Art. XL.—*On some new and undescribed Species of New Zealand Insects, of the Orders* Orthoptera *and* Coleoptera. By W. Colenso, F.L.S.

[*Read before the Hawke's Bay Philosophical Institute, 8th November*, 1880.]

### ORTHOPTERA.

Fam. Mantidæ. Genus *Mantis*.

*Mantis novæ-zealandiæ*, n. sp.

*Pronotum* five lines long, anterior end widest, ridged down the middle, minutely tuberculated all over in scattered dots, punctulate, punctures translucent when viewed between eye and light, side-margins rough finely sub-serrulate, edge straight sloping gradually to mesonotum. *Anterior pair of legs:* trochanter very slightly serrulate at margins; femur two rows of spines of irregular lengths, inner row small and closely set, outer four only large and distant, a large purple oval or kidney-shaped spot central within; tibia two rows of spines, regular, ending in one very long curved one at base; tarsus long; *costæ* of the *anterior wings* (elytra), one to each, run longitudinally parallel with and near the outer margin, with transverse flexuose nerves branching inwardly and diagonally from it, wholly filled up between them with fine anastomosing veinlets; *elytra* semi-transparent; *posterior wings* much smaller and very membraneous; wings extending far beyond base of abdomen; *abdomen* thick smooth. *Antennæ* short, 3½ lines long; *eyes* large, two small protuberances (? stemmata) between horns and just behind them: total length from head to posterior edge of elytra 1½ inches: length of *nympha* 1¼ inches. *Colour* (of both states nearly alike), mostly light emerald green; underneath, about mouth and thorax, and inside of fore-legs pale lemon; outside of legs and head (above) dark orange; a dark purple reniform spot on inside of each fore femur.

*Hab.*—Scinde Island, Napier, on trees (*nympha* state only), 1878–1879, Mr. J. A. Rearden; *imago* state (one specimen), 1880, Mr. J. D. Ormond.

This species has pretty close affinity with the European species *M. religiosa*, but it is very much smaller, with shorter horns, and less spiny and narrower fore-legs, etc.

During the summer of 1878–1879 I had several living specimens of this insect in its *nympha* state; some of them I sent to the Colonial Museum in spirits. I kept them alive for some time, although I did not succeed in finding out their natural food; one of them, however, shed its skin. I had long been on the look-out for a New Zealand species of *Mantis*, as we had known from Dieffenbach's work on New Zealand (vol. ii., p. 280), that some eggs, or egg cases, of a species of *Mantis* had been taken to England by Dr. Sinclair nearly forty years ago, and I was consequently much gratified on receiving the perfect insect.

Fam. Phasmidæ. Genus *Bacillus.*

*Bacillus sylvaticus*, n. sp.

General *colour* dirty yellowish-grey, abdomen darker; *pronotum, mesonotum*, and *metanotum* slightly spiny with a few small low spines; three longitudinal rows of large distant spines on *pronotum*, 3–4 in each row; *prosternum, mesosternum*, and *metasternum* very spiny with long sharp spines; all spines blackish pointed; a close row of fine sharp spines runs along side ridges of *mesothorax* and *metathorax*; *abdomen* below with two rows of spines from anterior end to end of the sixth segment, which are tolerably large at the anterior end; above smooth or very slightly and sparingly muricated; fourth, fifth, and sixth *segments* dilated on sides at posterior ends, the sixth the most so; *anal appendages* produced, broad; *anus* very large; anterior pair of *coxæ* slightly tubercled, others smooth, or roughish, wrinkled; *anterior pair of femora* angular, regularly crenulated on upper edge, and distantly muricated on both upper and lower edges; *middle and posterior pair of femora* with 2–3 small scattered spines; *posterior and middle tibiæ and tarsi* slightly crested at bases, those of tibiæ twin and very small; all *tarsi* slightly pubescent; *vertex* slightly tubercled, smooth between the eyes and under throat; *antennæ* slightly pubescent, black-jointed, muticous, 1¼ inch long; length of body 5¼ inches.

*Hab.*—On trees, forests, Hampden, Hawke's Bay, 1879.

This species has affinity with *B. horridus*, nevertheless it differs considerably.

A peculiarity of one of my specimens is worth noticing, *viz.*, that it has evidently lost one of its middle legs; and now a much smaller one, perfect, though not one-third of the size of the other, was being developed.

Fam. Locustidæ. Genus *Hemideina.*

*Hemideina gigantea*, n. sp.

*Colour:* head, thorax, femora, two fore pairs of tibiæ and tarsi, red-brown; pronotum a darker and very rich red-brown, slightly punctured with whitish spots; abdomen (dorsal) smoky light-ochre with transverse symmetrical dark-brown (raw umber) bands at edges of all the segments, widest in the middle and decurrent centrally beginning at the mesonotum; sides of abdomen deep black-brown; ventral segments throughout blotched with black-brown in three irregular and wide longitudinal lines; posterior tibiæ, tarsi, and spines, with the ovipositor, piceous; *tibiæ* quadrangular, *anterior pair* with ten spines in two inner rows; *middle pair*, fourteen spines in three rows; and *posterior pair* with seventeen spines in four rows (three of them alternately bearing five spines each), the outer row being very long and acute, increasing in length downwards, the lowest spine at the base of tibia 4 lines long; *femora, anterior,* and *middle pairs* smooth and spineless; *posterior pair* each having two longitudinal rows of spines, eight in a row, on the inner side, regularly marked on the outside with transverse wavy light lines; *coxæ* each armed with a single spine, those of anterior pair long and sharp, of posterior short and very obtuse; four joints of *tarsi* cushioned, each with a prominent broad transverse pad, besides pulvilli; last joint of tarsi the longest; terminal spines, or hooks, of tarsi large, long, and falcate; *ovipositor* curved upwards, blades slightly concave, thin, and elliptical at apex; four long stout acute spines above, two on each side of anus; posterior *femur* 1½ inch long, *tibia* 2 inches long, *tarsus* 1 inch long; maxillary *palpi* stout, long, and largely clavate; *labrum* very broad and obtuse; *eyes* broadly elliptic and very prominent; *antennæ* light reddish-brown, annulate, 7½ inches long, distant at base; rings of horns smaller and finer than in the much smaller species (*infra*) *H. speluncæ*: size, body without appendages 4 inches long, and very bulky.

*Hab.*—In a small low wood behind Paihia, Bay of Islands; 1839.

This species is bigger every way than *H. hetaracantha*, with which species, however, it has close affinity. It is also much more spiny, and differs greatly in colour, etc. It is a very fine and handsome insect.

It has a little semi-public history, which may be here very briefly given. It has been seen and admired by Dr. Dieffenbach, Dr. Sir Joseph Hooker (and the other officers of that Antarctic expedition), Dr. Sinclair, Lady Franklin, the several early French and American naturalists who had visited New Zealand, etc., etc.

It was long supposed (from the publication of Dr. Dieffenbach's work on New Zealand in 1843) to be identical with *Deinacrida heteracantha* of that work (vol. ii., p. 180), and, if so, should have been the type (being the old original specimen); but a close examination of *late years* served to show their respective and great differences. This specimen remained packed up in the box in which it was brought away from the Bay of Islands, from 1843 to 1864! It was, however, exhibited at the New Zealand Exhibition* at Dunedin in 1865, as *Deinacrida gigantea*, COL.; and although it has been

* *Vide* Jurors' Reports, p. 254.

now forty-two years in spirits, its colours are unaltered. It is still in its original clear glass bottle with the liquid clear and pure: but the ground-glass stopper having become firmly fixed, and not choosing to run the risk of injuring the specimen (which, as far as I know, is unique), I have given some of its measurements as approximate only,—but they were carefully taken and are very nearly quite correct, at all events within a line or two.

*Hemideina speluncæ*, n. sp.

*Colour:* body beneath light ochreous; pronotum, both anterior and posterior edges broadly banded with black, mesonotum and metanotum also having a black band close to posterior margin, but all the thoracic and abdominal segments have a narrow white line on all their dorsal posterior and side edges; abdomen above brownish, dirty raw umber at the base; posterior femora (upper parts only) light reddish-brown, transversely and closely banded with finely waved and regular lines of a darker brown, in three longitudinal and separate rows, the markings all different in each row; middle and anterior femora (upper part only) ochreous; tibiæ and lower parts of femora banded with black and white rings (resembling porcupine quills in miniature); tarsi light straw colour, translucent: *posterior pair of legs*; femur 1¼ inch long, with one row of seven very small distant spines on the inner edge; tibia 1½ inch long, slightly hairy, with two rows of fine close spines, 35–40 in a row, on two inner edges, sulcated between the rows, at base of tibia two long and villous white spines; tarsus 4-jointed, 8 lines long, smooth, translucent, finely and thickly pubescent, with a single small spine at the base of each joint, joint nearest to the tibia the longest (as long as the other three taken together: *middle pair of legs*; femur 9 lines long, naked; tibia 10 lines long, with four rows of small spines, five in each row; tarsus 7 lines long, spineless: *anterior pair*; femur 10½ lines long, with a row of six small spines; tibia 11 lines long, with a row of four small spines; tarsus 8 lines long, spineless, slightly villous and translucent; two long spine-shaped *processes*, each 4 lines long, at end of abdomen near anus, one on each side, whitish, finely ciliated with long flexuose patent ciliæ, 1–2 lines long; *head* rather small, narrower than pronotum, and scarcely appearing before it; maxillary *palpi* long and slender, slightly clavate; *eyes* rather large, semi-lunar, at base of antennæ and nearly behind them, gibbous edge towards thorax; *antennæ* thick at base and close together, 8 inches long, articulated, light reddish-brown but darker at articulations, very setaceous, each bearing a row of short obtuse spines on the outer edge in the middle for nearly one-third of its length, spines irregular in size and position, some being near, one on each articulation, some more distant, with 2–3 vacant articulations between, spines always at anterior end of joint, rings of its horns coarser than in the large species *(supra) H. gigantea*; *body* without appendages, 1½ inch long.

*Hab.*—In dark underground caves near the head of the Manawatu river, in the "Forty mile bush," 1879.

This peculiar and very interesting animal, (of which I regret to say I have but one whole specimen), inhabits in great numbers those small caves which are difficult of access; there they hop and spring about like shrimps, and having such excessively long and fine horns and legs, it is a very difficult matter to secure a perfect specimen; of course the necessity of having a candle burning when in those dark recesses, greatly increases the difficulty. I am indebted to Mr. J. W. Thomson, of Norsewood, for this specimen here described, who captured the insect there, together with some others, which, however, were unfortunately much crushed and broken. The brightness of its colours when fresh, particularly of its black-and-white ringed legs, their excessive tenuity, and the extreme length of its fine setaceous horns, all tend to give this creature an elegant and graceful appearance; in this respect widely differing from the other known species of this genus.

## COLEOPTERA.

### Fam. CURCULIONIDÆ. Genus *Scolopterus.*

*Scolopterus submetallicus*, n. sp.

General *colour* black-green, very glossy, *femora* purple-black, legs piceous; *elytra* punctured coarsely in lines on back, faintly on sides; *head* smooth; shoulder-spines straight, acute; *posterior femora* large, armed with a large acute tooth near base; *pulvilli* bordered with white. Length 4¼ lines.

*Hab.*—Forests near head of Manawatu river, 1880.

This specimen flew down from a high tree, and alighted on the sleeve of my coat. As a species it ranks near to *S. tetracanthus.*

### Genus *Rhyncodes.*

*Rhyncodes weberi*, n. sp.

*Insect* villous; general *colour* reddish-brown intermixed with grey, and mottled with small greyish-white blotches on elytra; *pronotum* brown, finely punctulate; *elytra*, five black shining longitudinal lines slightly and closely tuberculated in small raised dots, parallel with five black smooth lines, outer edge stout, black, glossy, strongly and regularly marked with small transverse riblets running inwards at right-angles; *abdomen* beneath black glossy, with a few short scattered hairs, and three broad longitudinal rows of mottled hairs; *femora*, and sides (shoulders) of pronotum, black, glossy, and slightly punctulate; a small tuft of reddish hairs at bases of femora; *coxæ* densely villous; *tibiæ* and *tarsi* very hairy; *pulvilli* very large, broadly orbicular-obcordate; *antennæ* stout, serrated, hairy throughout and coarsely ciliated, nearly as long as the rostrum; *head* and *rostrum* very hairy, with red-brown hairs. Length, including rostrum, 15 lines.

*Hab.*—Hawke's Bay; C. H. Weber, Esq., 1878.

A species near to *R. ursus*, but much larger.

*Rhyncodes rubipunctatus*, n. sp.

*Insect* wholly covered with very short whitish-grey down, finely and thickly speckled with light-red, which (below especially) assumes a flattish semi-scaly appearance, each minute speck of reddish down or hair showing a regular circumscribed shape; *pronotum* dotted profusely and finely with black raised irregular dots, and bearing two semi-lunate and two smaller brown spots; *elytra* extending sharply over abdomen, with 12–14 longitudinal sub-striated rows of black raised shining dots, mottled with 2–3 small brownish markings in a line with those on pronotum; *abdomen* below with three fine transverse black lines near anus; *head* between eyes and base of rostrum coarsely dotted with raised brown dots; *eyes* large; *rostrum* jet-black, smooth; *antennæ* as long as rostrum and slightly hairy. Length, including rostrum, 9 lines.

*Hab.*—Hawke's Bay, Patangata; captured by Mr. G. W. Tiffen, 1880.

Another specimen, taken in the same neighbourhood by Mr. Winkelmann, bit its captor's hand pretty sharply through his handkerchief, causing it to bleed.

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## Art. XLI.—*Descriptions of New Shells.*

By T. W. Kirk, Assistant in the Colonial Museum.

[*Read before the Wellington Philosophical Society, 21st January,* 1882.]

The three species mentioned below all possess a deep notch at the anterior end of the columella, which at once distinguishes them from *Euchelus*, the columella of which has only a "small tooth in front." It thus becomes necessary to create a new genus for the reception of the New Zealand species.

Professor Hutton, to whom I have dedicated the new genus, informs me that while in Sydney he examined a series of specimens representing the various species of *Euchelus*, but in no instance could anything approaching a notch be discovered.

### Huttonia, gen. nov.

Shell moderate; turbinated, sub-globose; perforate or imperforate; columella with a deep notch at the anterior end. Outer lip thickened and crenated internally.

*H. bella.*

*Euchelus bellus*, Hutton; Cat. Marine Moll., p. 37.

*H. iricolor*, sp. nov.

Shell *imperforate;* larger, spire more prominent, and granulated ribs much coarser than in *H. bella.*

*Colour:* dirty chocolate, apex greenish-white. Inside bluish-green, with an iridescent play of colours, except the outer lip which is green, and the columella which is white.

Sometimes entirely covered with short brown *Algæ.*

*Hab.*—Waikanae.

*H. hamiltoni,* sp. nov.

Shell *perforate* ; spiral granular ribs very fine.

*Colour:* white, or faint pinkish-white, with points of darker colour forming diagonal lines arcoss the whorls. Apex white. Inside white.

*Hab.*—Wellington.

*Aplysia hamiltoni,* sp. nov

Animal about 7 inches in length, 2½ inches high, and weighed 14 ozs.

*Colour:* umber-brown, with fine irregular dark markings; lighter below.

*Shell* ear-shaped, horny, firm, ribbed on left half, irregularly concentrically striated; epidermis bright straw colour, highly polished. Inside white, with a pearly lustre.

Length, 1·6 inch. Breadth, 1·45 inch.

*Hab.*—Napier. Two specimens received from Mr. A. Hamilton of Petane, Hawke's Bay.

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## Art. XLII.—*Description of new* Cephalopoda.

By T. W. Kirk, Assistant in the Colonial Museum.

[*Read before the Wellington Philosophical Society, 11th February,* 1882.]

Plate XXXVI.

*Sepiola,* Rondelet.

Body oval; mantle globose; its dorsal or hinder edge is connected in the middle with the head by a broad ligament: fins thin, small, placed behind the middle of the sides. Eyes partly covered by a cuticle or lid. Arms in unequal pairs. Shell small, bat-shaped.

*Sepiola pacifica,* sp. nov.

Body smooth, long bell-shaped. Fins moderate, front ma ns free. Tentacles vermiform, as long as head and body together; club thickly and irregularly studded with minute suckers. Sessile arms unequal, the ventral or lowest being the largest; all armed with suckers arranged in two alternating rows, and extending right to the tip of each arm. Head stout, eyes prominent.

Colour: *Above,* flesh-colour irregularly and profusely spotted and blotched with purple, the ground-colour of the head and anterior part of the body being almost hidden; spots becoming finer as they approach the posterior end of the body. *Below*, pale flesh-colour, spotted as above, but spots much larger and further apart. The funnel, sides of sessile arms, and under surface of fins white. Tentacles white, with exception of a row of purple spots on the back of the club.

Total length 1·4 inch. Length of body 1 inch. Length of head ·4 inch.

*Hab.*—Wellington.

*Architeuthis*, Steenstrup.

Oplysninger om Atlanter, Collossale Blæksprutter, Förhandlinger Skand. Natur., 1856, vii., p. 182, Christiana, 1857.

Size large; body stout, nearly round, swollen in the middle. Caudal fin very small, sagittate. Head large, short. Eyes very large, oblong-ovate, with well developed lids and anterior sinus. Sessile arms stout, their suckers large, very oblique, with the edges of the horny rings strongly serrate, especially on the outer margin. The margin has around it a free-edged membrane, which closely surrounds the denticles when the sucker is used, and allows a vacuum to be produced. Tentacular arms very long and slender in extension, the proximal part of the club furnished with an irregular group of small, smooth-rimmed suckers, intermingled with rounded tubercles on each arm, the suckers on one arm corresponding with the tubercles on the other, so that by them the two arms may be firmly attached together without injury, and used in concert; other similar suckers and tubercles, doubtless for the same use, are distantly scattered along the slender part of these arms, one sucker and one tubercle always occurring near together. The internal shell is thin and very broad, expanding from the anterior to the posterior end, with divergent ribs (Verrill).

*A. verrilli*, sp. nov. Fig. 1.

Body short, stout and nearly round, dilated in the middle.

Sessile arms unequal in size and length; the first, second and fourth pairs about same length as body and head together, third pair longer and stouter; all armed with similar suckers, but varying in number, the third pair carrying more than either of the others.

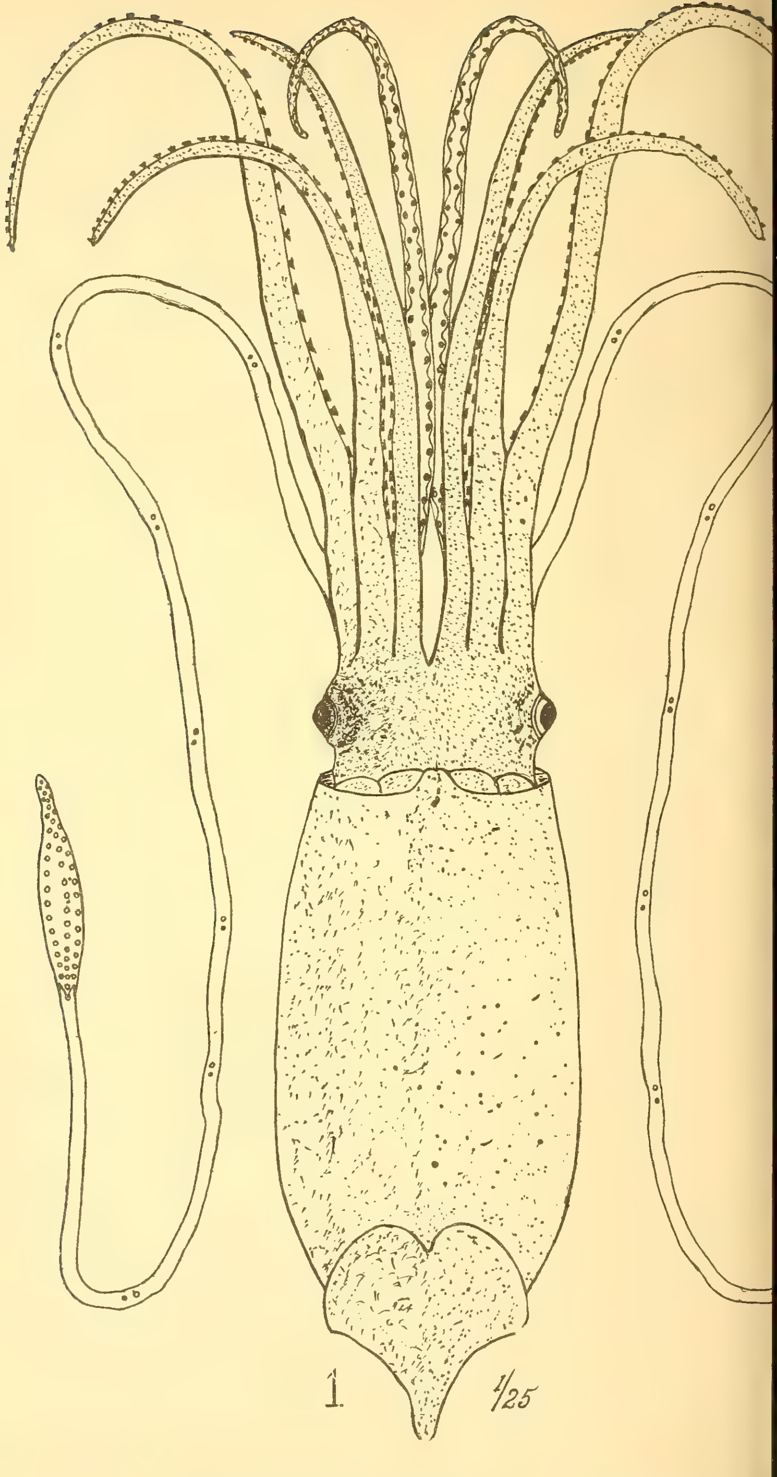
Tentacular arms, when extended, nearly three times the length of head and body.

Caudal fin obcordate, small dorsal; from tip to front margin about one third the length of the body; terminating posteriorily in a blunt point.

Suckers stalked.

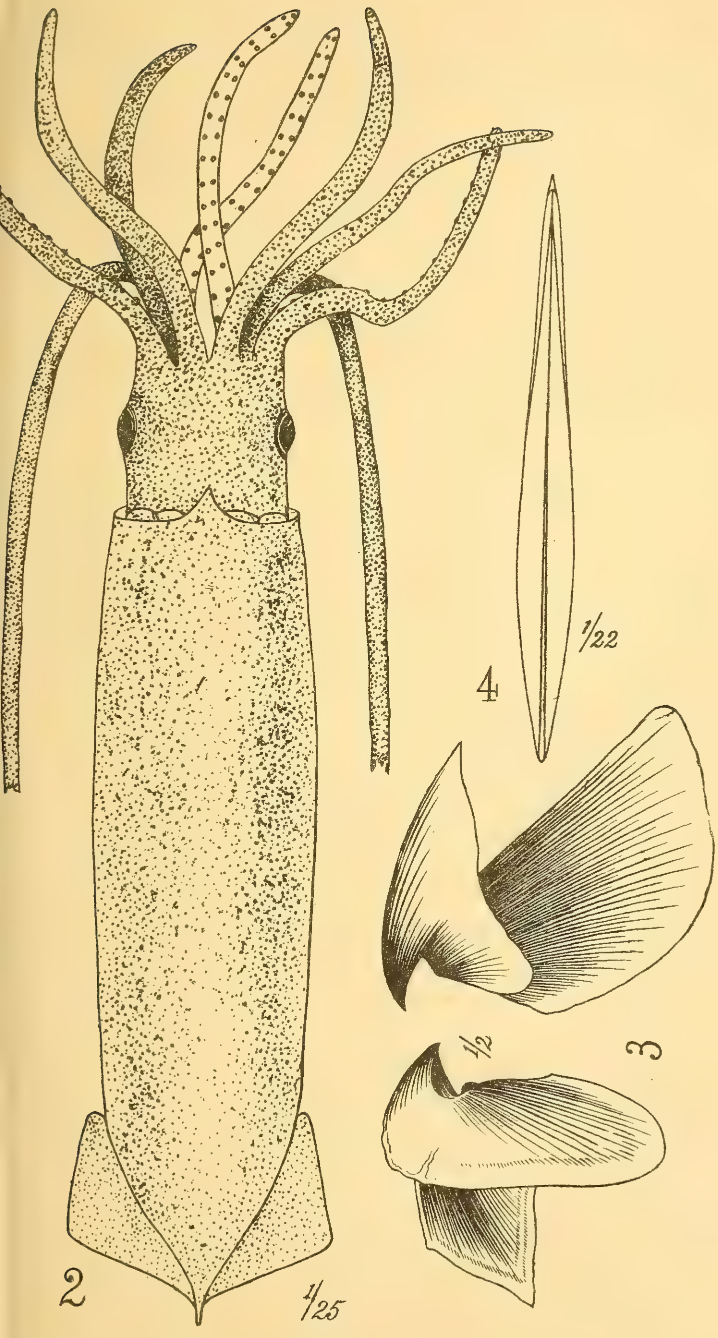
| | | |
|---|---|---|
| Length of body and head .. .. .. .. .. | 9 feet | 1 in. |
| „ 1st, 2nd, and 4th sessile arms .. .. | 9 „ | 0 „ |
| „ 3rd sessile arm .. .. .. .. .. | 10 „ | 5 „ |
| Circumference of body .. .. .. .. .. | 9 „ | 2 „ |

*Hab.*—Cook Strait.

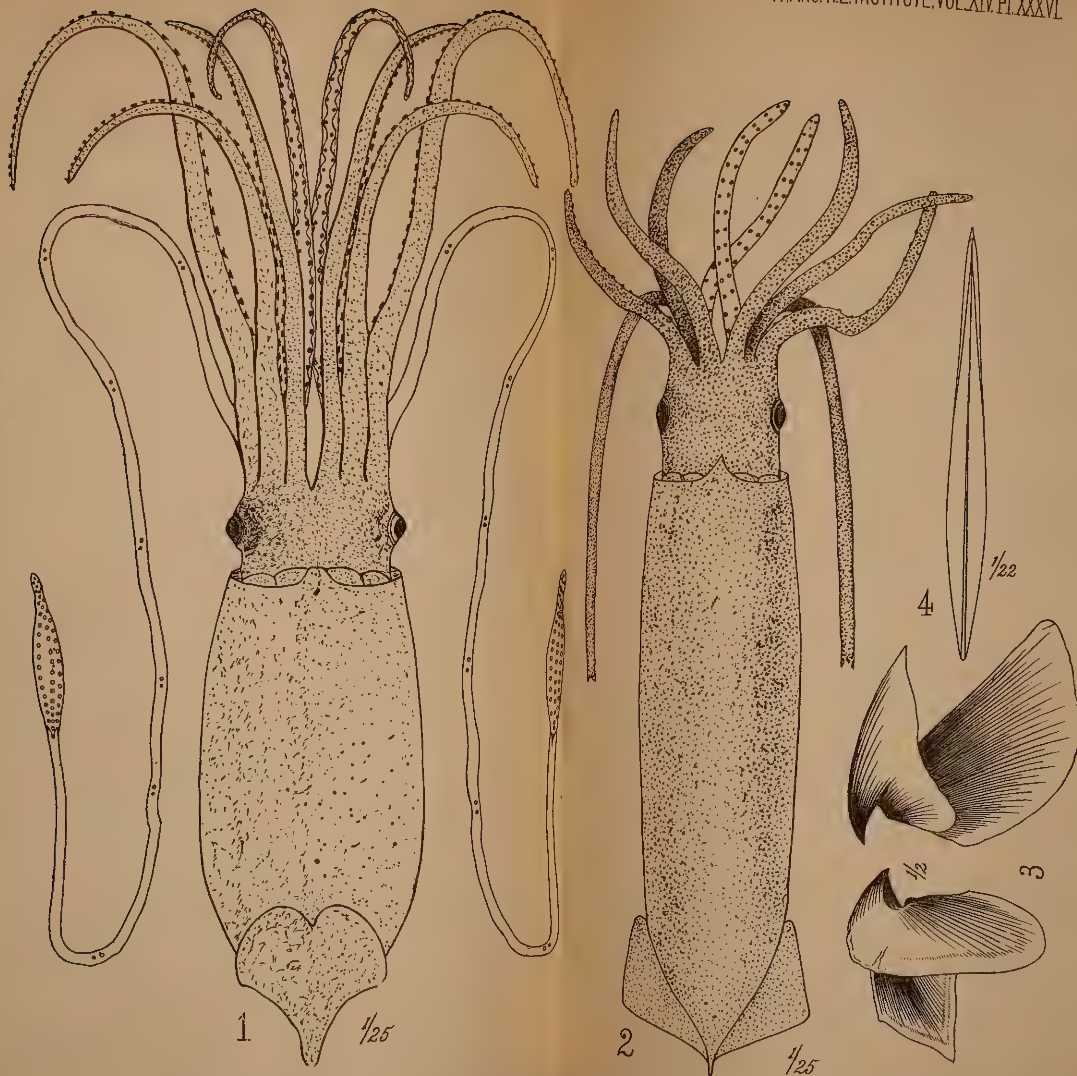



T.W.Kirk, del.

ARCHITEUTHIS VERRILLI, sp. nov, T.W.Kirk.




TRUPIA STOCKII, gen. et sp. nov, T. W. Kirk.




T. W. Kirk, del. *ARCHITEUTHIS VERRILLI, sp. nov, T. W. Kirk.* *STEENSTRUPIA STOCKII, gen. et sp. nov, T. W. Kirk.*

*Special Description.*

This specimen was stranded at Island Bay, Cook Strait, on Sunday, 6th June, 1880. When I reached the spot a very large portion of the tentacular arms had been torn off and carried away by the sea. Mr. James McColl, who was then living near the bay, informed me that he discovered the animal on the beach about seven o'clock that morning; it was then not quite dead. After recovering from his surprise, he "straightened out the longest feelers and measured them; they were just twenty-five feet, with broad pieces at the ends. The broad pieces had a row of fifteen suckers along each side, and a middle row of nineteen." The portions of the tentacular arms remaining measured—right, eleven feet nine inches; left, eleven feet; and seven and a half inches in circumference. At intervals of about three feet were placed a sucker and a small fleshy tubercle, the sucker on the left arm corresponding with the tubercle on the right.

The first, second, and fourth pairs of sessile arms were of equal length and size, viz., nine feet long by fifteen inches in circumferance, each carrying sixty-five suckers. The third pair much longer and stouter, being ten feet five inches in length and twenty-one inches in circumference, armed with seventy-one suckers. The suckers were arranged in two alternate rows. Along each angle of the arms ran a fleshy membrane about one and a half inches deep, which could be folded over the suckers.

Arms connected by a web eleven inches deep, forming a funnel round the mouth.

Head four feet three inches in circumference, and nineteen inches from root of arms to anterior margin of mantle. Eye five inches by four.

Body from anterior margin of mantle to tip of tail seven feet six inches; greatest circumference nine feet two inches; at anterior end, six feet four.

Fins extending on to the back as in the case of *Onychoteuthis*, length to anterior margin, thirty inches; width, twenty-eight inches.

The beak and portions of the skeleton had been extracted by some Italian fishermen, and although an effort was made to trace and procure them, it failed.

This species may be considered as intermediate between *Architeuthis*, Steenstrup, and *Stenoteuthis*, Verrill, from both of which, however, it differs so much as almost to demand the creation of a new genus, but until more specimens are procured I prefer to place it under *Architeuthis*.

I have dedicated it to Prof. Verrill, to whom I am greatly indebted for a copy of his exhaustive paper on the gigantic Cephalopoda of North America.

*Steenstrupia*, gen. nov.

Size large, body comparatively slender, cylindrical, very slightly swollen in the middle. Caudal fin small, rhomboidal, lateral. Head long and narrow. Eyes large, round. Sessile arms small, all the same size. Suckers stalked. Internal shell lanceolate.

*S. stockii*, sp. nov. Figs. 2, 3, 4.

Body long, slender, almost a cylinder, but very slightly swollen in the middle. Head long and narrow, sides nearly straight. Eyes large and furnished with a lid. Sessile arms small, all same length and size; suckers thirty-six on each arm, arranged in two equal rows, each sucker strengthened by a bony ring, armed with from forty to sixty sharp incurved teeth. Tentacular arms slight, these were torn off at length of 6 feet 2 inches, no trace of suckers or tubercles on remaining portions.

Fin rhomboidal, posterior, lateral. Internal shell lanceolate, furnished anteriorly with two lengthened wing-like expansions similar to those at anterior of shell of *Sepia*, and a hollow conical apex $1\frac{1}{8}$ inch deep.

| | | | | |
|---|---|---|---|---|
| Total length of body and head .. .. .. .. | 11 | feet | 1 | in. |
| Length of body .. .. .. .. .. .. | 9 | ,, | 2 | ,, |
| ,, head .. .. .. .. .. .. | 1 | ,, | 11 | ,, |
| Greatest circumference .. .. .. .. .. | 7 | ,, | 2 | ,, |
| Circumference of head .. .. .. .. .. | 4 | ,, | 0 | ,, |
| Length of sessile arms .. .. .. .. .. | 4 | ,, | 3 | ,, |
| Circumference of sessile arms .. .. .. .. | 11 | ,, | 0 | ,, |
| Length of internal shell .. .. .. .. .. | 6 | ,, | 3 | ,, |
| Width (greatest) .. .. .. .. .. .. | 11 | ,, | 0 | ,, |

*Hab.*—Cook Strait.

This is the No. 3 of former paper (see "Trans. N.Z. Inst." vol., xii., p. 312). Named after the Ven. Archdeacon Stock, to whom I am indebted for information of its stranding.

# III.—BOTANY.

## Art. XLIII.—*On the Fresh-water* Algæ *of New Zealand.*

By W. I. Spencer, M.R.C.S. England.

[*Read before the Hawke's Bay Philosophical Institute*, 11*th July*, 1881.]

Plate XXIII.

Reference to Sir J. Hooker's "Handbook of the New Zealand Flora," pp. 645–646, will show how little attention has in this country been hitherto bestowed upon one of the most beautiful orders of the vegetable kingdom. And as one reads in paragraph after paragraph, in which the various tribes of the fresh-water Algæ are enumerated, such statements as "Very numerous, not hitherto collected in New Zealand"—"This beautiful fresh-water group has not hitherto been collected in New Zealand"—and again, "The species are very numerous and have never been collected or studied in New Zealand," one cannot help feeling that the reiteration suggests to the naturalists of this colony a powerful incentive to undertake the systematic study of this most remarkable and interesting order of plants.

It is with much diffidence that I lay this paper before you to-night, because I feel that I am treading upon unbroken ground, and that the subject is a vast one, involving for its complete investigation much study and much time, neither of which I have been able to devote to it, and also the consultation and comparison of many books which have not been at my command. Nevertheless, if my imperfect attempt has the result of drawing the attention of some of the many able naturalists in this country to a hitherto neglected section of its natural history, and of enlisting other and more competent workers than myself in its investigation, I shall feel that the object I proposed in drawing up this paper has been fully accomplished.

The fresh-water Algæ comprise a large proportion of the *Chlorospermeæ* or *Confervoideæ*; the number of green Algæ which are inhabitants of sea water being comparatively small. They are to be found on damp ground, under the drippings of water, in ponds, streams, waterfalls, even in hot springs where the water has a nearly boiling temperature. They form a green scum on walls, on the bark of trees, and on stones in damp weather—in fact, given the one condition of fresh water moisture, they are almost ubiquitous. Many are plainly visible to the naked eye, and may be seen floating in water, either as scum, as compact green or purple masses, as skeins of threads attached to stones, sticks, or water plants, or as a simple discoloration mingled with the mud at the bottom;—others again are only discoverable by the microscope, or by the fact that, when they exist in vast numbers, they impart to the water a distinctive colour. But, in whatever situation or habitat these Algæ are found, microscopic analysis reduces them all to the same elements as exist in the higher aerial plants—the vegetable cell—composed of an outer cellulose coat, a primordial utricle, and within this the coloured cell-contents, the endochrome, in which its vital activity is situated.

A comparison of these subaqueous plants with their terrestrial congeners would form a most interesting subject of enquiry, but one of such vast dimensions that I can only venture to touch upon one or two of its most salient points this evening.

Probably the typical form of the vegetable cell is a sphere. In all plants, however, except the very simplest—the unicellular—the spheres by aggregation become changed into various other figures, by mutual compression, and by their growing in the lines of least resistance. Thus we have the free globular cells of the *Volvocineæ*; the cylindrical ones of the *Confervæ*, the *Zygnemaceæ*, etc., corresponding to the elongated cells of vascular and woody tissue;—the quadrangular, polygonal, and irregular cells of *Ulvaceæ*, *Pediastreæ* and *Desmidiaceæ*, which find their analogues in many parts of the epidermis, the expanded portion of leaves, the petals, etc., of the higher plants. Again the markings in dotted, spiral, and glandular vessels, are very similar in appearance, if in nothing else, to the markings in *Lyngbyæ*, *Spirogyræ*, *Calothrices*, etc. It is singular to notice also, how, under some circumstances, the cell appears to endeavour to revert to its typical form, as in pl. XXIII., fig. 10, where the front view of the pediastrum shows a complex geometrical outline, and the side view exhibits four simple circular cells.

Into the question of the modes of combination of these algal cells, and the exquisitely beautiful geometrical figures they often form, or of the siliceous patterns secreted by the Diatoms, it is not my purpose to enter at present, though doubtless they have analogues in the shapes and forms of various flowers, and the arrangements of the elements of many leaf-buds.

The colour of the endochrome of the fresh water Algæ varies nearly as much as it does in flowering plants. In most it is green; in some, as the *Oscillatorieæ*, it varies from light green through various shades of blue and purple to black; in the *Protococci* again, we meet with different and often brilliant tints of red, and lastly in some Desmids and the majority of Diatoms with a reddish or yellowish brown hue, although the endochrome of many Diatoms is, in early life, of a brilliant green colour. Taking the fresh-water Algæ altogether, and comparing them with the leaves and flowers of the aerial plants, there appears to be a strong resemblance between the colours exhibited by these two extremes of the vegetable kingdom. The various shades of green, from dark olive to emerald, of red, and of blue, from purple to sky blue, which we find in the Algæ, are very much the prevailing tints of the leaves and flowers of aerial plants. And again the reddish and yellowish brown hues of some *Batrachospermeæ*, *Lyngbyæ*, Desmids and Diatoms, correspond closely with the shades assumed by the leaves of trees, shrubs, and herbs, after they have lost their summer verdure, and to which is due the picturesqueness of their autumnal foliage. Many Confervoids, which when young have green endrochrome, assume in more adult age a yellowish or brownish hue, and the analogy between this change and that which occurs in the leaves of the oak, the ash, the elm, and other trees, is at least both striking and suggestive.

Many Algæ exhibit colours which cannot be referred to autumnal influences, or to the effects of age. The prevailing tints among some of the *Volvocineæ* and *Oscillatorieæ* have strong points of resemblance with those of the flowers of phanerogamous plants. In the latter the diversities of colour appear to be connected in some way (of which various explanations have been advanced) with the multiplication of the plant, and so we find that the flowers are the parts which are most liable to variations of colouration. On the other hand, in these simple organisms there is no division into stem, leaves, and flowers, almost every portion is concerned in the process of reproduction—each filament or frond represents a perfect herb, shrub, or tree, and every sporiferous cell is the analogue of a flower. In the phænogamic class the floral colours are useful as attractions to insects of various kinds, which, visiting them for food, carry away the pollen to other flowers, and so conduce to their fertilization. Although, so far as I am aware, no observations have been made on the subject, is it not something more than possible that the multitudes of *Infusoria*, *Rotatoria*, *Paramecia*, etc., which we continually meet with seeking their food amongst the Algæ, may assist in the same way as insects in conveying antheridial spores from one plant to another; and that the varying colours of the filaments may be attractive to them as those of flowers are to insects; and that thus may be reproduced in the subaqueous world some of those phenomena with which we are familiar in the aerial? Should future observation verify this conjecture we shall see amongst the Algæ the exact analogue of the entomophilous fertilization of flowers, and also be able to understand why the various and beautiful tints they exhibit are, to a certain though much less extent, reproduced in the filaments and fronds of the fresh-water Algæ.

In submerged vegetation anemophilous fertilization is of course out of the question, yet even here a substitute appears to have been afforded by the provision of cilia to the androspores and zoospores, to enable them to perform the requisite movements through the water which is their home, and to guide themselves, the former to their relative gymnospores, the latter to appropriate places whereon to rest and recommence the process of germination and growth.

In the methods of fructification, moreover, the resemblances between flowering plants and Algæ are probably as close as in any other particular. Setting aside the *Volvocineæ*, *Palmellaceæ*, and some others in which the process of multiplication is merely a process of cell division, either intrinsic or extrinsic, we find in the *Confervæ*, *Siphonaceæ*, *Oscillatorieæ*, etc., that the single cell has the power of producing reproductive spores, thus (keeping in mind that an algal cell is the equivalent of a phænogamic flower) affording an analogy with the class of so-called hermaphrodite flowers. A strictly monœcious form of fertilization is met with in the *Œdogoniaceæ*, where the contents of certain inflated cells are vivified by the contents of contiguous antheridial cells which, by rupture of the cell division, gain access to the inflated cells. A distinct advance upon this method is found in many *Œdogonia* and *Chætophoræ*. Here the distinction between antheridial and sporidial cells is evident—they often occur upon different filaments, though sometimes upon distant portions of the same, and are easily recognized by their shape and appearance. The contents of the antheridial cell (androspore) when mature escape through rupture of the cell wall, and, being furnished with cilia, lead an active locomotor life until, coming in contact with the gonidial cell (oospore), the locomotion comes to an end and the contents of the two combined form a zoospore which eventually becomes a young plant.

The *Zygnemaceæ* are veritable diœcious plants, and propagate by a process of conjugation—the cells of two contiguous filaments throw out a connecting tube through which the contents of one (the antheridial) cell pass into the other (the gonidial), and thus fertilize them, the result being a zoospore. In this process the fertilization of the ovule by the pollen tube in Phanerogams is closely imitated. But further, that abnormal self-fertilization that takes place in certain flowers under unusual conditions, and which is termed cleistogamy, would appear to occur at times in certain *Spirogyræ*, the filaments of which have the power of producing zoospores—the so-called pseudogonia—in certain cells without conjugation; in fact these cells are, like the cleistogamous flowers, not only hermaphrodite, but contain within themselves the power of self-fecundation.

In the following list of fresh-water Algæ which have come under my observation during the last eighteen months I have included only such as I feel pretty certain I have verified. Many others are not enumerated, because I am at present doubtful of their classification; but with further search and observation I have no doubt the list may be extended indefinitely.

Batrachospermeæ.

1. *Batrachospermum moniliforme.* Not uncommon.

2. ,, *pulcherrimum*, H., xiv., 1. From river Esk.

3. ,, *vagum*, H., lxiii., 2. From a creek on the Ruataniwha Plains. An unusual specimen of this plant was given me by Mr. Hamilton, from the Horokiwi river. Its peculiarity consists in the development of a vast number of hair-like appendages, on some parts of the filament, of considerable length, and forming in some places a densely intricate matwork round the filament which not only obscures it but also the whorls that emanate from it.

Chætophoraceæ.

1. *Draparnaldia tenuis*, H., xi.

2. *Chætophora endiæfolia*, H. ix.

,, *elegans*, H., ix.

,, sp. n.

Fig. 1.

In the species marked n. above, the filament tapers from base to apex. It is irregularly branched, with few ramuli. Gelatinous investment not apparent. Cells of the ramuli (varying from four to eight) filled with endochrome. Terminal cell broad at the base, narrowing to a not very acute point, exceeding the ordinary cells three or four times in length, hyaline. Cells of the filament and branches as long, or twice as long, as broad. Antheridial cells half to a quarter as long as broad, compressed. Stipitate, capsular fructification was observed attached to both sporiferous and antheridial filaments. Zoospore, the only one seen, commencing to germinate, quadrangular in outline, contains two large sporules, surmounted by four cilia, one at each angle; motile.

Confervaceæ.

1. *Conferva bombycina*, M.D., p. 158.

,, *floccosa*, M.D., pl. V.

2. *Cladophora crispata*, H., lv.

,, *glomerata*, H., lvi.

,, *lyallii*, Hooker, Fl. N.Z.

,, sp. n. (1).

,, sp. n. (2).

3. *Ulothrix mucosa*, M.D., pl. V.

*Cladophora lyallii* is described by Hooker—"Handbook N. Z. Flora," p. 717, and "Fl. N.Z. Ant. Voyage," vol. ii. p. 262. He mentions it as having been found in Stewart Island.

*Cladophora crispata* occurs in Kerguelen's Land. Hooker "Ant. Voyage."

*Cladophora*, sp. n. (1), I found in gently flowing water, attached by a short stem to a piece of iron pipe. It is nearly spherical in shape, about $\frac{1}{12}''$ in diameter, tufted, green. Filaments bright green, alternately branched, articulations $1\frac{1}{2}$ to 2 times longer than broad, slightly constricted at the nodes. Branches of two kinds—*chætophorous*, of which the articulations are 2–3 times longer than broad, filled with endochrome, ending in elongated bristly processes; and sporiferous with articulations constricted at the nodes, cells from $\frac{1}{2}$ to $1\frac{1}{2}$ times as long as broad, terminal cells sometimes clubbed. Capsular fructification on some of the rami either terminal or shortly stipitate. Fig. 2.

*Cladophora*, sp. n. (2). Filaments have a distinct gelatinous investment. Cells three times longer than broad. Here and there, mostly at attachment of rami, occur large hexagonal cells, very like the inflated cells of *Œdogonium*, containing a circular spore. Terminal cells elongated, tapering to a rounded point. Antheridial cells broader than long, spores subglobose, compressed. Free zoospores I have seen only once, and failed to discover cilia. Fig. 3.

### Zygnemaceæ.

1. *Spirogyra communis*, H., xviii.
   ,, *quinina*, H., xxviii.
   ,, *nitida*, H., xxii.
   ,, *interrupta*, H., xxi.
   ,, *rostrata*, H., xxiii.
   ,, *quadrata*, H., xxxvii.
   ,, *pellucida*, H., xxv.
   ,, sp. (?)
2. *Zygnema cruciata*, H., xxxviii.

This family is tolerably abundant in the locality. I have, I think, been able to discriminate all the species that have come under my observation, with one exception. In this specimen the band of endochrome commences at one end of the cell, and after making a spiral and a half reaches the further extremity of the cell, where it bends upon itself, and after another spiral and a half reaches the end from which it started; here it bends a second time, and finally terminates at the opposite end of the cell, forming altogether a series of figure-of-8 knots. Fig. 4.

In this family the normal mode of reproduction is by the conjugation of cells of distinct filiaments; it is distinctly diœcious. In certain cases, however, and they are not uncommon, the endochrome of a filament appears to have the power of self-fertilization, and spores are formed in the cells either with or without communication with contiguous cells. In this process we have a close analogy with the peculiar phenomenon of self-fertilization seen in some normally wind- or insect-fertilized flowers at certain seasons. In fact, we find cleistogamous flowers in our subaqueous plants as well as in their aerial congeners.

ŒDOGONIACEÆ.

*Œdogonium ciliatum* (?), H., lii.
,, *compressum*, H., liii.

OSCILLATORIACEÆ.

1. *Bacterium*, M. Dic., p. 3.
2. *Vibrio rugula* (?), M. Dic., p. 3.
3. *Spirillum volutans*, M. Dic., p. 3.
4. *Spirulina jenneri*, M. Dic., p. 3.
5. *Oscillatoria autumnalis*, H., lxxii.
,, *decorticans*, H., lxxi.
,, *nigra*, H., lxxi.
,, *tenuis*, H., lxxii.
,, *limosa*, H., lxxi.
,, *contexta* (?), H., lxxi.
,, sp. n. (?)
6. *Microleus gracilis*, H., lxx.
7. *Lyngbya muralis*, H., lix.
8. *Calothrix.*
9. *Polypothrix* (?).

*Oscillatoria.*—I have no doubt that with further research this list may be indefinitely extended. The characters of some of the species are not very distinctly marked; and I imagine their nomenclature is not yet settled. Certainly the description and figure of *O. autumnalis* as given by Hassall are very different from those in the Micrographic Dictionary. The peculiar characteristic of this genus, from which its name is derived, is the singular movements of the filaments. What the cause of these movements is has been the subject of some speculation, but has not been determined. No special organs of motion have been discovered. Whether they are vital or merely mechanical phenomena, is at present impossible to decide. I have seen them in plants which had been immersed many days in Hantzsch's fluid still continuing, feebly but quite perceptibly. The movements are of two kinds—oscillatory and progressive. In the first, the filament, being apparently fixed at one end, sways backwards and forwards upon a centre like the pendulum of a clock, and it may either remain in a state of rigidity, or may curve with a flexibility resembling that of the long thin branch of a tree when agitated by the wind. The other movement is one of direct progression. A filament will, after a period of quiescence, begin to move forward, end on as it were, and having advanced a certain distance will, without any discoverable cause, suddenly reverse the direction and retrograde. It is a very interesting sight sometimes to watch these minute organisms in their advance across the field of the microscope. I have seen in *O. tenuis* the two or three end cells waving backwards and forwards slowly and deliberately as though the filament were feeling its way across the field of view. On meeting an obstacle, such as another Alga, the filament would halt as though it were investigating the nature of the obstruction—if the Alga happened to lie at an acute angle the *Oscillatoria* would accommodate itself and move along the side in contact with it; if, however, it lay at a right angle, it would, after a short examination, pass either over or under it, and continue its onward march, or occasionally begin to move backwards, and so retrace its steps. In one specimen the terminal cell was surmounted by a short bristle, which was used apparently as a feeler. The singular deliberative motions I have attempted to describe, I have never seen except when the filament was moving forward; they do not seem to occur when it is performing a movement of retrogression.

*Oscillatoria*, sp. n.? The usual method of reproduction in this genus is stated to be by the breaking up of the filaments, each articulation of which then takes upon itself the functions of a gonidium. I believe, however, they do sometimes emit spores, though I have not had an opportunity of watching them after their detachment from the parent filament. And in one instance—a specimen occurring as a purple stratum on a damp stone, which I have not been able to specify—there appears to be a series of special sporiferous cells, amongst, but quite distinct from, the ordinary articulation. (Fig. 5.)

*Lyngbya*, common.

*Polypothrix distorta* (?). I do not feel sure of this species, as I have seen only a single specimen.

NOSTOCHACEÆ.

*Nostoc commune*, M. Dic., 4.

,, *verrucosum*, H., lxxvi.

ULVACEÆ.

*Enteromorpha intestinalis*, H., lxxvii; M. Dic., 5.

*Ulva bullosa*, H., lxxviii.

,, *crispa*, H., lxxviii.

*Tetraspora (lubrica?)*, H., lxxviii.

PALMELLACEÆ.

*Microhaloa rupestris*, M. Dic., 3.

*Botrydina vulgaris*, H., lxxxi.

*Coccochloris vulgaris*, M. Dic., 3.

,, *protuberans*, H., lxxvi.

*Pleurococcus.*

*Hydrocytrum acuminatum*, M. Dic., 45.

DESMIDIACEÆ (including PEDIASTREÆ).

1. *Hyalotheca dissiliens*, R., i; H., lxxxiii.
   ,, *dubia*, R., xxxv.
2. *Aptogonum undulatum.*
3. *Sphærozosma vertebratum*, R., vi.
   ,, *pulchrum*, R., xxxv.
4. *Micrasterias pinnatifida*, R., x.
   ,, *ampullacea*, Maskell, "Trans. N.Z.I.," vol. xiii.
   ,, var. $\alpha$, $\beta$.
5. *Cosmarium cucumis*, H., lxxxvi.
   ,, *undulatum*, R., xv.
   ,, *tetraophthalmium*, R., xvii.
   ,, *botrytis*, R., xvi.
   ,, *margaritiferum*, R., xvi.
   ,, sp. n.
6. *Staurastrum muticum*, R., xxi.
   ,, *orbiculare*, R., xxi.
   ,, *gracile*, R., xxii.
   ,, *tetracerum*, R., xxiii.
   ,, *paradoxum*, R., xxiii.
   ,, sp. n.
7. *Closterium lunula*, R., xxvii.
   ,, *acerosum*, R., xxvii.
   ,, *lanceolatum*, R., xxviii.
   ,, *moniliferum*, R., xxviii.
   ,, *jenneri*, R., xxviii.
   ,, *leibleinii*, R., xxviii.
   ,, *dianæ (venus)*, R., xxviii.
   ,, *attenuatum*, R., xxix.
   ,, *striolatum*, R., xxix.
   ,, *lineatum*, R., xxx.
   ,, *cornu*, R., xxx.
   ,, *acutum (tenerrimum)*, R., xxx.
8. *Pediastrum tetras*, R., xxxi.
   ,, *heptactis*, R., xxxi.
   ,, *pertusum*, R., xxxi.,
   ,, *napoleonis*, R., xxxi.
   ,, *boryanum*, R., xxxi.
   ,, *ellipticum*, R., xxxi.
   ,, sp. n.

9. *Scenedesmus quadricauda*, R., xxxi.
   ,, *obliquus*, R., xxxi.
   ,, *obtusus*, R., xxxi.

I have included the *Pediastreæ* in this family for the sake of convenience, although the definition of the Desmids as given by both Hassall and Ralfs would exclude them, and Carpenter arranges them as a separate family. (When this paper was read I had not seen Mr. Maskell's article on the *Desmidiaceæ* of Canterbury.* Since then I have considerably modified my remarks on this family, in order to avoid useless repetition and to bring it as far as possible into accordance with Mr. Maskell's paper).

*Micrasterias ampullacea*, var. ($\alpha$) from Ruataniwha.

,, ,, var. ($\beta$) Ruataniwha. This plant resembles var. $\beta$, in general outline, but differs in the smoothness of the edges of the fronds, in the flatness of the tips of the segments of the lobes, and in the absence of punctæ inside the margins of the frond. The flask-like shape of the segments is very marked. I have placed it under the head of *M. ampullacea*, var. $\beta$, for the present, but I am not sure that it will remain there permanently. Fig. 6.

*Cosmarium cucumis?* I have marked this with a note of interrogation, because I have seen only one specimen. It corresponds, however, so entirely with Ralfs' description in the smoothness of the frond, the deep constriction, and the equality of length and breadth, and the rotundity of the ends of the segments, that I have little doubt as to its identity.

*Cosmarium tetraophthalmium* is common.

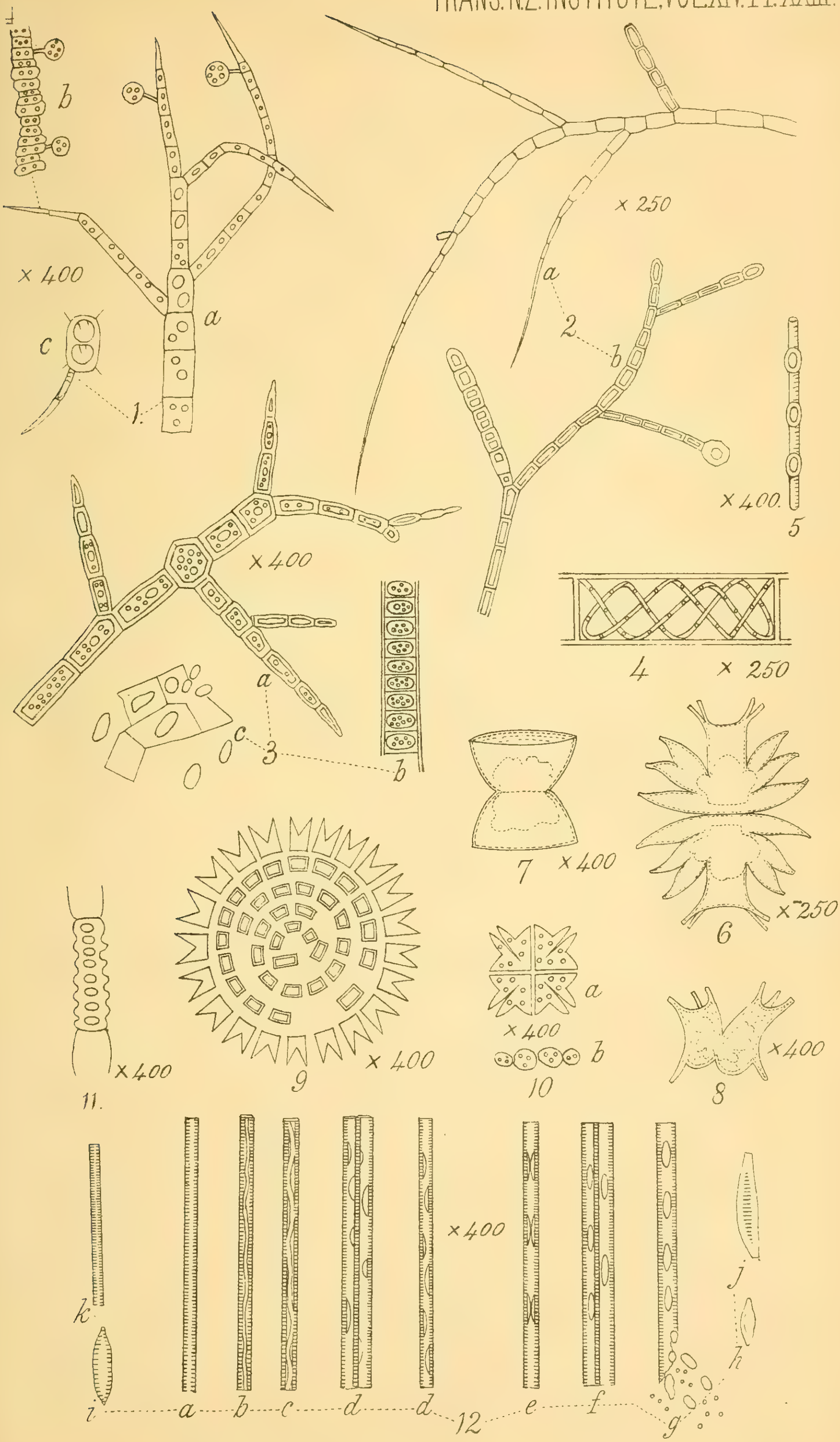
,, *margaritiferum* abundant.

,, sp. n. Frond quadrate, slightly longer than broad, not deeply constricted. Segments conical truncated, united at the truncations, edges smooth. End view circular. This plant is remarkable for its peculiar hour-glass shape. I have found no description of anything like it in such books as have been accessible to me. If it prove a new species I should propose the name of *C. clepshydra*. Fig 7.

*Staurastrum*, sp.? Edges of frond smooth, segments united below, divaricating. Upper and outer borders concave, uniting at an acute angle, inner slightly convex, lower rounded. On the upper concave border are three hyaline processes with smooth sides and flattened ends. At junction of outer and lower borders is one process similar to the upper ones but curved slightly outwards. This little plant is unlike anything in Ralfs—it might be an unusual form of *S. læve*, but in the latter the processes are forked, in the former not. Fig. 8.

*Closterium*. In this genus I have not found any specimen that could not be referred to Ralfs.

* Trans. N.Z. Inst., vol. xiii., art. xxxviii., pp. 297—317.




N.Z. FRESH-WATER ALGÆ.

W. Spencer, del.

*Pediastrum tetras*, and *P. heptactis* are both common.

,, *pertusum.* Intestines of the frond hyaline; some of the inner cells are gone, therefore the foraminal appearance is uncertain. The rectangularity of the outer row of cells and the shape of the notch point to *pertusum.* On the other hand, the number of rows, and the number of circumferential cells, might lead one to infer a new species. On careful comparison, however, I am inclined to consider it as an unusually large specimen of *P. pertusum.* Number of rows, five; number of cells in inner circle, five. The two next rows are broken down. The fourth circle contains apparently eighteen, and the outer one—the fifth—twenty-one cells. Fig. 9.

*Pediastrum*, sp.n. Frond square, divided into four equal lobes by a crucial hyaline division. Lobes divided into segments by a deep narrow notch, which extends from the four corners towards the centre of the frond, the segments again partially subdivided by a broad shallow notch. Side view, four cells placed end to end, the central ones about twice the size of the terminal. Although at first sight so very unlike, there is a remarkable similarity between this plant and *P. tetras*; in fact, the only point of difference consists in the secondary segmentation of the lobes. Fig. 10.

*Scenedesmus quadricauda.* I have placed before you a figure of this Desmid, because it shows the unusual phenomenon of a broad well-defined coating of hyaline matter external to the cells, and further that the bristles are appendages of the investing coat and not of the cells themselves. Fig. 11.

DIATOMACEÆ.

*Meridion constrictum*, H., xcvi.; M.Dic., 12.
*Diatoma elongatum*, H., xciv.
,, *vulgare*, H., xciv.; M.Dic., 12.
,, *grande*, M.Dic.
*Melosira.*
*Campylodiscus costatus*, M.Dic., 12.
*Surirella bifrons*, M. Dic., 13.
*Synedra splendens*, H., xcvii.
*Cocconeis placentula.*
*Navicula.*
*Gyrosigma macrum*, M.Dic., 11.
,, *attenuatum*, M.Dic., 11.
*Pinnularia oblonga*, M.Dic., 11.
*Stauroneis phœnicenteron*, M.Dic., 11.
*Encyonema.*

The usual modes of multiplication of the *Diatomaceæ* are stated to be either division or conjugation. Facke however suspected, though he did not actually observe, a formation of spores or gonidia such as are found in many of the filamentous Confervoids. This method of reproduction I believe I have seen in *Synedra ulna.* In the autumn of last year I found, amongst a growth of *Spirogyræ* and *Oscillatoriæ*, a number of unusually large specimens of *Synedra*, some of such magnitude as to be visible to the naked eye. They were active, and evidently in a state of vigorous growth.

In fig. 12 I have endeavoured to depict the various stages of sporidial growth: *a* shows a full-grown *Synedra* with the endochrome diffused throughout the frond; at *b* the endochrome is beginning to gather itself into a distinct mass; at *c* it has divided, and a portion is attached to each of the frustules, and a division into definite masses is commencing; at *d* this division is complete, the masses forming lenticular bodies; at *e* they have moved into pairs, so that their convex surfaces are in contact; in the next stage (*f*) each pair has united and formed an elliptical spore; at *g* the frustule has been ruptured, and the spores are escaping. The escaped spores were evidently held together by a hyaline substance, and exhibited the peculiar motion termed swarming; *h*, *i*, *j*, show different stages of growth of the young *Synedræ*, until, at *k*, a perfect siliceous deposit has been formed, and the young Diatom is ready to recommence the whole process so soon as its endochrome is sufficiently mature.

VOLVOCINEÆ.

1. *Protococcus viridis*, M.Dic., 3.
   ,, *vulgare.*
2. *Hæmatococcus sanguineus.*
   ,, *binalis.*
   ,, *murorum*, H., lxxxi.
3. *Volvox globator*, M.Dic., 3.
4. *Pandorina murorum*, M.Dic., 45.

*Hæmatococcus.*—I have had a colony of this protophyte in my possession for two years. I first discovered it in a jar which happened to be standing in the rain and was half filled with water. By keeping water continually in the jar the supply of *Hæmatococcus* has never failed. Mr. Hamilton, of Petane, also brought me a sample in the wool of a sheep.*

* See "Trans. N.Z. Inst.," vol. vii., art. lv.

EXPLANATION OF PLATE XXIII.

Fig. 1. *Chætophora*, showing stipitate fructification; *(a)* filament, *(b)* antheridial filament, *(c)* zoospore.
,, 2. *Cladophora* *(a)* ordinary cells. *(b)* sporiferous cells.
,, 3. ,, *(a)* portion of filament. *(b)* antheridial filament. *(c)* zoospores.
,, 4. *Spirogyra.*
,, 5. *Oscillatoria* with sporidial cells.
,, 6. *Micrasterias ampullacea*, var. $\beta$.
,, 7. *Cosmarium*, sp.?
,, 8. *Staurastrum*, sp.?
,, 9. *Pediastrum pertusum.*
,, 10. ,, sp.? *(a)* front. *(b)* end.
,, 11. *Scenedesmus quadricauda.*
,, 12. *Synedra ulna*—to illustrate sporidial multiplication.

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## ART. XLIV.—*On some Additions to the Flora of New Zealand.* By T. F. CHEESEMAN, F.L.S.

[*Read before the Auckland Institute, 11th July*, 1881.]

### 1. *Pozoa reniformis*, Hook. f.

ALTHOUGH this plant has long been known to occur in the Auckland Islands, where it was originally discovered by the Antarctic Expedition in 1840, there is no recorded instance of its having been collected in New Zealand proper. In January, 1881, I found it growing in some profusion in clefts of rocks on the slopes of Mount Peel, Nelson, at an altitude of about 5,000 feet. A good description and excellent plate will be found in the "Flora Antarctica."

### 2. *Ligusticum deltoideum*, n. sp.

Small, stout, dark green and shining, very aromatic, 2–6 inches high. Rootstock stout, covered with pale chaffy scales. Leaves numerous, all radical, 2–4 inches long, petiole half the length, broadly deltoid in outline, bipinnate; segments broadly cuneate, cut down nearly to the base into 3–5 sharp flat spreading lobes, $\frac{1}{8}$–$\frac{1}{5}$ inch long, or again pinnate. Peduncles usually shorter than the leaves, naked or with one small leaflet. Umbels small, $\frac{1}{2}$–1 inch in diameter. Flowers white or pinkish. Ripe fruit not seen.

This is nearest to *L. filifolium*, but differs in its stemless habit, smaller size, more numerous leaves with much more copious divisions, and in the shorter peduncles.

*Hab.*—Grassy slopes on Mount Arthur, Nelson, alt. 4,000–5,500 feet.

3. *Poranthera alpina*, n. sp.

Small, perfectly glabrous, 2–4 inches high. Branches numerous, decumbent or suberect, usually densely compacted and interlaced, hard and woody at the base, scarred. Leaves opposite, all uniform, crowded, sessile or narrowed into a very short petiole, linear-oblong, quite entire, obtuse, $\frac{1}{8}$–$\frac{1}{5}$ inch long, smooth and veinless above, margins usually so much revolute as to conceal the whole of the under surface except the very thick and prominent midrib. Stipules large, triangular, entire or very slightly jagged, persistent. Flowers apparently diœcious; minute, greenish-white, shortly pedicelled, solitary in the axils of the upper leaves, and thus forming short leafy terminal heads. Males:—Labyx divided nearly to the base into 5 oblong segments. Petals wanting in all the flowers examined. Stamens 5, alternating with 5 rounded green glands. Females:—Labyx, etc., as in the males. Stamens, 0; ovary large, rounded, 6-lobed, 3-celled, ovules 2 in each cell. Capsule globose-depressed, apparently splitting into 3 cocci, but not seen perfectly ripe.

*Hab.*—Rocky ledges on Mount Arthur, Nelson, ascending to within a short distance of the summit of the mountain. Alt. 6,000ft.

This is a most unexpected and interesting addition to our Flora, and is perfectly distinct from any of the Australian species. The only other plant of the genus known from New Zealand is *P. microphylla*, Brong., which I discovered in the Nelson district in 1878.*

4. *Triglochin palustre*, L.

In January, 1880, when botanizing in the Canterbury mountains with my friend Mr. J. D. Enys, numerous specimens of a plant clearly referable to this species were collected, by a small tributary of the Broken river, at an altitude of about 2,500ft., and Mr. Enys has since met with it in several localities in the vicinity of the first station. *T. palustre* is a common plant in the northern hemisphere, being found throughout Northern and Central Europe, North Africa, North Asia to the Himalaya Mountains, and in North America. In the South Temperate Zone it has as yet only been recorded from Chili. *T. palustre* may be distinguished from *T. triandrum*, our only other native species, by its much larger size (some of my Canterbury specimens are nearly two feet high), stouter scape, more numerous flowers, and particularly by the linear-clavate fruit.

* "Trans. N.Z. Inst.," vol. xi., p. 432.

5. *Carex leporina*, L.

*C. ovalis*, Good.

This is also an abundant plant in Northern Europe and Asia, and in some parts of North America. In the "Flora Antarctica" it is recorded as a doubtful inhabitant of the Falkland Islands, but I am not aware that it has been collected elsewhere in the southern hemisphere. The following description is drawn up from New Zealand specimens :—

Culms 12–18 inches high, rather slender. Leaves usually much shorter, flat, grassy, $\frac{1}{8}$ inch broad. Spikelets 4–8, androgynous, ovoid, pale brown, shining, collected into an oblong head an inch long; male flowers at the base. Bracts wanting, or small and glume-like. Perigynia as long as the acute glumes, elliptic, plano-convex, striate, winged, narrowed into a long beak; margins and beak finely serrulate. Stigmas 2.

*Hab.*—Motueka Valley, Ngatimoti, and other places in the western portion of the Nelson district.

6. *Carex cinnamomea*, n. sp.

Slender, 1–2 feet high. Leaves longer than the culms, with harsh cutting edges, flat, striate, $\frac{1}{4}$–$\frac{1}{3}$ inch broad. Culms drooping, bracts long and leafy. Spikelets 5–8, distant, upper sessile, lower pedunculate, curved, nodding, 2$\frac{1}{2}$–4 inches long, $\frac{1}{4}$ inch in diameter; terminal one male, or male at the base only, the rest female, but usually with a few lax male flowers below. Glumes longer than the perigynia, lanceolate, cuspidate, entire; with a green keel and reddish-brown margins. Perigynia slightly spreading when ripe, pale, stipitate, narrow elliptic, strongly nerved, narrowed into a short stout beak; beak minutely 2-toothed. Stigmas 3.

*Hab.*—Graham River and other tributaries of the Motueka rising in Mount Arthur. Sources of the Takaka River, ascending to 3,500 feet altitude.

Most nearly allied to *C. vacillans*, but readily distinguished by its larger size, longer much stouter spikelets, longer glumes, and by the shape of the perigynia, which want the tapering deeply bifid beak of that species.

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## ART. XLV.—*Contributions to a Flora of the Nelson Provincial District.*

By T. F. CHEESEMAN, F.L.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 3rd October,* 1881.]

THE importance of obtaining an accurate knowledge of the geographical and altitudinal distribution of our native Flora, and of determining the correlation which exists between it and the geology, physical history, and climate of the country, is doubtless sufficiently obvious. But it must be admitted that no correct inferences can be drawn, or sure generalizations arrived at, until we possess carefully compiled lists of the plants of all the chief portions of the colony. The volumes of the "Transactions of the New Zealand Institute" bear witness that something has been done in this direction; but much more will be required before a firm basis is afforded for future work. As a slight contribution to the literature of the subject, I propose to give a list of the plants observed by myself during two visits to the Nelson Provincial District, in 1878 and 1881, when I was enabled to travel over a considerable portion of the district, and to make large collections, especially of the alpine species. Of course, it will be fully understood that my list can have no claim to completeness. To collect the material for even a tolerably complete catalogue of the plants of the Nelson district (or any other of similar area) would involve the expenditure of much time and labour, and is a work that can only be efficiently performed by local observers, who possess the great advantage of being able to examine the vegetation at all seasons of the year, and with more leisure and circumspection than can be given by a casual traveller, however industrious he may be. At the same time, the list will be found to represent all the chief features of the vegetation, and is probably not much more incomplete than those that have been prepared of other Provincial Districts.

At some future time I hope to consider in detail the principal features of plant-distribution in Nelson, and to suggest some possible explanation of certain curious anomalies therein. At present the known facts are not sufficient to warrant the attempt, large portions of the district never having been explored in a botanical point of view, and others being very imperfectly known.

The total number of species included in the catalogue is 666, but this will doubtless be largely added to by future observers. I have included a few species mentioned either in the "Handbook" or the "Transactions of the New Zealand Institute," as occurring in the district, but which have not been observed by myself. With the exception of these, all of which are specified in the list, I am personally responsible for the whole of the determinations and for the localities quoted:—

## CATALOGUE OF THE FLOWERING PLANTS AND FERNS OBSERVED IN THE NELSON PROVINCIAL DISTRICT.

### RANUNCULACEÆ.

*Clematis indivisa*, Willd. Common at low elevations. Nelson; Foxhill; Wairau Valley, etc.

,, *hexasepala*, DC. Near Moutere.

,, *parviflora*, A. Cunn., var. *depauperata*. "Nelson, *Travers*" (Handbook).

,, *colensoi*, Hook. fil., var. *rutæfolia*. Wairau Valley; Buller Valley.

*Ranunculus insignis*, Hook. f. Elevated plateau between Mount Arthur and Mount Peel, alt. 4,500 feet, extremely abundant; a small few-flowered form ascends to the summit of Mount Arthur, nearly 6,000 feet. Wairau Valley, in several localities between Top-house and the Wairau Gorge.

,, *pinguis*, Hook. f. Wairau Mountains, not uncommon. Ascends to 6,300 feet at the Wairau Gorge.

,, *geraniifolius*, Hook. f. Not uncommon in alpine localities. Mountains behind Lake Rotoiti; Raglan Range; Mount Arthur and Mount Peel, ascending to 5,500 feet. A most variable plant. Leaves often much dissected.

,, *haastii*, Hook. f. Shingle slopes, Wairau Gorge.

,, *crithmifolius*, Hook. f. "Wairau Gorge, on shingle slips, alt. 6,000 feet, *Travers*" (Handbook).

,, *sinclairii*, Hook. f. Raglan Mountains; mountains above the Wairau Gorge.

,, *plebeius*. Abundant. Ascends to 4,000 feet on the Mount Arthur plateau.

,, *lappaceus*, Sm., var. *multiscapus*. Common, especially in sub-alpine localities. Ascends to 5,000 feet on the Raglan Mountains.

,, *subscaposus*, Hook. f.? Mount Arthur plateau, alt. 4,500 feet; Raglan Mountains, 5,000 feet.

,, *rivularis*, Banks and Sol. Abundant in lowland swamps.

*Caltha novæ-zealandiæ*, Hook. f. Mount Arthur plateau; Raglan Mountains.

MAGNOLIACEÆ.

*Drimys axillaris*, Forst. Abundant in woods. The variety with blotched leaves, sometimes kept as a distinct species under the name of *D. colorata*, Raoul, is also plentiful.

CRUCIFERÆ.

*Nasturtium palustre*, DC. Not uncommon in moist places.

*Sisymbrium novæ-zealandiæ*, Hook. f. "Mountains of Nelson, *Rough;* shingle slips, Wairau Gorge, alt. 4,500 feet, *Travers*" (Handbook).

*Cardamine hirsuta*, L. Abundant. An alpine variety. Ascends to 5,000 feet on Mount Arthur, and to 6,000 feet at the Wairau Gorge.

,, *depressa*, Hk.f. Raglan Mountains; Wairau Gorge.

,, *fastigiata*, Hk.f. Wairau Gorge, alt. 3,000 feet.

,, *latesiliqua*, Cheeseman, *n. sp.* Mount Arthur, abundant from 4,500 to 5,500 feet; Raglan Mountains, alt. 5,000 feet.

*Notothlaspi rosulatum*, Hook. f. Raglan Mountains; Wairau Gorge.
,, *australe*, Hook. f. An abundant alpine plant, alt. 3,500 to 5,000 feet.

VIOLARIEÆ.

*Viola filicaulis*, Hook. f. Not uncommon. Graham River; Maitai Valley; Wairau Valley.
,, *lyallii*, Hook. f. Abundant.
,, *cunninghamii*, Hk.f. Near Nelson; Wairau Valley, etc.
*Melicytus ramiflorus*, Forst. Common in woods at low elevations.
,, *lanceolatus*, Hook. f. Forests near the source of the Takaka River, alt. 3000 feet; Clarke River; Buller Valley.
,, *micranthus*, Hook. f. Near Nelson; Buller Valley.
*Hymenanthera crassifolia*, Hook. f. Near Nelson, and coast to the northwards.
,, *latifolia*, Endl.? A slender shrub, 6–8 feet high, with obovate leaves 1½ inch long, is referred to this species for the present. Graham River, on limestone rocks.

PITTOSPOREÆ.

*Pittosporum tenuifolium*, Banks and Sol. Abundant.
,, *patulum*, Hook. f. "Wairau Mountains, alt. 5,000 feet, *Sinclair*" (Handbook).
,, *rigidum*. Maitai Valley and Dun Mountain Range; Buller Valley.
,, *eugenioides*, A. Cunn. Not uncommon in woods at low elevations.

CARYOPHYLLEÆ.

*Gypsophila tubulosa*, Boiss. "Tarndale Plain, 4,000 feet, *Travers*" (Handbook).
*Stellaria parviflora*, Banks and Sol. Common. Ascends to 4,500 feet on the Mount Arthur plateau.
,, *roughii*, Hook. f. Dun Mountain; Wairau Gorge.
,, *gracilenta*, Hook. f. Wairau Valley, abundant.
*Colobanthus quitensis*, Bartl. Dun Mountain; Mount Arthur plateau; Raglan Mountains.
,, *billardieri*, Fenzl. Abundant.
,, *acicularis*, Hook. f. Wairau Mountains, abundant.
*Spergularia rubra*, Pers., var. *marina*. Coast near Nelson.

PORTULACEÆ.

*Claytonia australasica*, Hook. f. An abundant alpine plant.
*Montia fontana*, L. Abundant in subalpine and alpine localities.

ELATINEÆ.

*Elatine americana*, Arnott. Lake Rotoiti. I am not aware of any previous record from the South Island.

HYPERICINEÆ.

*Hypericum japonicum*, Thunb. Lake Rotoiti; Buller Valley.

MALVACEÆ.

*Plagianthus divaricatus*, Forst. Salt marshes, Blind Bay. Common.

,, *betulinus*, A. Cunn. Lower Motueka; Graham River.

,, *lyallii*, Hook.f. Subalpine forests, abundant by the sides of streams, etc.

*Hoheria populnea*, A. Cunn., var. *angustifolia*. Near Nelson; Wakefield; Foxhill; Motueka and Motupiko, etc.

TILIACEÆ.

*Aristotelia racemosa*, Hook. f. Abundant in forests.

,, *fruticosa*, Hook. f. Abundant, especially in subalpine forests.

*Elæocarpus hookerianus*, Raoul. Apparently common; ascending to 3,500 feet. *E. dentatus*, Vahl, doubtless also occurs in the district, but I do not find it in my notes.

LINEÆ.

*Linum monogynum*, Forst. Nelson and coast line to the northwards, abundant. Inland, on Spooner's Range, alt. 1,000 feet.

GERANIACEÆ.

*Geranium dissectum*, L., var. *carolinianum*. Common about Nelson and elsewhere.

,, *microphyllum*, Hk.f. Common.

,, *sessiliflorum*, Cav. Not uncommon.

,, *molle*, L. Near Nelson; Motueka; Wairau Valley.

*Pelargonium australe*, Willd., var. *clandestinum*. Nelson; Foxhill, etc.

*Oxalis corniculata*, L. Not uncommon.

,, *magellanica*, Forst. Abundant by the side of streams, etc., in hilly districts.

RUTACEÆ.

*Melicope ternata*, Forst. "Nelson Province" (Handbook).

,, *simplex*, A. Cunn. Maitai Valley; Lower Motueka; Graham River.

OLACINEÆ.

*Pennantia corymbosa*, Forst. Common in woods.

STACKHOUSIEÆ.

*Stackhousia minima*, Hk. f. Mount Arthur plateau, alt. 4,000 to 5,000 feet.

RHAMNEÆ.

*Discaria toumatou*, Raoul. Most abundant, especially in river valleys.

SAPINDACEÆ.

*Dodonæa viscosa*, Forst. Coast hills near Nelson.

*Alectryon excelsum*, DC. Nelson and vicinity; Graham River; Lower Motueka.

CORIARIEÆ.

*Coriaria ruscifolia*, L. Abundant throughout the district.

,, *thymifolia*, Humb. Mount Arthur plateau; Wairau Gorge; Hope Mountains, Buller Valley.

LEGUMINOSÆ.

*Carmichælia nana*, Col. Dry shingly places in river beds. Motueka and Motupiko Valleys; Wairau Valley; Buller Valley, etc.

,, *australis*, Br. Near Nelson; Motueka; Foxhill, etc.

,, *odorata*, Col. Buller Valley.

,, *flagelliformis*, Col. Maitai Valley; Wairau Valley; Lake Rotoiti; Buller Valley.

*Sophora tetraptera*, Ait. Not uncommon.

ROSACEÆ.

*Rubus australis*, Forst., vars. $\alpha$, $\beta$, $\gamma$. Common in many places.

*Potentilla anserina*, L. Common.

*Geum urbanum*, L., var. *strictum*. Wairau Valley; Buller Valley.

,, *parviflorum*, Comm. Mount Arthur plateau; Raglan Mountains; Wairau Gorge.

*Acæna sanguisorbæ*, Vahl. Common. Ascends to 3,500 feet at the Wairau Gorge.

,, *novæ-zealandiæ*, Kirk. Near Nelson; Foxhill; Motueka.

,, *adscendens*, Vahl. Wairau Gorge.

,, *glabra*, Buchanan. Wairau Gorge.

,, *microphylla*, Hook. f. Buller Valley and Lake Rotoiti; Wairau Valley.

,, *inermis*, Hook. f. Upper Motueka and Motupiko; Wairau Valley; Lake Rotoiti.

SAXIFRAGEÆ.

*Donatia novæ-zealandiæ*, Hook. f. Tarns on Mount Peel, alt. 5,000 feet. The most northern locality yet recorded.

*Quintinia serrata*, A. Cunn., var. $\beta$. Graham River; Takaka River; "Aorere Valley, alt. 1,400 feet, *Travers*" (Handbook).

*Carpodetus serratus*, Forst. Abundant in lowland forests.

*Weinmannia racemosa*, Forst. Abundant in forests. Ascends to 4,000 feet elevation.

CRASSULACEÆ.

*Tillæa sinclairii*, Hook. f. Buller Valley, between the Devil's Grip and Lake Rotoiti; Wairau Valley.

,, *verticillaris*, DC. Near Nelson; Wairau Valley.

DROSERACEÆ.

*Drosera stenopetala*, Hook. f. Mount Arthur plateau, alt. 4,500 feet, the most northern habitat yet recorded; mountains between the Hope and Owen rivers, Buller District, alt. 4,000 feet.

,, *arcturi*, Hook. Common in alpine bogs.

,, *spathulata*, Lab. Lake Rotoiti; Mount Arthur plateau, ascending to 4,500 feet.

,, *binata*, Lab. Upper Motueka; Motupiko.

,, *auriculata*, Backh. Near Nelson.

HALORAGEÆ.

*Haloragis alata*, Jacq. Nelson; Foxhill; Motueka; Moutere, etc.

,, *tetragyna*, Lab., var. *diffusa*. Spooner's Ridge, Buller Valley.

,, *depressa*, Hook. f. Abundant. Buchanan's *H. aggregata*, if I rightly understand his plant, is simply a variety.

,, *micrantha*, Br. Motueka and Motupiko; Foxhill; Lake Rotoiti; Wairau Valley.

*Myriophyllum elatinoides*, Gaud. Wairau Valley.

,, *variæfolium*, Hook. f. Lake Rotoiti.

,, *robustum*, Hook. f. Moutere stream. I am not aware that this species has been previously recorded from the South Island.

*Callitriche verna*, L. Abundant.

*Gunnera monoica*, Raoul. Abundant by the side of streams.

,, *densiflora*, Hook. f. "Acheron and Clarence rivers, alt. 4,000 feet, *Travers*" (Handbook).

MYRTACEÆ.

*Leptospermum scoparium*, Forst. Common. Ascends to 4,500 feet on the granitic hills between the Hope and the Owen rivers.

,, *ericoides*, A. Rich. Generally distributed in woods throughout the district.

*Metrosideros florida*, Sm. Near Nelson.

,, *lucida*, Menzies. Not uncommon in woods, especially in rocky places.

,, *hypericifolia*, A. Cunn. Near Nelson; Lower Motueka; Graham River.

,, *colensoi*, Hook. f. Maitai Valley and other localities near Nelson; Lower Motueka; Graham River; Pearce River.

,, *scandens*, Banks and Sol. Nelson; Motueka; Ngatimoti.

*Myrtus ralphii*, Hk.f. Maitai Valley.

,, *obcordata*, Hook. f. Common in forests.

,, *pedunculata*, Hook. f. Nelson; Foxhill; Buller Valley.

### Onagrarieæ.

*Fuchsia excorticata*, Linn. f. Common.
,, *colensoi*, Hook. f. Lower Motueka; Graham River.
*Epilobium nummularifolium*, A. Cunn. Abundant.
,, *linnæoides*, Hook. f. Mount Arthur plateau; Buller Valley.
,, *macropus*, Hook. Mount Arthur plateau; Lake Rotoiti and Buller Valley; Wairau Valley.
,, *confertifolium*, Hook. f. Wairau Gorge.
,, *crassum*, Hook. f. Mountains above the Wairau Gorge, alt. 5,000-6,000 ft.
,, *microphyllum*, A. Rich. Abundant in dry shingly river beds.
,, *rotundifolium*, Forst. Motueka; Buller Valley, etc.
,, *glabellum*, Forst. Generally distributed.
,, *melanocaulon*, Hook. Buller Valley; Wairau Valley.
,, *junceum*, Forst. Abundant through the district.
,, *pubens*, A. Rich. Common.
,, *billardierianum*, Seringe. Mount Arthur plateau; Upper Buller; Wairau District, etc.
,, *pallidiflorum*, Sol. Motueka; Moutere; Buller Valley, etc.

### Passifloreæ.

*Passiflora tetrandra*, Banks and Sol. Lower Motueka; Graham River.

### Ficoideæ.

*Mesembryanthemum australe*, Sol. Coast near Nelson.

### Umbelliferæ.

*Hydrocotyle elongata*, A. Cunn. Motueka; Graham River; Foxhill; Wairau Valley.
,, *novæ-zealandiæ*, DC. Nelson; Wairau Valley.
,, *moschata*, Forst. Nelson and vicinity.
,, *microphylla*, A. Cunn. Maitai River; Wairau Valley.
*Pozoa reniformis*, Hook. f. Slopes of Mount Peel, alt. 5,000 feet. Not previously known from beyond the Auckland Islands.
,, *trifoliolata*, Hook. f. Mount Arthur plateau.
,, *pallida*, Kirk. Mount Arthur plateau; Lake Rotoiti; Wairau Valley.
,, *roughii*, Hook. f. Dun Mountain; Raglan Mountains; mountains above the Wairau Gorge.
*Crantzia lineata*, Nutt. Salt marshes near Nelson.
*Apium australe*, Thouars. Coast near Nelson.
,, *filiforme*, Hook. Coast near Nelson.
*Oreomyrrhis colensoi*, Hook. f. Common in subalpine grassy places.
,, *ramosa*, Hook. f. Head of Lake Rotoiti; Wairau Gorge.

*Aciphylla squarrosa*, Forst. Subalpine localities, not uncommon.
,, *colensoi*, Hook. f. Subalpine and alpine localities, abundant.
,, *lyallii*, Hook. f. Mount Arthur plateau, ascending to 5,500 feet.
,, *monroi*, Hook. f. Abundant in alpine situations.
*Ligusticum filifolium*, Hook. f. Dun Mountain; Wairau Mountains; Hope Mountains, etc.
,, *deltoideum*, Cheeseman, *n.sp*. Mount Arthur plateau, alt. 4,500 feet.
,, *carnosulum*, Hook. f. Shingle slopes above the Wairau Gorge.
,, *piliferum*, Hook. f. Mount Arthur plateau; Mount Peel; Raglan Mountains; mountains above the Wairau Gorge. Ascends to 6,500 feet.
,, *aromaticum*, Banks and Sol. An abundant mountain plant.
,, *imbricatum*, Hook. f. Summit of Mount Peel, alt. 6,000 feet.
*Angelica gingidium*, Hook. f. Abundant in many localities.
*Daucus brachiatus*, Sieber. Near Nelson, etc.

ARALIACEÆ.

*Panax simplex*, Forst. Abundant in woods throughout the district.
,, *edgerleyi*, Hook. f. Graham River; Pearce River.
,, *anomalum*, Hook. Not uncommon in lowland forests.
,, *lineare*, Hook. f. Mount Arthur plateau and sources of the Takaka River, forming a large proportion of the undergrowth in the *Fagus* forest, above 3,000 feet alt. The most northern locality yet recorded.
*Panax crassifolium*, Dcne. and Planch. Common in woods below 2,000 feet alt.
,, *ferox*, Kirk. Graham River; Buller Valley; near Nelson, *Kirk!*
,, *colensoi*, Hook. f. Abundant. Ascends to nearly 5,000 feet.
,, *arboreum*, Forst. Common throughout the district.
*Schefflera digitata*, Forst. Nelson; Motueka; Wairau Valley; Buller Valley.

CORNEÆ.

*Griselinia lucida*, Forst. Mackay's Knob, near Nelson.
,, *littoralis*. Everywhere in the *Fagus* forests.
*Corokia cotoneaster*, Raoul. Nelson; Lake Rotoiti and Buller Valley; Wairau Valley.

LORANTHACEÆ.

*Loranthus colensoi*, Hook. f. Common; parasitic on the species of *Fagus*.
,, *decussatus*, Kirk. Mount Arthur plateau; mountains in the Buller Valley; Wairau Valley. Ascends to a higher elevation than the preceding species.
,, *flavidus*, Hook. f. Abundant; usually parasitic on *Fagus solandri*.
*Tupeia antarctica*, Cham. and Schl. Lower Motueka; Graham River.

RUBIACEÆ.

*Coprosma lucida*, Forst. Abundant throughout the district.

,, *grandifolia*, Hook. f. Near Nelson; Foxhill; Lower Motueka; Moutere, etc.; Buller Valley. I can find no previous record of the occurrence of this species in the South Island; but it is too abundant to have escaped observation.

,, *baueriana*, Endl. Coast north of Nelson, *T.F.C.*; "Massacre Bay, *Lyall*" (Handbook).

,, *robusta*, Raoul. Abundant.

,, *cunninghamii*, Hook. f. Near Nelson; Graham River.

,, *serrulata*, Hook. f. Alpine localities in Nelson, *Buchanan* (Trans. N.Z. Inst., vol. iii., p. 212).

,, *rotundifolia*, A. Cunn. Apparently common in swampy forests at low elevations. Foxhill; Moutere; Lower Motueka, etc.

,, *rhamnoides*, A. Cunn. Nelson; Foxhill, etc.

,, *parviflora*, Hook. f. Common in many places.

,, *fœtidissima*, Forst. Plentiful throughout the district, in many places forming the chief undergrowth in the *Fagus* forests.

,, *cuneata*, Hook. f. Wairau Mountains.

,, *acerosa*, A. Cunn. Sand-hills, shores of Blind Bay.

,, *depressa*, Col.? Mount Arthur plateau.

,, *microcarpa*, Col.? Graham River; Mount Arthur plateau; Maitai Valley, etc.

,, *linariifolia*. Hook. f. Abundant.

,, *repens*, Hook. f. In alpine localities, not uncommon. I can find no distinguishing characters between this and *C. pumila*, and believe both to be forms of the same plant.

*Nertera depressa*, Banks and Sol. Mount Arthur plateau; Raglan Mountains.

,, *dichondræfolia*, Hook. f. Abundant.

*Galium umbrosum*, Forst. Nelson and vicinity; Wairau Valley; Buller Valley.

*Asperula perpusilla*, Hook. f. Not uncommon in dry and subalpine localities. Ascends to 4,500 feet on the Mount Arthur plateau.

COMPOSITÆ.

*Olearia nitida*, Hook. f. Not uncommon.

,, *cunninghamii*, Hook. f. From Nelson and Motueka to the Big Bush, abundant.

,, *lacunosa*, Hook. f. Sources of the Takaka River, alt. 3,000 feet; Mount Arthur plateau, 4,000 feet; Mountains between the Hope and Owen Rivers, Buller District, alt. 4,000 feet; "Lake Rotoroa" (Handbook).

*Olearia nummularifolia*, Hook. f. Dun Mountain; Mount Arthur plateau; Wairau Mountains.

,, *cymbifolia*, Hook. f. In several places in the Wairau Valley, alt. 1,500–3,000 feet.

,, *forsteri*, Hook. f. Nelson and coast to the northward.

,, *avicenniæfolia*, Hook. f. Abundant through the district.

,, *virgata*, Hook. f. Common, especially in river valleys.

*Celmisia*, *n. sp.* Mount Arthur plateau, abundant between 4,000 and 5,000 feet elevation. A most handsome and distinct species, remarkable for the large and broad bracts.

,, *discolor*, Hook. f. Plentiful. Dun Mountain; Wairau Mountains; Mount Arthur plateau; Buller Valley.

,, *hieracifolia*, Hook. f. Dun Mountain.

,, *incana*, Hook. f. Generally distributed in subalpine and alpine localities.

,, *sinclairii*, Hook. f. Mountains above the Wairau Gorge, alt. 5,000 feet. "Dun Mountain and Tarndale, *Sinclair*" (Handbook).

,, *coriacea*, Hook. f. Plentiful.

,, *monroi*, Hook. f. Dun Mountain; Raglan Mountains; Mount Arthur plateau; Mount Peel.

,, *viscosa*, Hook. f. Mountains above the Wairau Gorge, 5–6,000 feet.

,, *spectabilis*, Hook. f. Abundant above 1,000 feet altitude.

,, *traversii*, Hook. f. Mount Arthur, Mount Peel, and adjoining high land, abundant from 4,500 to 5,800 feet; Raglan Mountains, 4–5,500 feet. A most magnificent species.

,, *cordatifolia*, Buchanan. "Mount Starvation, Nelson, *A. Mackay*" (Trans. N.Z. Inst., vol. xi., p. 427). I have not seen specimens of this, but it must be very close to *C. traversii*, if not a form of that plant.

,, *longifolia*, Cass. Plentiful in the mountains; usually in swampy places.

,, *laricifolia*, Hook. f. Dun Mountain; Wairau Mountains; Mount Arthur plateau; Mount Peel; Hope Mountains, etc.

,, *lateralis*, Buchanan. "Mountains near Lake Guyon, *H. H. Travers*" (Trans. N.Z. Inst., vol. iv., p. 226).

,, *n. sp.* Slopes of Mount Arthur, 5–6,000 feet. Allied to *C. hectori*, but amply distinct.

,, *sessiliflora*, Hook. f. A most abundant alpine plant, 3,500–6,000 feet alt.

,, *n. sp.* Ravines on Mount Peel, alt. 5,000 feet. Nearest to *C. walkeri*, but easily distinguished by the smaller, narrower leaves, with margins revolute to the midrib.

*Celmisia bellidioides*, Hook. f. Mount Peel, alt. 5,500 feet.
,, *glandulosa*, Hook. f. Mount Arthur plateau.
*Vittadinia australis*, A. Rich. Common; ascending to 4,000 feet. An Australian form of this genus, considered by Bentham (Flora Australiensis, iii., p. 491) to be a variety (*dissecta*) of *V. australis* is naturalized on sea-cliffs to the north of Nelson Harbour.
*Lagenophora forsteri*, DC. Not uncommon.
,, *petiolata*, Hook. f. Near Nelson; Wairau Valley; Graham River; Mount Arthur plateau, ascending to 4,500 feet.
,, *pinnatifida*, Hook. f. Wairau Valley, abundant.
*Brachycome sinclairii*, Hook. f. Apparently common in alpine situations. Dun Mountain; Wairau Mountains; Mount Arthur, etc.
*Abrotanella linearis*, Berggren. Mount Arthur plateau, 4,500 feet; Mountains between the Hope and Owen Rivers, alt. 4,000 feet.
,, *sp.* Mountains between the Hope and Owen Rivers, alt. 4,000 feet, on bare granitic rocks. Perhaps *A. pusilla*, Hook. f., but the specimens are imperfect.
*Cotula coronopifolia*, L. Vicinity of Nelson; Moutere; Motueka, etc.
,, *atrata*, Hook. f. Shingle slips, Wairau Gorge, ascending to 6,000 feet.
,, *minor*, Hook. f. Wairau Valley; Buller Valley.
,, *pyrethrifolia*, Hook. f. Mount Arthur plateau; Mount Peel; Raglan Range; Wairau Gorge (ascending to 6,300 feet).
,, *perpusilla*, Hook. f. Mount Arthur plateau; "Tarndale, *Sinclair*" (Handbook).
,, *dioica*, Hook. f. Apparently not uncommon. Near Nelson; Wairau Valley; Buller Valley, etc.
,, *squalida*, Hook. f. Wairau Valley.
*Craspedia fimbriata*, DC. Abundant in the mountains.
,, *alpina*, Backhouse. Often found with the preceding.
*Cassinia leptophylla*, Br. Near Nelson, and shores of Blind Bay, abundant; Foxhill; Upper Motueka; Motupiko, etc.
,, *fulvida*, Hook. f. Dun Mountain range; Mount Arthur plateau.
,, *vauvilliersii*, Hook. f. A common mountain plant.
*Ozothamnus glomeratus*, Hook. f. Near Nelson; Wakapuaka; Motueka; Graham River.
,, *microphyllus*, Hook. f. Mount Peel; Raglan Mountains; Wairau Gorge.
,, *depressus*, Hook. f. Wairau Valley.
,, *selago*, Hook. f. Wairau Gorge.

*Raoulia australis*, Hook. f. Abundant in shingly river beds, etc., from sea-level (mouth of the Motueka River) to 4,000 feet elevation.
,, *apice-nigra*, Kirk. Mountains above the Wairau Gorge, ascending to 6,000 feet.
,, *tenuicaulis*, Hook. f. Abundant in similar localities to *R. australis*.
,, *subulata*, Hook. f. Mountains above the Wairau Gorge, alt. 6,000 ft.
,, *glabra*, Hook. f. Dun Mountain ; Raglan Range ; Wairau Gorge.
,, *subsericea*, Hook. f. Wairau Valley ; Buller Valley.
,, *grandiflora*, Hook. f. An abundant alpine plant, ascending to 6,000 feet.
,, *mammillaris*, Hook. f. Summit of Mount Peel, alt. 6,000 feet.
,, *bryoides*, Hook. f. St. Arnaud Mountains ; Raglan Range ; Wairau Gorge.

*Gnaphalium bellidioides*, Hook. f. Common.
,, *lyallii*, Hook. f. "Massacre Bay, *Lyall*" (Handbook).
,, *keriense*, A. Cunn. "Near Nelson, *Travers*" (Handbook).
,, *filicaule*, Hook. f. Abundant on dry hillsides, etc.
,, *traversii*, Hook. f. Wairau Valley, not uncommon.
,, *nitidulum*, Hook. f. Mount Arthur plateau, 4,000 feet. Specimens immature, and identification consequently doubtful.
,, *luteo-album*, L. Abundant throughout the district.
,, *colensoi*, Hook f. Raglan Range, alt. 5,000 feet; mountains above the Wairau Gorge, 5,000–6,000 feet.
,, *grandiceps*, Hook. f. Mount Arthur ; Mount Peel.
,, *involucratum*, Forst. Abundant throughout the district.
,, *collinum*, Lab. Common. Ascends to 4,500 feet on the Mount Arthur plateau.

*Haastia pulvinaris*, Hook. f. Mountains above the Wairau Gorge, alt. 5,000–6,000 feet.
,, *recurva*, Hook. f. Wairau Gorge ; Mount Peel, alt. 5,000–6,000 feet.
,, *sinclairii*, Hook. f. Raglan Range and St. Arnaud Mountains, alt. 4,000–5,500 feet, not uncommon on dry shingle slopes.

*Erechtites prenanthoides*, DC. Nelson and vicinity ; Moutere ; Motueka ; Foxhill, etc.
,, *arguta*, DC. Nelson to Motueka, not uncommon.
,, *scaberula*, Hook. f. Near Nelson.
,, *glabrescens*, Kirk. Graham River ; Upper Takaka ; Mount Arthur plateau, ascending to 4,500 feet ; Upper Buller Valley ; Lake Rotoiti ; Wairau Valley.
,, *quadridentata*, DC. Abundant.

*Senecio lagopus*, Raoul. Common in subalpine localities.

,, *bellidioides*, Hook. f. Common with the preceding.

,, *latifolius*, Banks and Sol. Sources of the Takaka River, alt. 3,000 feet. Leaves unusually broad, but the specimens do not otherwise differ from North Island ones.

,, *lautus*, Forst. Coast near Nelson, and shores of Blind Bay, abundant; Mount Arthur plateau, alt. 4,000 feet (a stout, succulent, large-flowered form).

,, *lyallii*, Hook. f. Wairau Gorge; mountains by the Rainbow River.

,, *hectori*, Buchanan. Graham River, Pearce River, and other tributaries of the Motueka rising on the Mount Arthur plateau, alt. 400 to 2,800 feet; sources of the Takaka River, alt. 3,000 feet; Upper Buller Valley. I am also informed that it is abundant in the upper part of the Aorere Valley. The finest species of the genus in New Zealand.

,, *laxiflorus*, Buchanan. Wairau Gorge, alt. 3,000 feet.

,, *elæagnifolius*, Hook. f. Mount Arthur plateau, abundant; Upper Buller Valley; Wairau Valley.

,, *bidwillii*, Hook. f. "Mountains of Nelson, *Bidwill, Rough*" (Handbook).

,, *n. sp.* Mount Arthur and Mount Peel, ascending to 5,500 feet. Allied to *S. robusta*, Buchanan, but differing in the lax panicled infloresence, smaller, oblong, much more coriaceous leaves, with strongly revolute margins. The whole plant is even more viscid than *S. robusta*. Inflorescence nearly glabrous.

,, *monroi*, Hook. f. "Nelson Mountains, *Monro*" (Handbook).

,, *cassinioides*, Hook. f. Upper Wairau Valley.

*Brachyglottis repanda*, Forst. Lowland forests, especially on dry soils.

*Traversia baccharoides*, Hook. f. Mount Arthur plateau; Upper Buller Valley and Lake Rotoiti; Wairau Valley.

*Microseris forsteri*, Hook. f. Common.

*Crepis novæ-zealandiæ*, Hook. f. Wairau Valley.

*Taraxacum dens-leonis*, Desf. In many places on the mountains.

*Sonchus oleraceus*, L. Abundant through the district.

STYLIDIEÆ.

*Oreostylidium subulatum*, Berggren. Not uncommon in alpine localities. Mount Arthur plateau, Hope Mountains; Buller Valley, between the Devil's Grip and Lake Rotoiti; Wairau Mountains; Wairau Gorge.

*Forstera sedifolia*, Linn. f. Hope Mountains, Buller District, alt. 4,000 feet; Wairau Gorge.

,, *tenella*, Hook. f. Not uncommon in subalpine and alpine localities.

*Phyllachne colensoi*, Hook. f. An abundant alpine plant.

Campanulaceæ.

*Wahlenbergia gracilis*, A. Rich. Abundant throughout the district.

,, *saxicola*, A.DC. Abundant throughout the district.

,, *cartilaginea*, Hook. f. Wairau Gorge.

*Lobelia anceps*, Thunb. Near Nelson, etc.

,, *roughii*, Hook. f. Dun Mountain; Wairau Gorge.

*Pratia angulata*, Hook. f. Abundant.

,, *macrodon*, Hook. f. Raglan Mountains; Wairau Gorge.

*Selliera radicans*, Cav. Salt marshes, Blind Bay.

Ericeæ.

*Gaultheria antipoda*, Forst. Abundant.

,, *rupestris*, Br. Throughout the district, but not so common as the preceding.

*Cyathodes acerosa*, Br. Abundant.

,, *empetrifolia*. An abundant mountain plant.

,, *colensoi*, Hook. f. Mount Arthur plateau; mountains between the Hope and Owen Rivers; Raglan Mountains.

,, *pumila*, Hook. f. Mount Arthur plateau, 4,000–5,000 feet.

*Lencopogon fasciculatus*, A. Rich. Generally distributed below 3,000 feet alt.

,, *fraseri*, A. Cunn. Abundant. Ascends to 4,500 feet on the Mount Arthur plateau.

*Pentachondra pumila*, Br. Common in mountain districts, alt. 2,000–5,500 feet.

*Epacris pauciflora*, A, Rich. "Nelson" (Handbook).

,, *alpina*, Hook. f. Mountains between the Hope and Owen Rivers, alt. 4,000 feet.

*Archeria traversii*, Hook. f. Sources of the Takaka River; Mount Arthur plateau, ascending to 4,000 feet; "Aorere River" (Handbook).

*Dracophyllum traversii*, Hook. f. Upper Takaka; Mount Arthur plateau; 3,000–4,500 feet.

,, *longifolium*, Br. Dun Mountain range; Wairau Valley; Buller Valley.

,, *urvilleanum*, A. Rich. Not uncommon, ascending to 4,500 feet on the Mount Arthur plateau.

,, *uniflorum*, Hook. f. Wairau Mountains; Wairau Gorge, etc.

,, *rosmarinifolium*, Forst. Dun Mountain; Wairau Mountains; Mount Arthur, etc.

MYRSINEÆ.

*Myrsine salicina*, Heward. Moutere, Ngatimoti, etc., in woods at low elevations. I am not aware of any previous record from the South Island.

,, *urvillei*, A.DC. Not uncommon in woods at low elevations.

,, *divaricata*, A. Cunn. Common, ascends to 3,500 feet near Mount Arthur.

,, *montana*, Hook. f. Upper Maitai Valley.

,, *nummularifolia*, Hook. f. Raglan Mountains; Wairau Gorge; Hope Mountains; Mount Arthur plateau.

PRIMULACEÆ.

*Samolus repens*, Pers. Coast near Nelson, and shores of Blind Bay.

APOCYNEÆ.

*Parsonsia albiflora*, Raoul. Common at low elevations.

,, *rosea*, Raoul. Near Nelson; Wairau Valley.

GENTIANEÆ.

*Gentiana montana*, Forst.
,, *pleurogynoides*, Griseb.
,, *saxosa*, Forst.
} All more or less abundant in mountain districts.

BORAGINEÆ.

*Myosotis spathulata*, Forst. Near Nelson; Maitai Valley; Wairau Valley.

,, *antarctica*, Hook. f. Wairau Valley.

,, *australis*, Br. Mount Arthur plateau, up to 4,500 feet; Wairau Valley, 2,000–4,500 feet.

,, *forsteri*, Rœm. and Sch. Near Nelson; Takaka River; Buller Valley.

,, *traversii*, Hook. f. Shingle slopes, Wairau Gorge, alt. 5,000–6,000 feet; "Tarndale, *Sinclair*" (Handbook).

*Exarrhena macrantha*, Hook. f. Dun Mountain, alt. 4,000 feet; Mount Arthur and Mount Peel, ascending to 5,500 feet; Wairau Mountains, 3,000–5,000 feet.

,, *saxosa*, Hook. f. Dun Mountain, 4,000 feet; Raglan Mountains, 4,000–4,500 feet.

CONVOLVULACEÆ.

*Convolvulus sepium*, L. Common at low elevations.

,, *tuguriorum*, Forst. Not uncommon.

,, *soldanella*, L. Sand-hills, Blind Bay.

*Dichondra repens*, Forst. Nelson to Motueka, abundant.

SOLANACEÆ.

*Solanum aviculare*, Forst. Motueka, Motupiko, etc.

,, *nigrum*, L. Nelson.

SCROPHULARINEÆ.

*Mimulus repens*, Br. "Nelson, *Bidwill*" (Flora Novæ-Zealandiæ, vol. i., p. 188).

,, *radicans*, Hook. f. Hope Mountains, Buller District.

*Glossostigma elatinoides*, Benth. Lake Rotoiti.

*Limosella aquatica*, L., var. *tenuifolia*. Buller Valley.

*Veronica salicifolia*, Forst. Common.

,, *parviflora*, Vahl. Near Nelson; Motueka Valley; Buller Valley.

,, *ligustrifolia*, A. Cunn. Near Nelson.

,, *traversii*, Hook. f. Common in river valleys in the interior of the district.

,, *vernicosa*, Hook. f. Mount Arthur plateau, ascending to 4,500 feet; Buller Valley; Lake Rotoiti; Wairau Valley to Wairau Gorge, etc.

,, *colensoi*, Hook. f. Not uncommon.

,, *lævis*, Benth. Dun Mountain Range; Wairau Valley; Mount Arthur plateau, etc.

,, *buxifolia*, Benth. Wairau Valley to the Wairau Gorge; Buller Valley and the adjacent mountains; Mount Arthur plateau, ascending to 5,000 feet.

,, *carnosula*, Hook. f. Mount Arthur plateau; Raglan Mountains; Wairau Gorge, etc.

,, *pinguifolia*, Hook. f. Mount Arthur; Mount Peel; Wairau Gorge, etc.

,, *pimeleoides*, Hook. f. Rainbow River and Wairau Gorge.

,, *lycopodioides*, Hook. f. Wairau Mountains, abundant above 4,000 feet.

,, *tetrasticha*, Hook. f. Mount Arthur, abundant; St. Arnaud Mountains; Wairau Gorge.

,, *armstrongii*, Kirk. Mount Arthur plateau; mountains between the Hope and Owen rivers; Wairau Mountains.

,, *salicornioides*, Hook. f. Mountains above the Rainbow River.

,, *cupressoides*, Hook. f. Wairau Gorge.

,, *haastii*, Hook. f. Summit of Mount Arthur, 5,500–6,000 feet.

,, *epacridea*, Hook. f. Mountains above the Wairau Gorge, ascending to 6,300 feet.

,, *macrantha*, Hook. f. Wairau Mountains; Mount Peel.

,, *raoulii*, Hook. f. Wairau Valley.

,, *lyallii*, Hook. f. Buller Valley; Wairau Valley.

,, *bidwillii*, Hook. f. River valleys in the interior of the district, not uncommon.

*Veronica, n. sp.* Raglan Mountains, alt. 5,500 feet. Habit approaching that of *Pygmæa;* but the corolla lobes are of the normal number; and the calyx is very peculiar, having long pinnatifid lobes. Very distinct from any described species.

*Pygmæa pulvinaris,* Hook. f. Raglan Mountains, 4,500–5,500 feet; mountains above the Wairau Gorge; summit of Mount Arthur.

*Ourisia macrophylla,* Hook. Abundant in sub-alpine damp and shaded localities.

,, *colensoi,* Hook. f. Mount Peel; Raglan Mountains; mountains above the Wairau Gorge.

,, *cæspitosa,* Hook. f. Mount Arthur plateau; Raglan Mountains.

*Euphrasia monroi,* Hook. f. Dun Mountain; St. Arnaud Mountains; Mount Arthur plateau, etc.

,, *revoluta,* Hook. f. St. Arnaud Mountains; Mount Arthur plateau.

,, *antarctica,* Hook. f. An abundant alpine plant.

VERBENACEÆ.

*Teucridium parvifolium,* Hook. f. "Nelson, *Bidwill, Travers*" (Handbook).

*Myoporum lætum,* Forst. Near Nelson; Stoke; Spring-grove; and other places near the shores of Blind Bay.

LABIATÆ.

*Mentha cunninghamii,* Benth. Not uncommon, ascending to 4,500 feet alt.

*Scutellaria novæ-zealandiæ,* Hook. f. Maitai Valley; "Foxhill, *Monro*" (Handbook).

PLANTAGINEÆ.

*Plantago brownii,* Rapin. Raglan Mountains; mountains above the Wairau Gorge.

,, *raoulii,* Decaisne. Abundant, ascending to 4,500 feet on the Mount Arthur plateau.

CHENOPODIACEÆ.

*Chenopodium triandrum,* Forst. Near Nelson.

,, *glaucum,* L., var. *ambiguum.* Salt marshes, Nelson Harbour, and shores of Blind Bay.

*Suæda maritima,* Dum. Shores of Blind Bay.

*Atriplex patula,* L. Salt marshes, Nelson Harbour.

*Salicornia indica,* Willd. Muddy shores, Nelson Harbour and Blind Bay.

PARONYCHIEÆ.

*Scleranthus biflorus,* Hook. f. Abundant through the district, ascending to 4,500 feet. A very variable plant. A variety with the flowers solitary instead of in pairs, is common in the Wairau Valley.

POLYGONEÆ.

*Polygonum minus*, Huds., var. *decipiens*. Lowland swamps. Nelson; Moutere; Lower Motueka, etc.

,, *aviculare*, L. Abundant.

*Muhlenbeckia adpressa*, Lab. ⎫
,, *complexa*, Lab. ⎭ Abundant below 2,000 feet.

,, *axillaris*, Hook. f. Of general occurrence in dry open shingly places.

*Rumex flexuosus*, Forst. Near Nelson; Lower Motueka; Wairau Valley; Mount Arthur plateau, alt. 4,500 feet.

LAURINEÆ.

*Nesodaphne tawa*, Hook. f. Vicinity of Nelson, but not common.

MONIMIACEÆ.

*Atherosperma novæ-zealandiæ*, Hook. f. Near Nelson; Wakapuaka. I am informed by Mr. Gaukrodger that some unusually fine examples formerly existed in the lower part of the Brook Street Valley, within the precincts of the present town of Nelson.

*Hedycarya dentata*, Forst. Near Nelson and coast to the northwards; Graham River and Lower Motueka.

THYMELEÆ.

*Pimelea longifolia*, Banks and Sol. "Nelson Mountains, ascending to 2,000 feet, *Travers*" (Handbook).

,, *gnidia*, Forst. Upper Maitai Valley.

,, *virgata*, Vahl. Near Nelson.

,, *prostrata*, Vahl. Not uncommon throughout the district.

,, *lyallii*, Hook. f. Dun Mountain range; Mount Arthur plateau; St. Arnaud Mountains, etc.

*Drapetes dieffenbachii*, Hook. A common alpine plant.

,, *lyallii*, Hook. f. Hope Mountains, Buller Valley; mountains above the Wairau Gorge.

SANTALACEÆ.

*Exocarpus bidwillii*, Hook. f. Dun Mountain and adjacent hills; Wairau Valley; Buller Valley.

EUPHORBIACEÆ.

*Poranthera microphylla*, Brong. Upper Maitai Valley.

,, *alpina*, Cheeseman, *n. sp.* Mount Arthur, alt. 5,000–6,000 feet.

CUPULIFERÆ.

*Fagus menziesii*, Hook. f. ⎫
,, *fusca*, Hook. f. ⎬ Abundant in forests throughout the province.
,, *solandri*, Hook. f. ⎭

,, *cliffortioides*, Hook. f. Wairau Mountains; Mount Arthur plateau.

URTICEÆ.

*Urtica incisa*, Poir. Near Nelson; Wairau Valley; Buller Valley; Mount Arthur plateau, 4,000 feet.

,, *ferox*, Forst. Graham River, not common.

*Parietaria debilis*, Forst. Nelson.

*Australina pusilla*, Gaud. Lower Motueka; Graham River.

PIPERACEÆ.

*Piper excelsum*, Forst. Near Nelson; Motueka Valley, etc.

CONIFERÆ.

*Libocedrus bidwillii*, Hook. f. Abundant in mountain forests, ascending to 4,500 feet.

*Podocarpus ferruginea*, Don. Lowland forests, not uncommon.

,, *nivalis*, Hook. f. Mount Arthur, Mount Peel, etc., alt. 4–5,000 feet; mountains above the Wairau Gorge, alt. 3,500–5,000 feet.

,, *totara*, A. Cunn. Abundant in lowland woods. A distinct looking variety (?) is common in the Buller Valley, and often fruits when only two or three feet in height.

,, *spicata*, Br. Abundant in lowland forests.

,, *dacrydioides*, A. Rich. Abundant in moist lowland forests.

*Dacrydium cupressinum*, Sol. Throughout the district.

,, *intermedium*, Kirk. Dun Mountain range; Hope Mountains, Buller Valley, alt. 2,000–4,000 feet.

,, *laxifolium*, Hook. f. An abundant subalpine and alpine plant. Dun Mountain; Wairau Mountains; Mount Arthur and neighbouring high land; Hope Mountains, Buller Valley.

,, *bidwillii*, Hook. f. Common on the mountains. Dun Mountain; forming most of the shrubby vegetation above the *Fagus* forest on the Mount Arthur plateau, 4,000–5,000 feet; Hope Mountains and elsewhere in the Buller Valley; Lake Rotoiti; St. Arnaud Mountains; Raglan Mountains; mountains above the Wairau Gorge.

,, *colensoi*, Hook. Dun Mountain range; Wairau Mountains.

*Phyllocladus trichomanoides*, Don. Maitai Valley.

,, *alpinus*, Hook. f. An abundant subalpine tree.

ORCHIDEÆ.

*Earina mucronata*, Lindl. Vicinity of Nelson; Maitai Valley.

*Gastrodia cunninghamii*, Hook. f. Maitai Valley; Moutere Hills; Graham River; Wairau Valley; Buller Valley.

*Cyrtostylis oblonga*, Hook. f. Buller Valley.

*Adenochilus gracilis*, Hook. f. Buller Valley, between the Hope and Owen Rivers. Not previously recorded from the South Island.

*Corysanthes triloba*, Hook. f. Near Nelson; Graham river; Wairau Valley.
,, *oblonga*, Hook. f. Near Nelson.
,, *rotundifolia*, Hook. f. "Nelson, *Travers*" (Handbook).
,, *macrantha*. Hook. f. Wairau Valley; Buller Valley.
*Microtis porrifolia*, Spreng. Vicinity of Nelson; Moutere Hills; Foxhill; Motupiko; Wairau Valley.
*Caladenia lyallii*, Hook. f. St. Arnaud Mountains, 4,000 feet; Mount Arthur, abundant between 4,500 and 5,500 feet.
*Pterostylis banksii*, Brown. Not uncommon.
*Chiloglottis cornuta*, Hook. f. Buller Valley.
,, *traversii*, F. Muell. Wairau Valley and the adjoining mountains, not uncommon; Mount Arthur plateau, abundant.
*Thelymitra longifolia*, Forst. Abundant in lowland districts.
,, *pulchella*, Hook. f. Lake Rotoiti; Wairau Valley.
,, *uniflora*, Hook, f. Lake Rotoiti; Wairau Valley; Mount Arthur plateau.
*Prasophyllum colensoi*, Hook. f. Not uncommon; ascends to 4,500 feet on the Mount Arthur plateau.
*Orthoceras solandri*, Lindl. Near Nelson; Foxhill; Spooner's Ridge. In the Handbook stated to ascend to an elevation of 4,000 feet in the Nelson District, on the authority of *Bidwill*. I have never seen it above 1,200 feet.

IRIDEÆ.

*Libertia ixioides*, Spreng. Near Nelson; Lower Motueka; Graham River; Buller Valley.
,, *micrantha*, A. Cunn. Nelson; Buller Valley, most abundant.

PANDANEÆ.

*Freycinetia banksii*, A. Cunn. Lowland forests, but not common. Nelson and coast to the northwards: Lower Motueka; Graham River.

TYPHACEÆ.

*Typha angustifolia*, L. Common in swamps at low elevations.

NAIADEÆ.

*Triglochin triandrum*, Michaux. Nelson Harbour; brackish-water swamps, head of Blind Bay.
*Potamogeton natans*, L. Moutere; Motupiko; Wairau Valley; Lake Rotoiti and Buller Valley.
*Ruppia maritima*, L. Salt-marshes, Blind Bay.
*Zostera marina*, L. Nelson Harbour.

LILIACEÆ.

*Rhipogonum scandens*, Forst. Near Nelson, and coast to the north; Moutere Hills; Lower Motueka; Graham River, ascending to 1,500 ft.

*Callixene parviflora*, Hook. f. Dun Mountain range; Wairau Valley.

*Cordyline australis*, Hook. f. Abundant below 2,000 feet alt.; usually in river valleys.

,, *banksii*, Hook. f. Near Nelson; Motueka Valley; Graham River.

,, *hookeriana*, Kirk. Sources of the Takaka River, alt. 3,000–3,500 feet.

*Dianella intermedia*, Endl. Nelson and vicinity; Moutere; Motueka; Spooner's Range; Buller Valley.

*Astelia cunninghamii*, Hook. f. "Aorere Valley, *Travers*" (Handbook).

,, *linearis*, Hook. f. Dun Mountain; Mount Arthur plateau.

,, *nervosa*, Sol. Abundant in subalpine localities.

*Arthropodium candidum*, Raoul. Maitai Valley; Wairau Valley; Mount Arthur plateau; Buller Valley.

*Anthericum hookeri*, Col. Common in subalpine and alpine swamps.

*Phormium tenax*, Forst. Abundant. Ascends to 5,000 feet on Mount Arthur.

,, *colensoi*, Hook. f. Abundant.

*Herpolirion novæ-zealandiæ*, Hook. f. Mount Arthur plateau, 4,000–5,000 feet, most abundant.

PALMEÆ.

*Areca sapida*, Soland. Wakapuaka, *T.F.C.*; Lower Takaka Valley, Aorere Valley, abundant, *J. Heath*.

JUNCEÆ.

*Juncus vaginatus*, Br. Nelson; Foxhill; Lake Rotoiti; Buller Valley.

,, *australis*, Hook. f. Wairau Valley.

,, *maritimus*, Lam. Nelson Harbour and shores of Blind Bay.

,, *communis*, E. Mey. Abundant throughout the district.

,, *planifolius*, Br. Nelson, Motueka, etc.

,, *bufonius*, L. Abundant through the district. Ascends to 4,000 feet on the Mount Arthur plateau.

,, sp. (Allied to *J. prismatocarpus*, Br.) Motueka Valley.

,, *scheuzerioides*, Gaud.? Mount Arthur plateau, alt. 4,500 feet. Specimens immature, and perhaps not really belonging to this species.

,, *novæ-zealandiæ*, Hook. f. Common in subalpine localities.

,, *articulatus*, L., var. *lamprocarpus*. Not uncommon. Foxhill; Motueka; Motupiko; Moutere; Wairau Valley; Buller Valley; Mount Arthur plateau, ascending to 4,500 feet.

*Rostkovia gracilis*, Hook. f. Mount Arthur; Mount Peel; Raglan Mountains; mountains above the Wairau Gorge, ascending to 6,000 feet.

*Luzula campestris*, DC. Abundant throughout the district.

,, *oldfieldii*, Hook. f. Wairau Gorge.

*Luzula pumila*, Hook. f. Mountains above the Wairau Gorge, ascending to 6,300 feet.

,, *colensoi*, Hook. f. Hope Mountains, Buller Valley, alt. 4,000 feet.

RESTIACEÆ.

*Leptocarpus simplex*, A. Rich. Salt-marshes, Nelson Harbour and shores of Blind Bay.

*Calorophus elongata*, var. *minor*. Not uncommon in subalpine bogs.

*Gaimardia setacea*, Hook. f. Mount Arthur plateau, 4,000–5,000 feet; Wairau Gorge.

*Alepyrum*, *n. sp.* Mount Arthur plateau, with the preceding; Hope Mountains, Buller Valley; Wairau Gorge.

CYPERACEÆ.

*Cyperus ustulatus*, A. Rich. Lowland districts, common.

*Schœnus pauciflorus*, Hook. f. A common alpine and subalpine plant.

*Carpha alpina*, Br. Everywhere in alpine bogs, ascending to 6,000 feet.

*Scirpus maritimus*, L. Shores of Blind Bay.

,, *pungens*, Vahl. Nelson Harbour, abundant.

*Isolepis nodosa*, Br. Nelson and vicinity, Buller Valley.

,, *prolifer*, Br. Near Nelson; Motueka; Graham River; Buller Valley; etc.

,, *riparia*, Br. Nelson, etc.

,, *cartilaginea*, Br. Dun Mountain.

,, *aucklandica*, Hook. f. Mount Arthur plateau; Raglan Mountains; Wairau Valley.

*Desmoschœnus spiralis*, Hook. f. Sandhills, Blind Bay.

*Gahnia setifolia*, Hook. f. Near Nelson.

,, *procera*, Forst. Buller Valley, between the Hope and Owen Rivers.

,, *hectori*, Kirk. Near Nelson; slopes of Dun Mountain; Graham River; Lower Motueka; Buller Valley.

,, *ebenocarpa*, Hook. f. Lower Motueka Valley.

*Lepidosperma tetragona*, Hook. f. Nelson; Foxhill; Motueka and Motupiko; Wairau Valley.

*Oreobolus pumilio*, Br. Common in alpine bogs.

*Uncinia leptostachya*, Raoul. Near Nelson; Foxhill.

,, *compacta*, var. *divaricata*. Mount Arthur plateau; Wairau Valley; Raglan Mountains.

,, *australis*, Pers. Common.

,, *cæspitosa*, Boott. Not uncommon.

,, *rupestris*, Raoul? Upper Takaka; Graham River.

,, *filiformis*, Boott. Upper Takaka; Buller Valley.

,, *rubra*, Boott. Mount Arthur plateau, 4,000–4,500 feet, abundant.

*Carex pyrenaica*, Wahl. Summit of Mount Arthur, circa 6,000 feet; Hope Mountains, Buller Valley, 4,000 feet; Raglan Mountains, 4,000–5,500 feet.

,, *acicularis*, Boott. Mount Arthur plateau; Wairau Valley and adjacent mountains; Hope Mountains, Buller Valley.

,, *inversa*, Br. Buller Valley.

,, *colensoi*, Hook. f. Not uncommon.

,, *stellulata*, Good. Wairau Valley, etc.; Lake Rotoiti; Buller Valley; Mount Arthur plateau.

,, *leporina*, Good. Swampy hollows on granitic rocks, Ngatimoti; Graham River; Motueka Valley.

,, *kaloides*, Petrie. Wairau Valley, abundant. A very distinct and well-marked species.

,, *virgata*, Soland. The typical form and the variety *secta* both abundant.

,, *gaudichaudiana*, Kunth. Buller Valley; Wairau Mountains, etc.; Mount Arthur plateau.

,, *subdola*, Boott. "Acheron Valley, alt. 4,000 feet, *Travers*" (Handbook).

,, *ternaria*, Forst. Abundant throughout the district. Ascends to 4,500 ft.

,, *testacea*, Soland. (?) Near Nelson, and elsewhere.

,, *raoulii*, Boott. Nelson and vicinity; Motueka; Graham River; Wairau Valley, etc.

,, *goyeni*, Petrie, MS. Graham River. A very distinct new species, of which I have specimens also from Otago, sent by Mr. Petrie under the above name.

,, *lucida*, Boott. Abundant.

,, *pulchella*, Berggren. Wairau Valley.

,, *neesiana*, Endl. Vicinity of Nelson.

,, *dissita*, Soland. Abundant.

,, *lambertiana*, Boott. Abundant.

,, *breviculmis*, Br. Near Nelson; Wairau Valley; Buller Valley.

,, *pumila*, Thunb. Sandy shores of Blind Bay.

,, *forsteri*, Wahl. Not uncommon.

,, *cinnamomea*, Cheeseman, *n. sp.* Sources of the Takaka River, alt. 3,000 feet.

GRAMINEÆ.

*Ehrharta colensoi*, Hook. f. Mount Arthur plateau, and slopes of Mount Arthur and Mount Peel, 4,000–5,500 feet, abundant.

*Microlæna stipoides*, Br. Near Nelson; Moutere; Lower Motueka.

,, *avenacea*, Hook. f. Nelson; Foxhill; Moutere Hills; Wairau Valley; Buller Valley.

,, *polynoda*, Hook. f. Lower Motueka; Graham River.

*Alopecurus geniculatus*, L. Wairau Valley.
*Hierochloe redolens*, Br. Not uncommon.
,, *alpina*, Rœm. & Sch. Common in subalpine and alpine localities.
*Spinifex hirsutus*, Labill. Sandhills, Blind Bay.
*Panicum imbecille*, Trin. "Nelson, *Travers*" (Buchanan, N.Z. Grasses).
*Zoysia pungens*, Willd. Near Nelson; Motueka Valley, abundant.
*Echinopogon ovatus*, Pal. Nelson; Foxhill; Moutere; Lower Motueka.
*Dichelachne crinita*, Hook. f. Nelson and vicinity; Spooner's Range; Motueka Valley; Graham River; Wairau Valley; Buller Valley.
*Agrostis muscosa*, Kirk. Buller Valley, between Lake Rotoiti and the Devil's Grip.
,, *canina*, L. An abundant alpine plant.
,, *muelleri*, Benth. Raglan Mountains, 3,000–5,000 feet; Mount Arthur; Hope Mountains, Buller Valley.
,, *parviflora*, Br. Mount Arthur plateau; Raglan Mountains; Wairau Gorge.
,, *æmula*, Br. Common at low elevations through the district.
,, *pilosa*, A. Rich. "Subalpine districts of Nelson, *Travers*" (Buchanan, N.Z. Grasses).
,, *billardieri*, Br. Coast near Nelson.
,, *setifolia*, Hook. f. I have a specimen of this from Mr. Buchanan, labelled "Mount Arthur, *A. McKay*."
,, *avenoides*, Hook. f. Wairau Valley.
,, *quadriseta*, Br. Abundant.
*Arundo conspicua*, Forst. Abundant at low elevations.
*Danthonia cunninghamii*, Hook. f. Near Nelson; Buller Valley, etc.
,, *raoulii*, Steud. } Abundant in alpine and subalpine localities.
,, *flavescens*, Hook. f. }
,, *pilosa*, Br. Nelson and vicinity; Lower Motueka.
,, *semi-annularis*, Br. Abundant throughout the district, at all elevations.
,, *nuda*, Br. Mount Arthur plateau, 4,000 feet.
*Deschampsia cæspitosa*, Pal. Not uncommon. Ascends to 4,500 feet on the Mount Arthur plateau.
*Kœleria cristata*, Pers. Common, especially in subalpine localities.
*Trisetum antarcticum*, Trin. Abundant, ascending to 4,500 feet.
,, *subspicatum*, Pal. Raglan Range, 4,000–6,000 feet.
,, *youngii*, Hook. f. Mount Arthur plateau, 4,000–5,000 feet, abundant.
*Glyceria stricta*, Hook. f. Nelson Harbour.

*Poa breviglumis*, Hook. f. Near Nelson; Wairau Valley; Mount Arthur plateau, alt. 4,000 feet.

,, *foliosa*, Hook. f., var. *β*. Mount Arthur plateau and the adjacent mountains; Raglan Mountains; mountains above the Wairau Gorge.

,, *anceps*, Forst. Abundant in some of its forms throughout the district, in all situations.

,, *australis*, Br., var. *lævis*. Abundant, especially in flat river valleys.

,, *colensoi*, Hook. f. Abundant, especially in alpine and subalpine localities.

,, *kirkii*, Buchanan. Upper Wairau Valley; Mount Arthur plateau, 4,000–5,000 feet, abundant.

,, *mackayi*, Buchanan. Mount Arthur plateau, 4,000–5,500 feet, not so common as the preceding.

*Festuca littoralis*, Lab. Sandhills, Blind Bay.

,, *duriuscula*, L. Abundant in the mountains.

*Triticum multiflorum*, Banks and Sol. Vicinity of Nelson.

,, *scabrum*, Br. Not uncommon.

*Gymnostichum gracile*, Hook. f. Lower Motueka; Graham River.

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*Gleichenia dicarpa*, Br., var. *alpina*. Wairau Mountains; Hope Mountains, Buller Valley, ascending to 4,000 feet.

*Cyathea dealbata*, Swz. Lowland forests. Near Nelson; Motueka, etc.; Graham River; Buller Valley.

,, *medullaris*, Swz. Lowland forests. Nelson and vicinity; Lower Takaka.

*Hemitelia smithii*, Hook. Near Nelson; Maitai Valley, etc.; Motueka Valley; Graham River; Buller Valley.

*Alsophila colensoi*, Hook. f. Sources of the Takaka River; Mount Arthur plateau, ascending to 3,500 feet; Buller Valley.

*Dicksonia squarrosa*, Swartz. Common at low elevations.

,, *antarctica*, Br. Common at low elevations.

,, *lanata*, Col. "Massacre Bay, *Travers*" (Handbook).

*Hymenophyllum rarum*, Br. Vicinity of Nelson; Graham River; Buller Valley.

,, *polyanthos*, Swz. Abundant below 2,000 feet.

,, *villosum*, Col. Mount Arthur plateau, ascending to 4,000 feet; Buller Valley.

,, *javannicum*, Spreng. Maitai Valley.

,, *demissum*, Swz. Abundant in lowland forests.

,, *flabellatum*, Lab. Not uncommon. Ascends to 3,500 feet on the Upper Takaka.

*Hymenophyllum scabrum*, A. Rich. Nelson; Maitai Valley and Dun Mountain Range; Lower Motueka; Graham River; Buller Valley.

,, *dilatatum*, Swz. Not uncommon in damp lowland forests.

,, *pulcherrimum*, Col. Takaka Valley; Buller Valley.

,, *ciliatum*, Swz. "Nelson, *Travers*" (Handbook).

,, *subtilisimum*, Kunze. Maitai Valley, etc.

,, *rufescens*, Kirk. Sources of the Takaka River; Mount Arthur plateau, ascending to 4,000 feet; Hope Mountains, Buller Valley.

,, *malingii*, Mett. "Mountains between Blind Bay and Massacre Bay, *Maling*, *Brunner*" (Handbook).

,, *tunbridgense*, Sm. Not uncommon.

,, *multifidum*, Swz. Nelson; Motueka; Buller Valley, etc.

,, *bivalve*, Swz. Common in *Fagus* forests, etc., throughout the district.

*Trichomanes reniforme*, Swz. Maitai Valley, etc.; Graham River; Takaka River; Buller Valley.

,, *venosum*, Br. Graham River, etc.

,, *colensoi*, Hook. f. "Nelson, *Travers*" (Handbook).

,, *strictum*, Menz. "Massacre Bay, *Lyall*, *Travers*" (Handbook).

*Davallia novæ-zealandiæ*, Col. Graham River, Motueka.

*Cystopteris fragilis*, Bern. In alpine localities. Mount Arthur plateau, 4,000–5,000 feet; Wairau Gorge, 3,000–6,000 feet; Hope Mountains, Buller Valley, 4,000 feet; Raglan Range.

*Lindsaya viridis*, Col. "Massacre Bay, *Lyall*" (Journal of Botany, 1878, p. 108).

*Adiantum affine*, Willd. Common in lowland districts.

,, *æthiopicum*, Swz. Near Nelson.

*Hypolepis tenuifolia*, Bernh. Foxhill; Graham River; Wairau Valley.

,, *millefolium*, Hook. Common in the interior of the district. Lake Rotoiti; Wairau Valley; Buller Valley; Mount Arthur plateau.

,, *distans*, Hook. Maitai Valley.

*Cheilanthes sieberi*, Kunze. Vicinity of Nelson.

*Pellæa rotundifolia*, Forst. Lowland situations, not uncommon.

*Pteris aquilina*, L., var. *esculenta*. Abundant at low elevations in the eastern portion of the district.

,, *tremula*, Br. Motueka Valley; Graham River; near Nelson.

,, *scaberula*, A. Rich. Nelson; Motueka; Moutere; Buller Valley.

,, *incisa*, Lab. Not uncommon at low elevations.

,, *macilenta*, A. Rich. Near Nelson.

*Lomaria procera*, Spreng. Abundant through the district.
,, *fluviatilis*, Spreng. Lower Motueka; Graham River; Moutere; Buller Valley.
,, *filiformis*, A. Cunn. Near Nelson; Lower Motueka.
,, *vulcanica*, Blume. Not uncommon. Nelson; Graham River; Upper Motueka; Big Bush; Wairau Valley; Buller Valley.
,, *patersoni*, Spreng. Vicinity of Nelson; Maitai Valley; Foxhill; Buller Valley.
,, *lanceolata*, Spreng. Common.
,, *discolor*, Willd. Common.
,, *alpina*, Spreng. Abundant, especially in the high interior country. Ascends to 5,000 feet.
,, *fraseri*, A. Cunn. "Massacre Bay, *Lyall*" (Handbook).

*Asplenium obtusatum*, Forst. Nelson and coast to the north; Motueka Valley; Moutere; Graham River, etc. An alpine variety ascends to 4,500 feet on the Mount Arthur plateau.
,, *trichomanes*, L. Wairau Gorge.
,, *flabellifolium*, Cav. Nelson; Wairau Valley; Buller Valley; Mount Arthur plateau, ascending to 4,500 feet.
,, *falcatum*, Lam. Lower Motueka; Moutere Hills; Graham River.
,, *hookerianum*, Col. Maitai Valley; Graham River.
,, *bulbiferum*, Forst. Abundant.
,, *colensoi*, Hook. f. Maitai Valley.
,, *richardi*, Hook. f. Wairau Gorge.
,, *flaccidum*, Forst. Abundant through the district, ascending to 3,000 feet.
,, *umbrosum*, Br. "Nelson, *Travers*" (Handbook).

*Aspidium aculeatum*, Swartz, var. *vestitum*. Abundant throughout the district; ascending to 4,000 feet.
,, *richardi*, Hook. Maitai Valley; Nelson; Motueka; Graham River.
,, *cystostegia*, Hook. Mountains above the Wairau Gorge; Raglan Mountains.
,, *capense*, Willd. Lower Motueka; Graham River.

*Nephrodium velutinum*, Hook f. Vicinity of Nelson; Graham River.
,, *decompositum*, Br. Near Nelson; Moutere; Motueka; Graham River.
,, *hispidum*, Hook. Nelson and vicinity; Lower Motueka; Graham River.

*Polypodium australe*, Mett. Not uncommon. A dwarf variety ascends to 4,000 feet on the Mount Arthur plateau.

*Polypodium grammitidis*, Br. Nelson; Foxhill; Graham River.
,, *pennigerum*, Forst. Lowland localities, not uncommon.
,, *punctatum*, Thunb. Nelson; Foxhill; Moutere; Graham River.
,, *serpens*, Forst. Nelson and coast to the north; Lower Motueka.
,, *cunninghamii*, Hook. Maitai Valley.
,, *pustulatum*, Forst. Nelson; Lower Motueka; Graham River.
,, *billardieri*, Br. Abundant in lowland districts.

*Nothochlæna distans*, Br. Near Nelson.

*Todea hymenophylloides*, Presl. Plentiful through the district.
,, *superba*, Col. Takaka Valley, ascending to 3,500 feet; Buller Valley. "Near Reefton, Valley of the Inangahua, etc., not uncommon," *R. W. Raithby!*

*Ophioglossum vulgatum*, L. Maitai Valley; Wairau Valley; Lake Rotoiti.

*Botrychium ternatum*, Swz. Maitai Valley; near Foxhill; Wairau Valley.

Lycopodiaceæ.

*Lycopodium selago*, L. Wairau Gorge; Hope Mountains, Buller Valley; Mount Arthur plateau.
,, *varium*, Br. Wairau Valley; Mount Arthur plateau.
,, *billardieri*, Spring. Near Nelson.
,, *clavatum*, L., var. *magellanicum*. Abundant in subalpine localities.
,, *scariosum*, Forst. Near Nelson; Dun Mountain range; Wairau Valley; Buller Valley.
,, *volubile*, Forst. Abundant throughout the district.

Rhizocarpeæ.

*Azolla rubra*, Br. Near Nelson; Motueka Valley; Wairau Valley.

*Isoetes alpinus*, Kirk. Lake Rotoiti, abundant.

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## Art. XLVI.—*A Description of a few new Plants from our New Zealand Forests.* By W. Colenso, F.L.S.

[*Read before the Hawke's Bay Philosophical Institute, 14th November*, 1881.]

*Class* I. Dicotyledons.

Order 1. RANUNCULACEÆ.

Genus 1. Clematis, *Linn.*

*Clematis quadribracteolata*, n.sp.

*Plant* diœcious, small, very slender, trailing, extending only a few feet each way; *branches* sulcated, glabrous or with the young ones slightly and finely puberulent; *leaves* few, very minute, trifoliolate, on long petiolules 2–3 lines long, mostly ovate-acuminate and broadly lanceolate, or spathulate, ½–1½ lines long, and sometimes linear-lanceolate 3–5 lines long acute with a knobbed point, no lateral veins, only a mid-rib, with here and there a trifid leaflet, glabrous on both sides, sub-coriaceous, entire, dark-green margined with a deep black line; *petioles* glabrous, opposite, 1–2 inches long; *flowers* opposite, axillary, solitary, sometimes (though rarely) two from one axil, and very rarely three pedicelled on one peduncle; *peduncle* ½–1½ inches long, shorter than petioles, tri- and quadri-bracteolate, slightly pubescent below, densely so from uppermost pair of bracteoles; *bracteoles* free, connate, cup-shaped, pubescent, very obtuse and rotund at apices, obsoletely veined, each pair increasing in size upwards, the largest pair nearest the flower; *sepals* four, dull light-purple, thin, slightly spreading and revolute, 3 rarely 4 lines long, ovate, oblong-lanceolate, obtuse, glabrous within, silky pubescent without, ciliated, finely and obscurely veined longitudinally with 4–5 veins; *male flowers* on peduncles usually shorter than those bearing the hermaphrodite ones, and with only three pairs of bracteoles; *anthers* 25–28, elliptic, obtuse, light yellow; *filaments* broadly linear-lanceolate, flat, dark purple, outer shorter than sepals, inner sub-sessile; *hermaphrodite flowers* with only four stamens; *pistils* white, silky, very glossy at first, a little longer than sepals, glabrous, curved and clubbed at points; *achenes* 22–24, capitate, sessile, ovate, subsetose with short white hairs; *tails* very hairy, 8–9 lines long.

*Hab.*—In low-lying marshy spots, Hawke's Bay, S.W. and S. side.

This little plant has long been imperfectly known, no doubt partly owing to its small size (when compared with its indigenous congeners), to its want of striking colours, to its lowly growth, and to its peculiar habitat—hidden among the rank vegetation of marshes and on the edges of watery places, and not unfrequently springing from within a large tuft of *Carex virgata*. I first met with it so long back as 1847, on the banks of the Lake Rotoatara, near Te Aute, but my specimens then were incomplete. Subsequently (1872) it was detected by Mr. Sturm in the low ground between the Ngaruroro and Tukituki rivers, near Clive. Mr. Sturm also removed plants to his nurseries in hopes of cultivating them, but failed. Last year (1880) it was also found by Mr. Hamilton, in similar localities, near Petane; from him I have received ample specimens, in various states, which have enabled me to draw up this description. Though small, it is a neat-looking, almost a graceful plant, and differs widely from all our indigenous species of *Clematis*, as well as from the described Australian, Tasmanian, and South Pacific species. This species has but very slight affinity with *C. fœtida*, Raoul, under which species Dr. Sir Jos. Hooker had provisionally placed it as a variety.*

*Clematis parkinsoniana*, W.C.

Hermaphrodite, or Female, Plant: *Leaves* trifoliolate, smaller and much more regular in size and outline than in the male plant, each leaflet usually ovate, 4–10 lines long, and deeply incised with 2–6 incisions,

* "Flora Novæ-Zealandiæ," vol. i., p. 7, and "Handbook New Zealand Flora," p. 2.

mucronate, not unfrequently a leaflet is again subdivided into three leaflets, when each lesser leaflet is also petiolulate, and then is pinnate below; *veins* as in male plant; *hairs* the same, but the whole plant is still more thickly covered with them, golden and glossy; *common petiole* 1–1½ inches long, slender, filiform; *petiolules* 4–12 lines long: *flowers* numerous, diameter 9–12 lines, disposed in opposite axillary free panicles, 2½–3 inches long, bi-bracteolate at or near base; *sepals* six, as in male flower, longer than pistils; *anthers* (infertile) 8–9, narrow, linear; *filaments* somewhat lanceolate, broad, flat, one-nerved, shorter than pistils, about half the length of the sepals; *pistils*, at first silky, shorter than the sepals; *pedicels* opposite, 5–7 lines long, single-flowered, bracteolate at base, lowermost ones also bracteolate about the middle and 8–10 lines long; *bracts* and *bracteoles* connate, etc., as in male plant: *achenes*, 22–26, capitate, sessile, broadly oblong-lanceolate, sub-hispid with short patent hairs; *tails* very hairy, 12–14 lines long, flexuose, with curved and thickened tips.

*Hab.*—In forests, banks of streamlets, head of River Manawatu, 1881, (same localities as male plant), flowering in October, fruiting in December.

This, the female plant, bears a generally neater and more graceful appearance than the male plant, owing to its smaller, more regular, and more silky foliage; like the male plant it forms thick, dense, impassable bushes, often enveloping other plants and shrubs. I noticed, also (this year), that the flowers of the male plant were not so fugacious as I had formerly found and described them; which, at that time (in 1879), was no doubt owing to my first finding them later in the season (November) and just after very heavy rains.

For a full description of the male plant, see "Trans. N.Z. Inst.," vol. xii., p. 359.

### ORDER 47*. APOCYNEÆ.

### Genus 1. PARSONSIA, *R. Brown.*

*Parsonsia macrocarpa*, n.sp.

*Plant*, a shrub of very diffuse rambling growth, climbing over shrubs and bushes to the height of 12–14 feet; *stem* stout, ¾–1 inch diameter; *branches* pubescent with scattered white adpressed hairs; *young branches* densely tomentose; *leaves* papyraceous, opposite, elliptic-lanceolate (sometimes obovate), 2½ inches long (with a few smaller, 1–1½ inches), mucronate, pubescent, margins entire, slightly revolute, bright green above, pale yellowish-green below; midrib stout, tomentose on both sides, lateral veins opposite, nearly straight, parallel and regular, rather obscure; *petioles* slender, 5–6 lines long, slightly pubescent.

* The numbers here attached to both Orders and Genera are those of the "Handbook of the New Zealand Flora."

*Flowers* numerous, 12–00, terminal in long loose panicles and cymose-panicles, on long leafy axillary and opposite branchlets much longer than the leaves, scentless: *calyx* large, coloured dark pink, (and with pedicels and peduncle) densely velvety tomentose with light brown hairs; *lobes* acuminate acute, teeth about ½ line long, spreading, ciliated; the lobes lengthen much *after* flowering on the fruit: *pedicels* 2 lines long, each with one small bracteole: *corolla* pure white, urceolate, inflated, 3½–5 lines long, finely pubescent on the outside with very short scattered squarrose hairs; *lobes* small, scarcely 1 line long, subacute, subrevolute; *throat* constricted with a slightly raised corona: *anthers* wholly included below constriction. *Follicles* (immature and green) sub-cylindrical, tapering gradually to apex, points very obtuse, 8 inches long, 2½ lines in diameter, 8 lines circumference, striated longitudinally, umber-brown when dry, minutely strigose-pubescent with small scattered white adpressed hairs.

The nodal stipules or appendages, on the young long flagelliform densely tomentose branches (*rami viminei*) present a very curious appearance; they are opposite, erect, large, 3 lines long, subulate or linear with small dilated sub-leafy apices; at first, however, each one projects squarely out, about a line, at a right angle from the stem, with the outer point or elbow slightly dropping downwards, after the manner of a bracket corbel or drip; the whole possessing a peculiar quadrate and regular appearance.

*Hab.*—"Seventy-mile Bush," Hawke's Bay; thickets near banks of streams, 1876–1881: flowering in April, also in November, and possibly throughout the summer.

I had long known this plant in its leafing state, and had suspected—from its general tomentose appearance, and the regularity of the outline of its large leaves—that it might prove to be distinct from the two established New Zealand species, *P. rosea* and *P. albiflora*. Last autumn I was so fortunate as to obtain good flowering and fruiting specimens, which proved my conjecture to be correct, as it very widely differs, specifically, from both of those species,—more so indeed, than they do from each other. It is, however, allied to *P. albiflora*; and probably to an Australian species. It is a fine healthy-looking large and thickly-leaved species, and is evidently a fast grower.

## *Class* II. Monocotyledons.

### Order 1. ORCHIDEÆ.

#### Genus 4. Sarcochilus, *Brown.*

*Sarcochilus breviscapa*, n. sp.

*Plant* epiphytical; *roots* stout, clasping, issuing from bases of leaves and forming large irregular masses, from which 4–8 plants grow: *stems* 6–10 lines high, compressed, subcylindrical, very stout, glabrous, purple, covered by the imbricated sheathing bases of the leaves: *leaves*, usually 4–5 to a plant at a time, thick, glabrous, oblong or oblong-lanceolate, acute and pointletted, with a distinct mucro (almost like a short awn, so that each leaf has a vertical double-pointed apex), diminishing but slightly towards base, 1, 1½–2 inches long, 5–6 lines broad at middle, and 2–3 lines broad at base, sessile, sheathing, jointed immediately above clasping sheath, somewhat keeled, distichous, spreading, sub-falcate, dark-green spotted with purple, mid-rib below purple, 8–nerved longitudinally, nerves parallel and sparingly transversely netted, but only visible when leaf is dried: *scape*, slender, axillary in lower leaves, 4–8 lines long, (and with rhachis) green, closely spotted and blotched with purple; two solitary sheathing *bracts*, one at base, and one much larger and acuminate on one side in the middle: *rhachis*, 6–12 lines long, thickened.

*Raceme* 5–8-flowered, flowers not crowded: *pedicels* 2 lines long, alternate and scattered, purple striped, each having a single broadly ovate acute bract, embracing at base. *Perianth* conniving, not split quite to base, 3 lines diameter, light-green, striped and spotted with purple: *sepals* oblong-ovate, obtuse, with a purple stripe down the centre on outside; dorsal one largest: *petals* oblong-lanceolate, subacute, smaller than sepals, margined spotted and blotched with purple: *labellum* shorter than petals, greenish-white minutely spotted with purple without, green within, gibbous at apex, subcucullate with a minute notch on each side of lip; *lateral lobes* very slightly produced, conniving, with two thick transverse opposite ridges (*calli*) within. *Capsule* oblong-linear, pointletted, stout, turgid, 7–8 lines long, light-greenish, striped longitudinally with purple; densely woolly within: seeds minute, lanceolate, and with their wool light-brown.

*Hab.*—High up in forks of large pine trees (*Podocarpus dacrydioides* and *P. totara*), "Seventy Mile Bush" (1878-80), and at Glenross (1881, *D. P. Balfour*), Hawke's Bay; flowering in September. A species allied to some of the smaller Australian species of this genus, and possessing close affinity with *S. adversus*, Hook. fil., but very distinct.

## Order 7. LILIACEÆ.

### Genus 5. Astelia, *Banks and Solander.*

*Astelia polyneuron*, n. sp.

A middle-sized species, few-leaved and not bushy; epiphytical.

Male Plant: *Leaves* spreading drooping sub-coriaceous, 4·9–5 feet long, linear-lanceolate very acuminate acute, 1¼ inch wide at middle, largely sub-recurved, dark green, glabrous on upper surface, canescent-tomentose below with fine white closely adpressed hairs, possessing (under a lens) a minutely and regularly dotted appearance, 1½ inch wide at base and there densely clothed with long straight white hair, deeply furrowed on each side of the mid-rib, mid-rib keeled, ciliated at edges and on mid-rib below with longish white hairs, 12-nerved longitudinally, nerves white clear and parallel: *scape*, sub-flexuous, pendulous, 16 inches long, obtusely trigonous, very stout, thickest and more angular at top, shaggy throughout with dense white floccose cottony wool, particularly at base, and bearing a branched loose *panicle* 9 inches long, composed, *below*, of 5 symmetrical alternate sub-panicles, the lowermost one having 4 racemes, and each of the upper four 3 racemes, 6–2 inches long springing from one base or short peduncle, the middle raceme of each sub-panicle always the longest, and each of the five with a single leafy sessile *bract* at its base, the lowermost bract being 2 feet long and 8 lines wide at the base, rather suddenly widening at 3 inches from base to $1\frac{1}{4}$ inch, and 10-nerved; the next bract 14 inches long, and both lanceolate and very acumimate from the widest part, light-green and glabrous above; the remaining three bracts small; *above*, the panicle is composed of five single alternate bractless racemes; racemes, smaller bracts, peduncles, pedicels and bracteoles densely clothed with silky hairs: *flowers* numerous, free, scattered on long pedicels; pedicels 3 lines long and bracteolate; *bracteoles* linear, as long as pedicels, reddish: *perianth* glabrous, light-green with a dash of yellow, each segment bearing a reddish central stripe on the outside, stellate, $\frac{1}{2}$ inch diameter; *segments* free to base, nearly equal, sub-recurved; *sepals* larger, ovate-lanceolate, sub-acuminate, with a slight protuberance a little way in from the tip; *petals* narrower obtuse: *filaments* long, slender, spreading: *anthers* oblong, obtuse, almost circular after bursting.

Female plant smaller in all its parts than the male plant; *leaves* 2 feet 3 inches—2 feet 6 inches long, $\frac{3}{4}$ inch broad at the middle, and only 8–10-nerved: *scape* as in the male, but straight and shorter, 8–9 inches long: *bracts* as in the male, but smaller; the lowermost 14–17 inches long, and 6-nerved; the next one $3\frac{1}{2}$ inches long, the other three small: *panicle* erect, 7 inches long, free; composed *below* of three alternate subpanicles, each containing three racemes of flowers springing from one base or peduncle; and *above*, of five single racemes, the upper two being without bracts: *flowers* as in male, but smaller, with shorter pedicels and bracteoles, which are white: *perianth* greenish-yellow, scented, densely clothed on the outside with silky hairs: *segments* spreading, not recurved, and broader than those of the male plant: *style* short, stout: *stigma* sessile, trifid, very obtuse, smooth: *ovary* globose, red, succulent (like a small red currant when fully ripe, and of the same colour), very slightly marked from top downwards with three angular furrows: *anthers* (infertile) very small, oblong, narrow, obtuse, just appearing from under the ovary, and closely embracing it.

*Hab.*—In dense forests near the head of the river Manawatu, North Island; epiphytical on living trees, at no great height from the ground; 1880–1881; flowering in December.

This species of *Astelia* is very distinct from all our known New Zealand (and other described) species; still, in some respects, it has affinity with *Hamelinia veratroides* of A. Richard, (a New Zealand species of this genus), judging from his copious description of the female plant of that species and his botanical drawing of the same;* which species Dr. Sir Joseph Hooker has placed with a doubt, under *Astelia cunninghamii*, in his "Handbook of the New Zealand Flora;" but I do not thing it will be found to belong to it. Indeed I think that A. Richard's plant,† (collected in New Zealand by D'Urville and Lesson) has not been subsequently detected in this country. A. Cunningham, in his "Precursor of the Botany of New Zealand," placed it under *A. banksii*, as a synonym of that species; I doubt, however, if Cunningham ever gathered it.

*Astelia spicata*, n. sp.

*Plant* small, cæspitose, sub-grass-like, throwing out many young ones from axils of lower leaves; epiphytical on the lower bare branches of trees, and on prostrate trees and logs, forming small thick tufts. *Leaves* thickish, spreading, 6–9 inches long, 3–7 lines wide, sessile, much dilated at base and clasping, linear-elongate, acuminate, distichous, falcate, light-green, almost glaucous, slightly keeled, glabrous above but slightly scurfy and margined (above) with a narrow silvery shining line of closely adpressed hairs, hoary below, much as in *A. polyneuron (supra)*, obscurely 6-nerved, striated, and with short transverse veins near base, and finely ciliated with white hairs at margins, and on midrib below: *scape* (female) erect, 2 inches long, cylindrical, succulent, and (together with pedicels) clothed with fine and closely adpressed silky white hairs; *spike* 1½ inches long, bearing 25–30 flowers; the lowermost four, however, are distant from each other and pedicelled, each one of them is also singly bracteated with a long leaf-like lanceolate bract, the lowermost one being 3 inches long; the upper flowers are subsessile, clustered in a dense cylindrical obtuse spike; a few only of the lower ones are free on very short pedicels, each one having a subulate reddish bracteole, 6–9 lines long, hanging downwards from its base: *perianth* free half-way down, white, shining, very membraneous, semi-transparent; *lobes* long, oblong-ovate, obtuse, thickened at tips, and one-nerved, at first completely enclosing the ovary, though open and gaping at the sides; afterwards they are wholly recurved from the centre of the same, which is still embraced closely below by the tube, when the whole assumes

* Atlas Botanique, "Voy. de L'Astrolabe," t. 24.

† *Astelia richardi*, Endl., apud Kunth, *Enum. Plant.*, vol. iii., p. 365.

a light-brown scarious appearance: *ovary* large for the plant, ovate obtuse, succulent, green, slightly marked above with three sutures: *style*, o: *stigma* sessile, trifid, finely penicillate and spreading: *anthers* (infertile) opposite segments, long and linear, almost subulate.

*Hab.*—In the forests about Kopua and Norsewood, North Island, 1878–1881: flowering in December. Often found in a leafing state on trees and logs, but perfect specimens are rarely met within reach. This, however, in those parts, is mainly owing to the settlers' cattle, which seem very fond of this plant, apparently preferring it to much other good green food around.

This is an interesting little species, by far the smallest of all the epiphytical ones of this genus; and, indeed, the smallest of all our known New Zealand ones, save the smaller alpine one (*A. linearis*), found by me on the summits of the Ruahine mountain range;* and by Dr. Sir Jos. Hooker in Auckland and Campbell Islands. This species is so very distinct, that (although I have not yet detected a perfect *male* plant) I have ventured to describe it from the *female* ones. Some leafing states of it remind one at first sight of a large species of *Luzula*.

## *Class* III. Cryptogamia.

### Order 1. FILICES.

### Genus 22. Polypodium, *Linn.*

*Polypodium* (*Grammitis*) *paradoxum*, n. sp.

*Plant* small, cæspitose, suberect, 4–6-fronded, with a compact mass of large light-brown scales at base; *roots* many, long, filiform, rich dark-brown and very hairy; *fronds* thin, submembranaceous, sub-sessile, linear-lanceolate or ligulate, subfalcate, very obtuse at apices, 2–3¼ inches long, 1–1½ lines broad (broadest part about middle), decreasing very gradually quite to base, light-green above, lighter below, villous on both sides with long reddish hairs, margin entire but slightly undulated, ciliated with stout long red hairs; midrib black-purple, flexuose, scarcely continued to apex; *veins* alternate, rather distant, simple, and only once forked on the inside, not produced to the edge; *sori* separate, oblique on inner fork of veins, rather nearer the midrib than the margin, rich red-brown, from close to apex downwards throughout two-thirds length of the frond, at first linear-oblong afterwards elliptic, completely hidden by long villous adpressed whitish hairs growing from each side of the sori and permanent; *scales*, at base, large, ovate-acuminate, 1–1½ lines long, thin, shining, finely reticulated, chesnut-brown.

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* Not, however, "in swamps" ("Handbook New Zealand Flora," p. 284), but on the open hill-tops, with *Caltha*, *Euphrasia revoluta* and *antarctica*, *Myrsine nummularifolia*, etc.

*Hab.*—Forests between head of Wairarapa Valley and Manawatu River, 1850 (*W.C.*); also near Takapau, S.W. end of Ruataniwha Plains, Hawke's Bay, 1881 (*Mr. John Stewart*); on the ground.

This little fern has been long known to me, though, originally, only from a single plant of some 4–5 fronds, discovered by me in 1850, and though often sought (in subsequent travelling through those woods) never again met with: specimens of its fronds were sent to Sir W. J. Hooker; those, however, were not in so good a state (being only old) as these I have lately received from Mr. Stewart. And, no doubt, at Kew, those have been considered and described as belonging to *Polypodium australe.* To this, however, I could never consent, for I know *P. australe* well; two other allied yet much smaller New Zealand ferns, have also been described with it, *viz.*, *Grammitis ciliata (mihi)*,* which always grows in single plants on trees—and a curious stout dwarf broadly spathulate form, from holes and cavernous places in the rocks on the hills, which always grows in dense masses.

*Polypodium australe* (or *Grammitis australis*), *vera*, with which (as I take it) other allied ferns have been mixed up, is altogether a very different plant, and possesses characters not to be found in *P. paradoxum*, and *vice versa.* That fern was originally described by its discoverer, the celebrated botanist R. Brown, who also (as he says) had the great advantage of seeing it in its living state; Brown describes it as "frondibus linearibus v. lanceolato-linearibus obtusiusculis, integris glabris, marginibus simplicibus."† And just so its latest describer, Bentham, who describes it more fully and from ample specimens, obtained from various places in Australia and Tasmania, saying—"Fronds entire, coriaceous, glabrous, * * * contracted into a short stipes. Veins * * once or twice forked, free, and concealed in the thick substance of the frond."‡ Bentham also includes with it a new species of Baker's—*P. diminutum*, from Lord Howe's Island; which also has a "creeping rhizome, surfaces naked, and texture rigidly coriaceous."§ This new species of Baker's, I may further observe, is also placed by him as coming next in regular natural succession to *P. australe*, and, like that species, belonging to what he has classed as the "Eremobryoid series (of the genus), having their stems articulated at the point of junction with the (creeping) rhizome;"‖ to which natural series the plant I have above described does not belong.

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* Described in "Tasmanian Journal of Natural Science," vol. ii., p. 166, 1843.

† *Prodromus* "Flora Novæ-Hollandiæ," p. 2.

‡ Bentham's "Flora Australiensis," vol. vii., p. 762.

§ "Syn. Fil.," p. 507.

‖ *Loc. cit.*, p. 319.

Sir W. Hooker, in his "*Species Filicum*," gives a full description of *P. australe*, (in which, however, other allied plants from other countries, described by other botanists, are also by him included,)—in his description, he says,—"at the base and also on the stipites deciduously hairy, the rest at least in maturity glabrous." Baker also, in his late edition of "*Synopsis Filicum*," describes *P. australe* as having, "Rhizome creeping, texture coriaceous, stipes and both sides naked or slightly ciliated,* and Dr. Sir Jos. Hooker, both in his "Flora Novæ-Zealandæ," and his "Handbook of the New Zealand Flora," describes *P. australe* as being "glabrous, pubescent, pilose, or ciliate," etc., etc.—done, as I take it, and as I have already observed, to embrace all our New Zealand allied plants in *one* specific description; believing them to be but one species; but there are great natural and characteristic differences separating them.

The rather coarse and long villous adpressed hairs on the under side of *P. paradoxum*, growing across and hiding the sori, and giving it there a kind of coarse matted arachnoid appearance, the persistent stout marginal rufous hairs, and the numerous large and reticulated basal scales,—together with each plant being of strictly defined single cæspitose growth,—are good natural characters not pertaining to *P. australe, vera.*

*Polypodium (? Goniopteris) pennigerum*, Forst., var. *hamiltonii*, W.C.

*Rhizome* erect, tufted: *fronds* 15–18 inches high, glabrous, oblong-lanceolate, very membraneous, pinnate, slightly pinnatifid at top, light-green; *stipes* and *rhachis* slender, subsucculent; *rhachis* and *mid-rib* hairy above, hairs light-brown; *pinnules* opposite, distant, slightly petiolate, broadly linear-elongate, not acuminate, pinnatifid to below the veins very nearly to mid-rib, middle ones 3 inches long, 1 inch broad, lowermost pairs very distant, small and auricled upwards, the upper ones are sometimes forked near tips; *lobes* large, 5–6 lines long, 3 lines broad, very irregular, puckered and crisped, deeply cut into 4–5 incisions on each side, truncate, retuse, and sharply pointed, the *sinus* between the lobes large and semicircular; *veins*, 4–5 pairs to each lobe, opposite, distant, free throughout; *sori* globose, few, only a single sorus central on each of lowermost pair of veins: *stipes* 2–2½ inches long, scaly at base; *scales* ovate, obtuse, rich dark-brown, and finely reticulated.

*Hab.*—Wet rocky sides of mountain streamlets, country S.W. from Napier, North Island; found by Mr. A. Hamilton in 1881.

This is an elegant species (or new variety) of fern, and will, I have no doubt (if it continues true), become a garden favourite; at present, plants of it are thriving well in Mrs. Tiffen's fernery in Napier. For some little

* *Loc. cit.*, p. 322.

time it has been a puzzler, as it was not originally found bearing fruit, and its richly crisped very membraneous form was so widely different from all our New Zealand ferns; yet, from its regular and simple venation, etc., I supposed it to be closely allied to *P. pennigerum*. This is now proved, from the plants in cultivation having produced fruitful fronds bearing similar sori, whence this description is in part made; but another great and striking difference is the not-meeting of the lower pair of veins (as in that species), the lobes being separated much beyond them; and this character (if constant) would cause the removal of this fern from *Goniopteris*. There are also other and great differences between these two ferns; still, I cannot bring myself to consider them as really specific—time, however, will show. I have very great pleasure in naming this pretty plant after its zealous discoverer.

*Polypodium (Goniopteris) pennigerum*, Forst., var. *giganteum*, W.C.

Whole plant, pretty nearly as *P. pennigerum*, is described in "Handbook Flora of N.Z." (and in other botanical works), but with these differences:—*Fronds*, 5–6 feet long, 14–16 inches wide, broad-oblong lanceolate; *stipes* very stout, woody, semi-circular, deeply channelled on upper surface, and marked on both upper outer edges with a continuous white ridge, scaly below; *scales* scarious, large, 2–3 lines long, ovate, rich dark-brown, elegantly reticulated; *rhachis* and midribs of pinnules, hairy *(hirsute)* above; *pinnules* 7–8 inches long, 1¼ inch broad, broadest at base, sub-petiolate, acute, alternate, distant, patent, largely and regularly conniving towards apex but not falcate; *lobes* 7–8 lines long, 2–2½ lines broad, linear-oblong, slightly falcate, rather distant, toothed, margin recurved, and slightly and sparsely hairy at tips and edges; *sinus* between the lobes acute; each lobe with 9–10 pairs of *veins*, lowest two pairs of veins opposite, those above sub-opposite, and all bearing a single sorus, the lowermost two veins meeting the opposite two above them, and so generally throughout the pinnule; the lowermost pair of lobes on each pinnule are the longest, the lowermost lobe is auricled, the auricle bearing 1–2 sori extra on small veinlets.

*Hab.*—Skirts of woods and thickets, head of River Manawatu; 1875–1881.

This fern seems to be a large var. of *P. pennigerum*, possessing however several characters differing from that plant, which are noted above. *P. pennigerum*, the common form, is also plentiful in the same localities. I have long known this plant, but should not care to bring it forward, were it not for the still more striking var. (or species) discovered by Mr. Hamilton (*supra*).

## Order 5. HEPATICÆ.

### Genus 3. Plagiochila, *Nees and Montagne.*

*Plagiochila subsimilis*, n. sp.

*Rhizome* stout, creeping, long, irregular, densely covered with short brown hair, much-branched, with many long rootlets; *main stems* pretty close together, erect or pendulous, 6–8 inches long, flattish, sulcated on back, very dark purple-brown almost black, sometimes forked below, 1–2 inches from base, and occasionally each of those main stems again forked; bipinnately branched, sub-fastigiate; branches crowded above, 3–5 inches from base, patent, plane, taken together 2–3 inches broad; *stems* rich red-brown and semi-translucent; lowermost pair of branches opposite, others sub-opposite and alternate; all, together with main stem, closely leaved throughout: *leaves* laxly imbricate, opposite, distichous, patent, dimidiate-ovate; apices obtuse and rotund; light green, translucent, finely and irregularly toothed *(denticulato-ciliatis)* on ventral side and round the apex, dorsal side entire, slightly recurved and greatly decurrent; those on middle of main stem subrotund and larger, above 1 line in length, decreasing in size downwards, lowermost very much smaller, alternate and 1 line apart, and sometimes slightly denticulate also on dorsal edge; *involucral leaves* more rotund, and more closely and deeply ciliate-toothed. *Perianth* produced, 1 line long, elliptic or broadly obovate, apiculate *(obtusus cum acumine)*, inflated, whitish-brown, semi-transparent, terminal on upper branches and on short lateral branchlets near the tops; sometimes 2–3 perianths very nearly together; lips very large, open, entire. *Calyptra* cylindrical, enclosed, half the length of the perianth; *seta* longer than perianth, erect and nodding; *capsule* exserted, free, oblong-ovate, rich deep brown.

*Hab.*—On standing (living) and fallen rotten trees, and on earth damp sides of watercourses, "Seventy-Mile Bush" forest, head of the Manawatu River, Hawke's Bay; 1875–1881. Some living trees have their trunks completely hidden with the dense growth of this plant.

A fine species, having pretty close affinity with *P. stephensoniana* and *P. gigantea*, and in the shape of its leaves with *P. annotina*; and belonging to that same dendroid section of the genus.

### Genus 11. Gymnanthe, *Taylor.*

Gen. nov. *Marsupidium*, Mitten.

*Gymnanthe* (*Marsupidium*) *hirsutum*, n. sp.

*Rhizome* creeping, slightly hairy. *Plant* thickly tufted, sending out long stoloniferous succulent branches, erect, 1–2½ inches high, simple and 2–6-branched, drooping at tips; colour of leaves and young stems a lively green (which it retains in drying), of the short stipes, yellowish. *Leaves* pinnate, sessile, free, alternate, patent, 1 line or a little more long, sub-quadrate with a single deep notch at apex and nearer to the inferior side, slightly arcuated on the superior side, and very finely and closely toothed on its outer corner and round it a little way on the apex: *sac*, or *torus*, sub-terminal on both main and lateral branchlets, sub-globose or broadly oval, 1½–2 lines long, densely hirsute-hispid, colour light brown.

*Hab.*—On shaded clay banks and on rotten logs near watercourses in thick wood near head of the River Manawatu, North Island; 1879–1881.

A species possessing close affinity with *Gymnanthe tenella*, Taylor, and *Marsupidium knightii*, Mitten.

This species I have long known in its barren state; and although it appeared to be very nearly allied to *Gymnanthe tenella*, Taylor, of New Zealand and Tasmania (*vide* "Fl. Tasmaniæ"), yet I could never quite believe it to be the same; and now that I have found it pretty copiously in fruit, I am certain of its specific distinction. *G. tenella* is fully described by Taylor (who established the genus on that species), in "Lond. Journal of Botany," vol. iii., p. 377 (and in "Syn. Hepatic.," p. 192), and a drawing of it is also given in the "Fl. Tasmaniæ." In foliage and in size and in manner of growth the two plants are very much alike; still, the leaves of this species are not so closely set, and have many more and finer serratures at the apex (9–10) than there are in that one, which usually bears but three. But the chief distinction is in its *sac* or *torus*, which in *G. tenella* is described as "elongato obconico striato"; while in this species the same part is densely shaggy, almost echinate when fresh.

In the "Handbook of the New Zealand Flora," p. 520, *G. tenella*, *G. saccata*, and *G. urvilleana*, with other *Hepaticæ*, were all lumped together under the one species—*G. saccata*. (This, to me, who had formerly collected them all in New Zealand, seemed surprising, as I could not discern much of a close resemblance between them.) Subsequently, however, Mitten broke up the genus (though but a small one) into several new genera,* and in so doing not only restored the three above-mentioned species of *Gymnanthe* (which I was pleased to see) but even separated them into distinct genera.

It is not, however, stated in which of those new genera *G. tenella* is now placed; possibly in *Tylimanthus*; but this plant of mine will, I think, be found to rank naturally with *Marsupidium*, and seems pretty closely allied (judging from the short description) to Mitten's new species, *M. knightii* (p. 753, *l.c.*), which is also a New Zealand species.

* See "Handbook N.Z. Flora," pp. 751-754.

## Art. XLVII.—*On the Alpine Flora of New Zealand.*

By John Buchanan, F.L.S., of the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 20th August and 21st September*, 1881, *and 21st February*, 1882.]

Plates XXIV.–XXXV.

The present contribution to the Alpine Flora of New Zealand has been prepared from collections of plants made during Dr. Hector's geological visit to the Lake Districts of Otago in 1863–4, and more recently in the same districts including the mountains environing Lake Ohou, Canterbury, during Mr. McKay's geological visit there in 1881–2.

The first collection was submitted by Dr. Hector to Sir Joseph Hooker, for identification, and as many of the plants proved new to science they were added to the "Handbook of the New Zealand Flora," then in the press. Unfortunately good specimens of this collection were not retained in the colony for comparison and identification of future collections, and all our more recent alpine collections have been worked out since from description alone.

The purpose of the present paper is not only to place upon record new species, but also to assist in naming them, by illustrations, those who take a popular interest in our beautiful Alpine flora; the spread of population towards the lake districts of the South Island having no doubt added greatly to the number of those who take advantage of their alpine neighbourhood to make collections. Many of our alpine plants are very beautiful when in flower, and when seen aggregated in close, often rounded masses, firmly adhering to rock surfaces in sheltered places of the mountains, where favourable conditions exist for their full development, they in many instances excel the gardener's art. It is doubtful, however, if they will prove a success under cultivation, as certain conditions of life necessary for their healthy development only exist at great altitudes. The nearest approach to these healthy conditions of growth would be found under glass with a warm temperature when growing and flowering, after which a long period of rest during winter under a low temperature would be necessary to prevent exhaustion.

The altitudinal range of the New Zealand alpine flowering plants extends from 3,500 to 8,000 feet, but there is reason to assume that, but for the presence of snow, they would attain a greater altitude. Latitude is no doubt an indefinite influence in plant distribution, being so much controlled by local influences that identical floras may be found on distant mountain ranges with botanical altitudes inverse to their latitudes. This may be caused by ocean currents of different temperatures impinging on opposite coast lines, or by local hot winds; but, whatever may be the influencing cause, representative plants of the North Island pass several degrees of latitude southwards on the west side of the South Island, which are not found on the east side of that Island, thus indicating a higher temperature on the west; and this is also consistent with the alpine flora of the North Island being found at higher altitudes on the mountains of the South Island than on those of the North.

The alpine flora as observed has a rapid development. This is no doubt necessitated by the short period which intervenes between the melting of the snows and the next seasonal fall. The intense heat of the sun at high altitudes, is no doubt an important element in hastening growth, but the chief cause must be ascribed in many cases to the advanced stage at which the plants have arrived before the melting of the snows in spring has uncovered them. Large plants such as *Ranunculus buchanani* were found 8–10 inches high, breaking through their snowy covering, with the leaves and flower-buds fully formed; no sooner, however, did the last film of snow melt from above them, than they burst into flower while the leaves were yet blanched and colourless, and it is probable that in favourable weather seed may ripen in a few weeks.

On the Mount Aspiring Range may be seen, covering patches of snow, that peculiar 1-celled plant—*Protococcus*, or red snow. This plant was observed by Captain Ross on one of his expeditions to the Arctic regions, covering the surface of the snow over large areas, and penetrating downwards several feet.

*Pachycladon novæ-zealandiæ*, Hook. fil.

*Braya novæ-zealandiæ*, Hook. fil., Handb. N. Z. Fl., vol. i., p. 13.

A short depressed alpine plant, covered with stellate pubescence; root long, fusiform, $\frac{1}{4}$–$\frac{1}{3}$ inch diameter, bearing 1–6 stout branches, each branch terminating in a rosulate head of small imbricating leaves. Leaves in several series $\frac{1}{3}$–$\frac{1}{2}$ inch long, including the petiole, pinnatifidly lobed and narrowed into flat, short petioles, those on the scapes with longer petioles, and a minute ovoid blade, which is digitately lobed at top; scapes numerous, shorter or longer than the leaves, rising from the branches or root below them, and spreading horizontally, 3–5-flowered; flowers white, $\frac{1}{7}$ inch long, sepals obovate, obtuse, petals longer than the sepals, upper half round, tapering below to a narrow point; stamens 6, two longer than the others; pods $\frac{1}{3}$ inch long, $\frac{1}{12}$ inch broad, laterally compressed, linear oblong, septum incomplete; seeds 6–8 in each valve, ovoid, and with vertical ridges.

*Hab.*—Mount Alta Range, 6,000 feet alt.—*Hector* and *Buchanan*, 1862; *A. McKay*, 1881.

Plate XXIV., fig. 1, plant nat. size; 1 *a*, flower; 1 *b*, pod; 1 *b'*, seed; 1 *c*, 1 *c'*, leaves.

The present plant was collected on Mount Alta, Wanaka Lake District, where it is found on exposed ridges not under 5,000 feet alt., either in firm shingle or in crevices of the rocks, where it is often surrounded by snow. The progress of flowering and seeding is rapid, as the heat during the day in sunshine at these high altitudes is intense, producing a rapid vegetation.

*Pachycladon glabra*, Buchanan, n.s.

A short depressed, glabrous, alpine plant. Root long, fusiform, $\frac{1}{5}$–$\frac{1}{4}$ inch diameter, bearing 1–2 stout branches, each terminating in a loose rosulate head of long slender leaves. Leaves $\frac{3}{4}$–1 inch long including the petiole, in irregular series, pinnatifidly lobed and narrowed into long flat petioles. Scape leaves long narrow linear. Scapes few, shorter or longer than the leaves, and rising from the branches below them, 1–3 flowered. Flowers white, $\frac{1}{5}$ inch long. Sepals linear-obovate, petals longer than the sepals, narrow linear-obovate, rounded at top, tapering at bottom to a narrow point; stamens six, two longer than the others; pods $\frac{1}{4}$ inch long, $\frac{1}{20}$ inch broad, laterally compressed, linear, septum complete; seeds 8–10 in each valve, ovoid.

*Hab.*—Mountain range, head of Lake Ohou, 5,000 feet alt.—*Buchanan* and *McKay*, 1881.

Plate XXIV., fig. 2, plant nat. size; 2 *a*, flower; 2 *b*, *b'*, pod and section; 2 *c*, leaf.

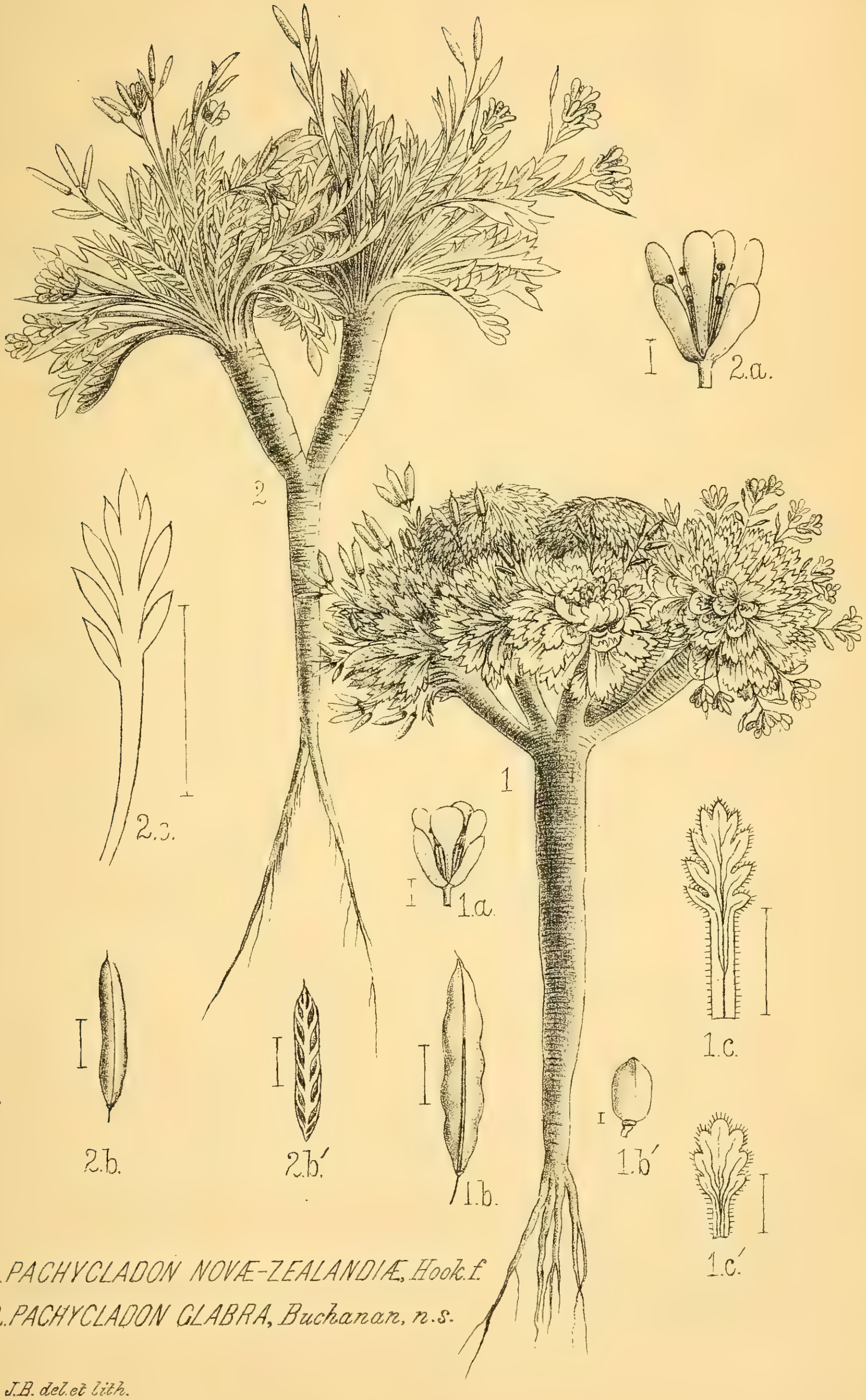
The present plant may probably be considered as only a form of *Pachycladon novæ-zealandiæ*, produced by climatic causes; the prevailing hot winds of the Lake Ohou District, where it was collected, being well known to exercise a great influence on the vegetation of both mountain and low lands. The upright habit and glabrous parts however of the present plant with other changes in the inflorescence necessitate a distinguishing name.

*Notothlaspi notabilis*, Buch., n.s.

A small circular densely-leaved biennial (?) plant, with the inflorescence forming a terminal sphere of small white flowers; stem none; leaves numerous, $\frac{3}{4}$–1 inch long, spathulate, crenate on the upper half, sparsely covered on margins and surface with ribbon-like hairs, 1-veined, and pitted on the surface; scape, 1–2 inches long, hollow, apparently formed by the union of the petioles, thus probably relegating the leaves to flower bracts; pods, $\frac{1}{3}$ inch long, obovate, with a very short style.

*Hab.*—Mountain range, head of Lake Ohou, 3,000 feet alt.—*Buchanan* and *McKay*, 1881.

Plate XXV. figs. 1, 2, plant nat. size, different views; 3, flower; 4, pod; 5, leaves, both sides; 5 *a*, portion of leaf much enlarged.




1. *PACHYCLADON NOVÆ-ZEALANDIÆ, Hook. f.*

2. *PACHYCLADON GLABRA, Buchanan, n. s.*

*J.B. del. et lith.*


*NOTOTHLASPI NOTABILIS*, Buchanan.

J.B. del. et lith.

This remarkable little plant agrees in several details with Hooker's description of *Notothlaspi rosulatum* ("Handbook of New Zealand Flora"); that species, however, being described as a pyramidal fleshy herb, with a scape thicker than the little finger, and a span high, presents sufficient differences to claim for the present plant a distinguishing name. The illustrations given on pl. XXV. are drawn from the largest specimens in a collection of over fifty.

*Hab.*—Fine loose shingle slopes, where its fine thread-like roots penetrate to a considerable depth, presenting an unique botanical form in the Flora of New Zealand, the leaves being arranged like a miniature umbrella, surmounted by a small dense ball of white flowers.

*Hectorella cæspitosa*, Hook. fil.

Handb. N.Z. Flora, vol. i., p. 27.

Leaves densely imbricated round the stem, spreading, variable in form and size, linear-acuminate, or oblong-obtuse, membraneous and much dilated at the bottom, entire. Flowers of two kinds, smallest with stamens only; sessile among the uppermost leaves, white or sometimes pale salmon colour; pedicel with 2 bracts at the base; sepals 2, ovate acute, continuous with the pedicel; petals 5, united at the base, erect and thickened beneath the tip; capsule not seen.

*Hab.*—This beautiful alpine is found abundantly on Mount Alta, where it may be seen in large patches on steep, rocky places, at an altitude of 5,000 feet.

A marked feature in this plant, and which adds much to its floral beauty, is the arrangement of the flowers in circles at the ends of the branches, many of the patch plants having only one terminal flower on each branch.

Plate XXVI., fig. 1, portion of plant nat. size; 1 *a* and 1 *b*, fertile and staminiferous flowers; 1 *c*, 1 *d*, 1 *e*, different forms and sizes of leaves.

*Pozoa exigua*, Hook. fil.

Handb. N.Z. Flora, vol. i., p. 87.

Plant, $\frac{1}{2}$–1 inch high. Leaves long, petioled, numerous, rising from a small rhizome, ovate, generally 3-lobed, petioles forming a close bundle. Scape longer than the petioles, involucral leaves linear-oblong, acute, connate at the base. Fruit linear, scarcely $\frac{1}{10}$ inch long, much longer than its pedicel, 5-ribbed, ribs terminating in unequal-sized hooked teeth. See description of flower in "Handb. N.Z. Fl.," vol. i., p. 87.

*Hab.*—South Island: Black Peak, 6,000 feet alt.—*Hector* and *Buchanan*, 1862; *A. McKay*, 1881.

Plate XXVI., fig. 2, plant enlarged; 2 *a* and 2 *b*, fruit, front and side views.

A most minute plant, and easily overlooked, although probably abundant in wet places at high altitudes.

*Dracophyllum muscoides*, Hook. fil.

Handb. N.Z. Flora, vol. i., p. 183.

A small, rigid, densely-branched shrub. Branches closely covered with minute, imbricate leaves. Leaves $\frac{1}{10}$ inch long, ovate, obtuse when young, inflexed and subulate at top when mature, coriaceous, sheathing at base, and minutely ciliate. Flower white, $\frac{1}{8}$ inch long, terminal, sepals ovate, as long as corolla tube.

*Hab.*—South Island: Mount Alta and Hector's Col, 5–7,000 feet alt.—*Hector* and *Buchanan*, 1862; *Buchanan* and *McKay*, 1881.

Plate XXVI., fig. 3, plant nat. size; 3 *a*, flowering branch, enlarged; 3 *b*, sepal; 3 *c*, leaf, showing the early ovate and later subulate forms.

This beautiful little alpine is worthy of attention as an ornamental plant for gardens, and probably under cultivation the close habit of growth might open out and produce a finer shrub.

*Aciphylla hectori*, Buch., n.s.

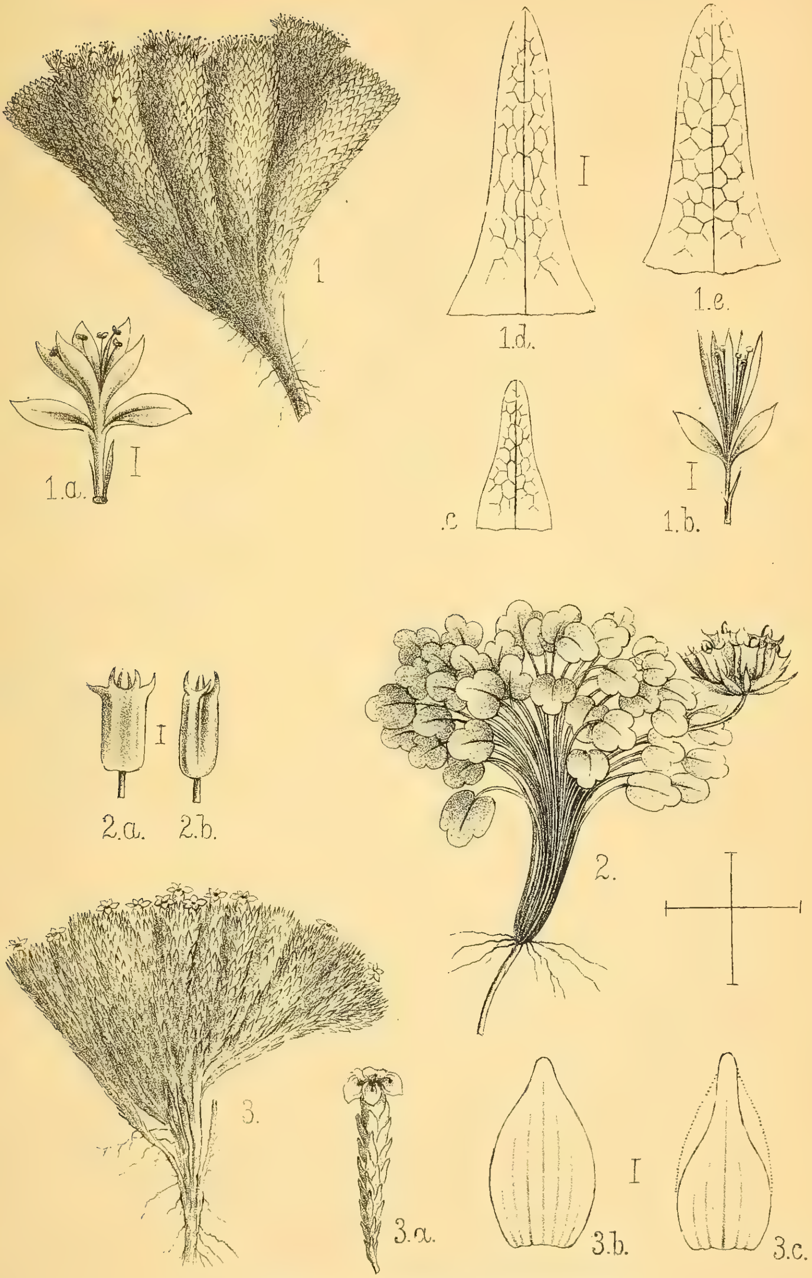
Stem 10–12 inches high, deeply grooved. Leaves all radical, sheathing near the root and forming a circle 6–8 inches diameter, pinnate, 3–5-foliate, leaflets $1\frac{1}{2}$–$2\frac{1}{2}$ inches long, $\frac{1}{5}$–$\frac{1}{6}$ inch broad, rigid, smooth, margins finely serrulate, pungent, striate. Male inflorescence racemose, occupying three-quarters of the stem, and with a 3-foliate stem-leaf at the base. Flowering bracts with large sheaths, 1–3 inches long, 3-foliate, soft, and membraneous, each bract enfolding a small spike of male flowers. Female racemes rigid, occupying less than the half of the stem, bracts $\frac{1}{2}$–1 inch long, 3-foliolate, sheaths very small. Carpels 3–5-winged.

Allied to *Aciphylla colensoi*, and may be considered as its alpine representative. Collected near Hector's Col on the Mount Aspiring range, at 5,000 feet alt. Named in compliment to Dr. Hector, who accomplished the passage in 1862.

Plate XXVII., fig. 1, spike of male plant; 1′, portion enlarged; 2, female plant in seed; 3, seed, front view; 3′, seed, side view.

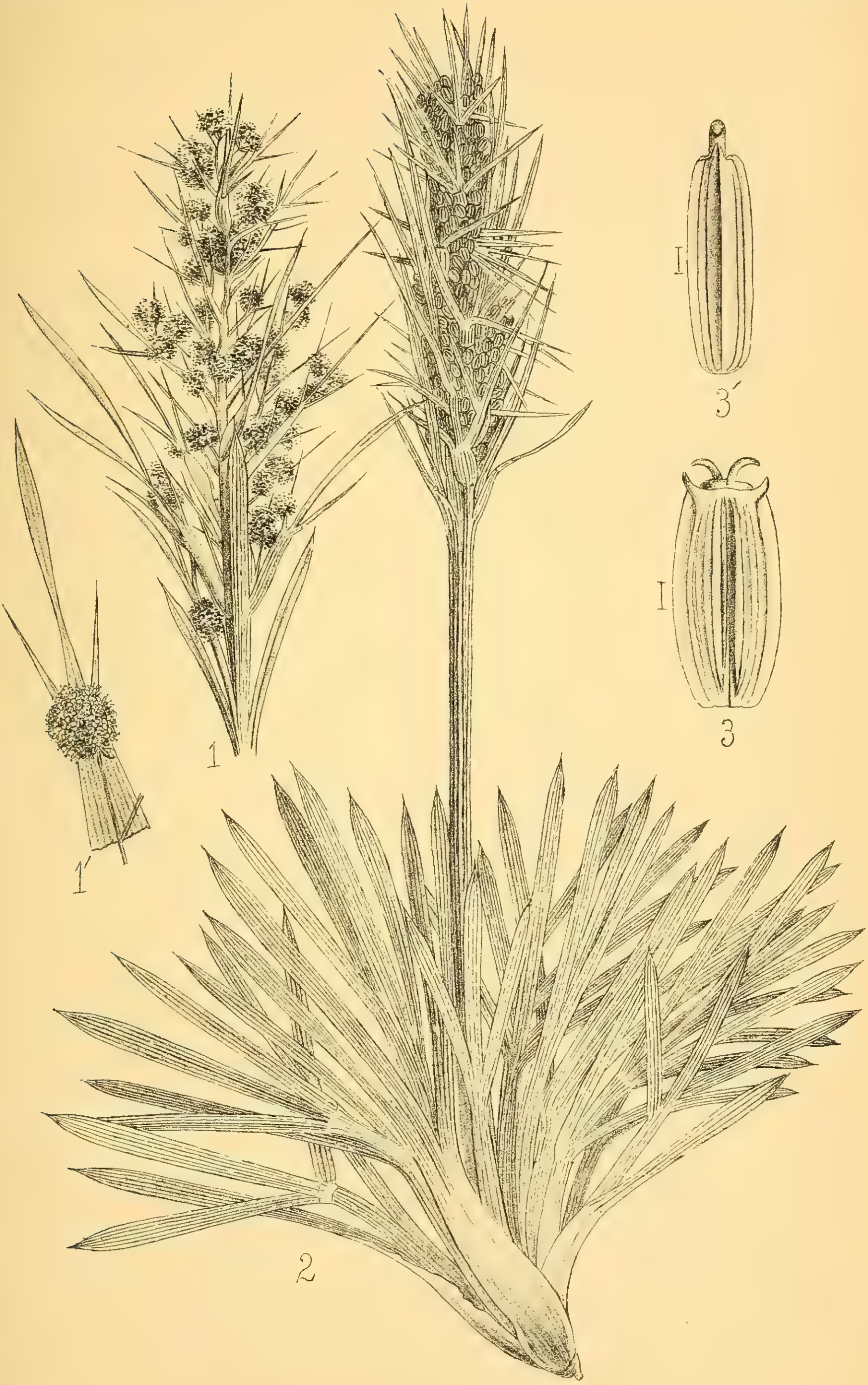
Note on the genus *Aciphylla*.—At the period of Dr. Hector's explorations in the Wanaka District in 1862, the valley of the Matukituki River was, on account of the prevalence of spear-grass (chiefly *Aciphylla colensoi*) impassable except by frequently crossing the river, which latter was often dangerous; at the present date scarcely a plant is to be seen, frequent burnings, and stocking the country with cattle and sheep, having destroyed the plants.

The alpine forms of the genus may still be collected in abundance, those collected at this time were *Aciphylla monroi*, *A. lyallii*, and *A. dobsonii*, the latter a very rare plant, being found only on Station Mountain, Lake Ohou, at an alt. of 6,000 feet where only a few plants were seen.




1. *HECTORELLA CÆSPITOSA*, Hook. f.
2. *POZOA EXIGUA*, Hook. f.
3. *DRACOPHYLLUM MUSCOIDES*, Hook. f.

J.B. del. et lith.




*ACIPHYLLA HECTORI*, Buchanan, n.s.

J.B. del. et lith.

*Lobelia roughii*, Hook. f.

A small glabrous alpine plant, full of white acrid fluid. Leaves ½–1 inch long, petioled, ovate or obovate, acute, deeply toothed or lobed, the sinus often round, more or less reticulated on 5–7 leading nerves, coriaceous. Peduncles erect, axillary, 1–1½ inches long, growing out as the fruit ripens, 1-flowered, calyx tube globose, lobes linear, obtuse, coriaceous. Corolla 5-partite, but by the frequent union of three lobes, 3-partite, lobes long, very narrow, round at top. Anthers glabrous, united round the style and supported by the filaments. Capsule ovoid, ¼–⅓ inch long.

*Hab.*—Lake Ohou Mountains; alt., 5,000 feet on loose shingle.—*Buchanan* and *McKay*, 1882.

Plate XXVIII., fig. 1, plant nat. size; 1 *a*, capsule with adherent anthers; 1 *b*, *b′*, *b″*, lobes of corolla, 1- and 3-partite; 1 *c*, anther.

A remarkable little alpine plant with smooth purplish green foliage, found always on shingle slopes, often getting buried by the sliding *debris*, and generally growing up again through deposits of several feet.

*Logania tetragona*, Hook. fil.

A small coriaceous prostrate plant, branches ascending, 1–3 inches long, ¼ inch diameter. Leaves closely 4-fariously imbricate, erect or spreading, linear obovate, rounded at the tip, entire, concave, ciliate on the margins of the lower half, connate in pairs at base. Flowers solitary, terminal, sepals 5, rugose and pubescent on the lower half, corolla 5-lobed, ⅓ inch diameter, tube short, stamens 2, inserted within the mouth of the corolla, anthers large, 2-cleft half-way up, capsule ovate, 2-valved.

*Hab.*—South Island: Mount Alta, 5,000 feet alt.—*Buchanan* and *McKay*, 1881.

Plate XXVIII, fig. 2, plant, nat. size; 2 *a*, leaf; 2 *b*, flower enlarged; 2 *c*, sepal.

Not uncommon on the mountains, and easily mistaken for a *Veronica*, more especially as all the specimens collected were found to have only 2 stamens.

*Logania armstrongii*, Buch., n.s.

A small rigid, close-branched prostrate plant, branches ascending, ½–1½ inches long, ⅐–⅙ inch diameter. Leaves densely 4-fariously imbricate, ovate, obtuse, entire, concave, ciliate on the margins of the lower half, connate in pairs at the base. Flowers solitary, terminal. Sepals 5, ciliate over the whole margins and back. Corolla 5-lobed, ⅙ inch diameter, tube short. Stamens 2, anthers 2-cleft half-way up, inserted within the mouth of the corolla. Capsule ovate, ciliate on the top, 2-valved.

*Hab.*—South Island: Hector's Col, Mount Aspiring, 5,000 feet alt.—*Buchanan* and *McKay*, 1881.

Plate XXVIII., fig. 3, plant nat. size; 3 *a*, leaf; 3 *b*, corolla; 3 *c*, diagram of corolla; 3 *d*, sepal; 3 *e*, ciliate capsule, etc.

A small inconspicuous alpine plant, closely related to *Logania tetragona*, Hook. fil., but differing much from that plant in the small closely-arranged rigid branches and leaves, the sepals being hispid over the back and margins, and in the ciliated capsule.

Named in compliment to J. B. Armstrong, who has added much to our knowledge of the Alpine Flora of New Zealand.

*Mitrasacme hookeri*, Buch., n.s.

Stems prostrate, much-branched, branches ascending, 1–4 inches high, $\frac{1}{4}$ inch diameter with the leaves on. Leaves coriaceous, closely 4-fariously imbricate, spreading, linear, widening at the base, obtuse, connate in pairs, ciliate along the margins, convex at back. Flowers tetramerous umbelled, umbels consisting of several 4-flowered spikes, each spike having two opposite pairs of bracteate flowers, the whole forming a ball near the ends of the branches. Calyx deeply 4-cleft, lobes glabrous, veined and ciliate on the margins. Corolla with a short tube, lobes orbicular. Stamens 2, inserted within the mouth of the corolla. Anthers oblong, sagittate. Capsule large, ovate or obovate, 2-celled. Seed numerous, ovate.

*Hab.*—South Island: Mount Alta, 5,000 feet alt.

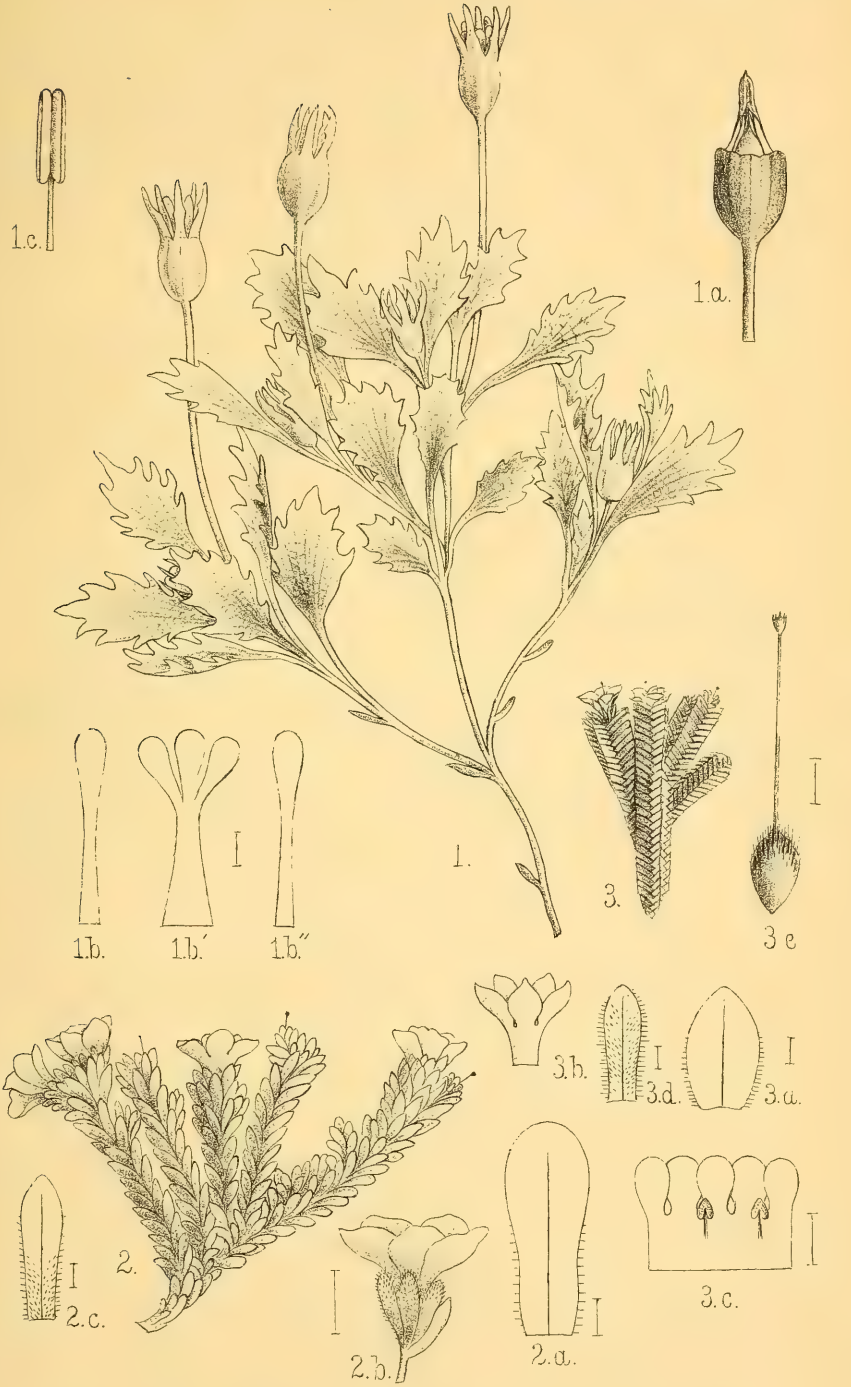
Plate XXIX, fig. 1, plant nat. size; 1 *a*, leaf; 1 *b*, 4-merous flowered spikelet with 2-opposite pairs of leaves; 1 *c*, single flower; 1 *d*, bract, calyx, and capsule of lower pair of flowers; 1 *e*, diagram of corolla; 1 f, capsule and stigma; 1 *g*, sepal; 1 *h*, flower-bract of upper pair of flowers.

This plant bears a general resemblance to Hooker's *Logania ciliolata*. See Supplement to the "Handb. of the N.Z. Flora," but that plant is described as having the flowers solitary in the axils of the upper leaves, whereas in the present plant they are arranged in umbels of bracteate spikelets, agreeing with Bentham's formula distinguishing between *Logania* and *Mitrasacme*.* It has therefore been considered necessary to place the present and following species, *M. cheesemanii*, in that genus.

*Mitrasacme cheesemanii*, Buch., n.s.

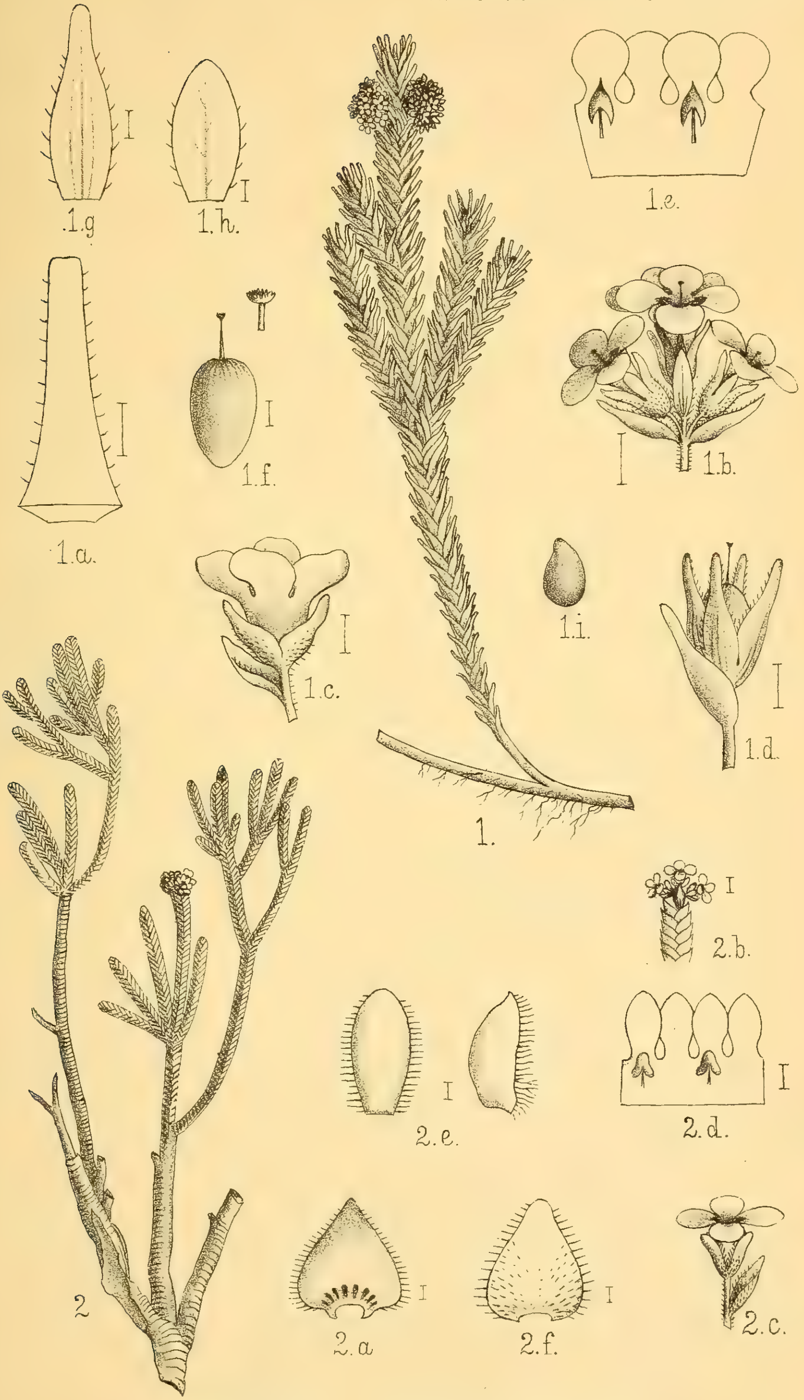
A small, much-branched, rigid, woody shrub, branches ascending, 3–5 inches long, with the leaves on $\frac{1}{16}$ inch diameter. Leaves coriaceous, densely, 4-fariously imbricate, triangular, acute, entire, concave, ciliate on the margins of the lower half, connate in pairs at the base. Flowers tetramerous umbelled, umbels consisting of 4 or more 4-flowered spikelets, each having 2 opposite pairs of bracteate flowers, forming a small ball at the termination of branches. Calyx deeply 4-cleft, lobes linear-obtuse, ciliate on the margins

* "Flora Australiensis," vol. iv., p. 348.




1. *LOBELIA ROUGHII*, Hook.f. 2. *LOGANIA TETRAGONA*, Hook.f.
*LOGANIA ARMSTRONGII*, Buchanan, n. s.

J.B. del. et lith.




1. *MITRASACME HOOKERI*, *Buchanan, n.s.*
2. *MITRASACME CHEESEMANII*, *Buchanan, n.s.*

J.B. del. et lith.

and outer base. Corolla with a short tube, lobes 4, linear, obovate, obtuse. Stamens 2 inserted within the mouth of the corolla. Anthers large on top, and cleft half way up, capsule narrow-oblong, seated in a cup-shaped disc.

*Hab.*—South Island: Mount Alta, 5,000 feet alt.—*Buchanan* and *McKay*, 1881.

Plate XXIX., fig. 2, plant nat. size; 2 *a*, leaf; 2 *b*, 4-flowered spikelet; 2 *c*, flower; 2 *d*, diagram of corolla; 2 *e*, sepals front and side view; 2 *f*, flower bract.

The tetramerous flowers and clustered arrangement of the spikelets place this species also in *Mitrasacme*, and the very small triangular-shaped leaves distinguish it from *M. hookeri*. The peculiar leafless-like branches and inconspicuous flowers of this small alpine cause it to be easily overlooked, but it is none the less interesting to botanists. Named in honour of T. F. Cheeseman, F.L.S., who has added much to our knowledge of the botany of New Zealand.

*Mitrasacme petriei*, Buch., n.s.

Stems prostrate, branched, branches ascending, 2–4 inches long. Leaves $\frac{1}{3}$–$\frac{1}{2}$ inch long, oblong, or linear-oblong, obtuse, membraneous, sparingly cilio-glandular on the margins, 1-nerved, in opposite pairs, and connate at the base without stipules; flowering branches covered on the upper $\frac{2}{3}$ of their length with closely-arranged tetramerous cilio-glandular leaf-like bracts. Flowers numerous, solitary in the axils of the upper bracts. Calyx deeply 4–5-cleft, lobes falcate, varying in size, linear-obtuse, and cilio-glandular on the margins. Corolla with a rather long funnel-shaped tube; lobes 4, unequal, linear-oblong, acuminate, spreading. Stamens 2, filaments short, inserted within the mouth of the corolla, anthers short, cleft half way up and rounded on the points. Capsule ovoid, compressed, seated in a shallow cup. Seeds ovate, few.

*Hab.*—South Island: Mount Bonpland, 6,000 feet alt.—*D. Petrie*, 1881.

Plate XXX., fig. 1, plant nat. size; 1 *a*, 1 *b*, 1 *c*, leaves; 1 *d*, floret; 1 *e*, bract, sepals, and capsule; 1 *f*, diagram of sepals; 1 *g*, position of stamens; 1 *h*, seed.

The tetramerous flowers and absence of leaf stipules in the present plant are sufficient reasons for placing it in *Mitrasacme*, and the large distant leaves present sufficient claim as a new species. This addition to the Loganial alliance in New Zealand also maintains the peculiar feature of possessing only two stamens.

Collected on Mount Bonpland, at 5,000 feet alt., by *D. Petrie*, in compliment to whom it has been named.

*Raoulia rubra*, Buch., n.s.

A small fragrant patch plant, forming dense hemispherical balls or patches on the ground or on rocks, 4–8 inches high, and 6–12 inches across.

Branches short, with the leaves on $\frac{1}{6}$ inch diameter, closely compacted, and terminating on the surface in numerous small firm knobs. Leaves imbricating in many series, $\frac{1}{8}$ inch long, spathulate, rounded at top, membraneous, 1-nerved, with dense patches of pale blueish-green hairs on both surfaces above the middle, and exceeding the tip of the leaf. Heads very small, $\frac{1}{10}$ inch diameter, 10–14-flowered; flowers dark crimson, in two series, inner bisexual, outer pistiliferous only, pistil sometimes 3-cleft, involucral scales numerous, glabrous, narrow-linear and rounded at the entire tip, or linear-spathulate with radiating tips. Pappus of few rigid, broad, or flattish-shaped hairs, thickened towards the tip, and incised along its length.

*Hab.*—Mount Holdsworth, Tararua range, North Island, 4,500 feet alt., 1882.

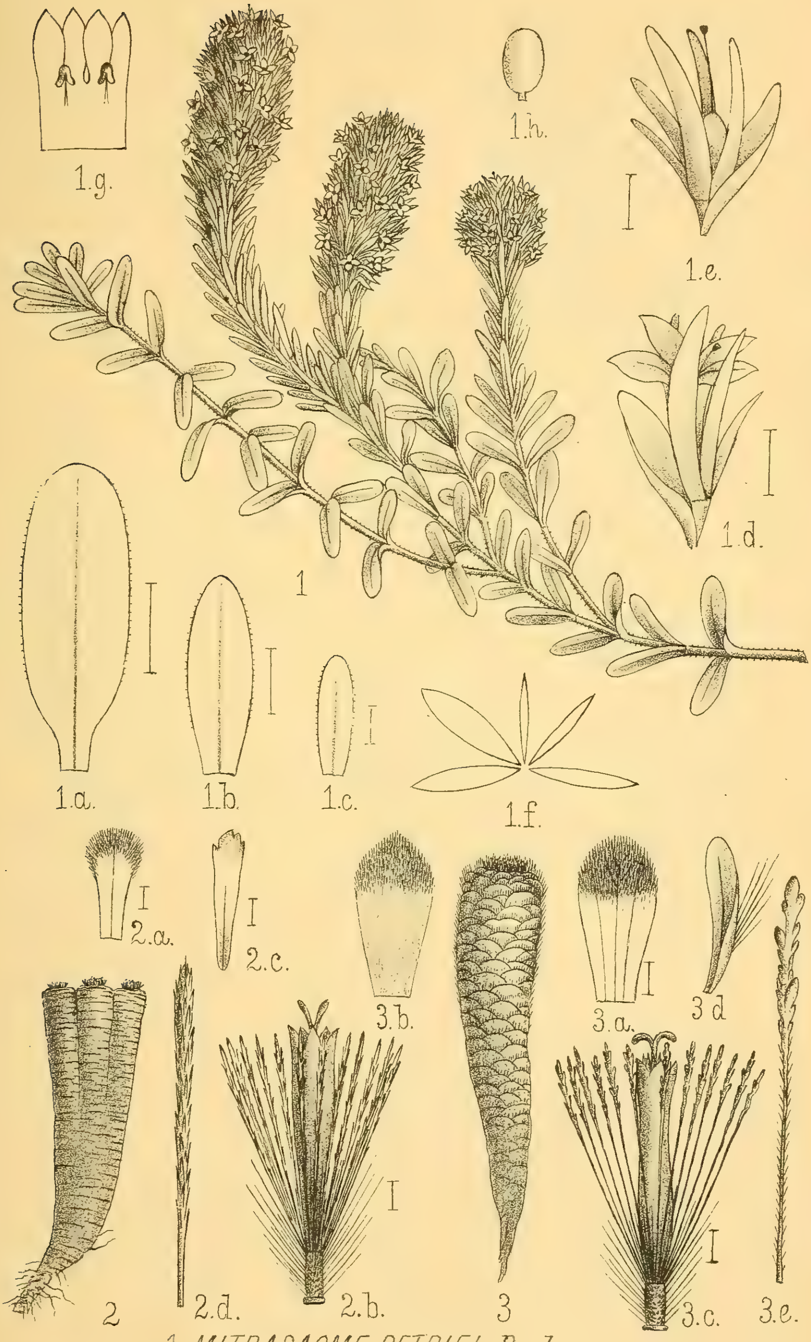
Plate XXX., fig. 2, plant nat. size; 2 *a*, leaf; 2 *b*, floret; 2 *c*, scale; 2 *d*, pappus hair.

This plant is closely allied to *Raoulia eximia*, Hook. fil., from the Canterbury Mountains, and difficult to describe botanically as possessing much difference, yet its smaller size and bright red fragrant flowers present such contrasts as to claim for it a distinguishing name. This is the first occasion on which the vegetable sheep, as this and other species of *Raoulia* and *Haastia* are popularly named, have been collected in the North Island, affording an additional link in connecting the alpine floras of both islands.

*Haastia loganii*, Buch., n.s.

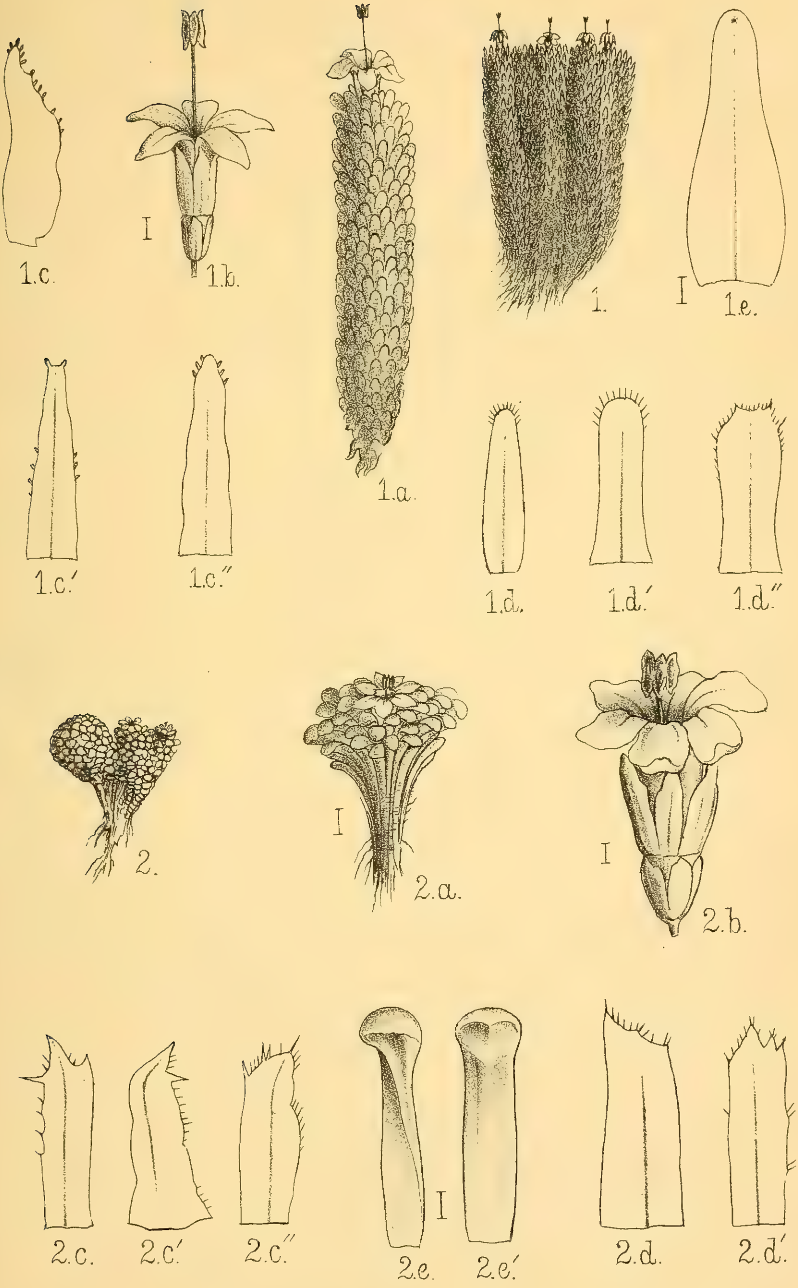
A small soft patch plant, forming little cushions on the ground or rocks, 6–12 inches across, and covered with soft, pale greenish-white wool, branches with the leaves on $\frac{1}{3}$ inch diameter. Leaves $\frac{1}{4}$ inch long, entire, obovate or oblong, rounded at the tip or slightly cuneate, membraneous, 3-nerved, the nerves branching from near the bottom, recurved, arranged in several series, and hidden by the soft woolly hairs, which form a patch on the inner surface above the middle, and entirely covering the back. Heads $\frac{1}{5}$ inch diameter, 40–50-flowered, involucral scales numerous, in several series, narrow-linear, obtuse, entire or with scarious tips, and with a small tuft of hairs on the middle of the back. Florets reddish, of two series, bisexual and pistiliferous, the first numerous, widening at the mouth, arms of style short, anthers without tails, the second with the corolla very short, tubular, mouth crenulate, styles with long exserted arms which are pappillose at the tip; pappus of 1 series of rigid hairs, free below, very much thickened at the tip and often incised. Achene compressed, linear, and covered with long silky hairs.

*Hab.*—Mount Holdsworth, Tararua Range, North Island, 4,500 feet alt., 1882.




1. *MITRASACME PETRIEI*, *Buchanan, n.s.*
2. *RAOULIA RUBRA*, " "
3. *HAASTIA LOGANII*, " "

J.B. del. et lith.




1. *PHYLLACNE HAASTII*, Berggren.
2. *HELOPHYLLUM RUBRUM*, Hook. f.

J.B. del. et lith.

Plate XXX., fig. 3, plant nat. size; 3 *a*, 3 *b*, leaves, back and front views; 3 *c*, floret; 3 *d*, scale; 3 *e*, pappus hair, much enlarged.

A very distinct little species, much smaller than *Haastia pulvinaris*, covered with soft, white, cottony wool, and with long silky hairs on the achene.

Named in honour of H. F. Logan, whose zeal in botanical science has added much to our knowledge of the flora of the North Island.

*Phyllacne haastii*, Berggen.

*Helophyllum colensoi*, Hook. fil. Handb. N.Z. Flora, vol. i., p. 168.

Stems 1–1¼ inch long, with the leaves on ⅕ inch diameter. Leaves obtuse, broad at the base. Flowers with the staminal column much exserted.

*Hab.*—North Island: Tararua Mountains, 4,500 feet alt.; South Island: Mount Alta, 5,000 feet alt.—*Buchanan* and *McKay*, 1881.

Plate XXXI., fig. 1, plant nat. size; 1 *a*, branch, enlarged; 1 *b*, flower, much enlarged; 1 *c*, 1 *c*′, 1 *c*″, flower bracts; 1 *d*, 1 *d*′, 1 *d*″, sepals; 1 *e*, leaf, enlarged.

*Helophyllum rubrum*, Hook. fil.

Handb. N.Z. Flora, vol. i., p. 168.

Stems much shorter than the last. Leaves narrow, coriaceous, with thick knobs. Flowers white, becoming bright red when dry. Corolla 5–7-cleft, column included, or slightly exserted.

*Hab.*—South Island: Mount Aspiring range, 5,000 feet alt.—*Buchanan* and *McKay*, 1881.

Plate XXXI., fig. 2, plant nat. size; 2 *a*, plant enlarged; 2 *b*, flower much larger; 2 *c*, 2 *c*′, 2 *c*″, flower bracts; 2 *d*, 2 *d*′, sepals; 2 *e*, 2 *e*′, leaves.

The present two plants are but little known, and may be considered rare, no doubt they are often overlooked when not in flower by the few who venture into their habitats plant-collecting. *H. rubrum*, Hook. fil., has not been seen till the present time, so far as known, since its first discovery on Dr. Hector's expedition to the West Coast of Otago in 1860. The peculiarity in this species is its white flowers becoming bright red when dry, hence its name.

*Veronica müelleri*, Buch., n.s.

A low flexuose, straggling, prostrate, glabrous or puberulent plant, 6–18 inches long, rooting along its numerous branches. Leaves shortly petioled, ⅕–⅓ inch long, ovate, ovate-oblong or linear-oblong, entire, or with 1–2 notches on each side. Flowers 1–2, terminal on the branches, and sitting among the leaves. Pedicels $\frac{1}{10}$–⅙ inch long. Sepals ⅙ inch long, very obtuse. Corolla ⅓ inch diameter, dark pink, tube long, stamens large. Capsule didymous, shorter than the sepals.

*Hab.*—South Island: Hector's Col, Mount Aspiring Range. Alt. 5,000 feet—*Buchanan* and *McKay*, 1881. On open ridgey patches where the snows melt in summer. Allied to *V. bidwillii* in size and form of leaves, but entirely different in their fascicular arrangement, and the absence of flowering racemes.

Named in compliment to the distinguished botanist Baron von Müeller.

Plate XXXII., fig. 1, plant nat. size; 2, flower; 3, capsule; 4, capsule, with pistil; 5, different forms of leaf.

*Notes on the genus Veronica.*—This beautiful family of plants has suffered much by the settlement of the Lake districts, few being now seen on the river flats where they were once abundant. A few collected previously in 1862 were not seen at this time, although it is probable they may still be found in the more inaccessible parts of the mountains. The large ornamental shrub, *Veronica cupressoides*, once abundant, and often cultivated in gardens, is now rare. The alpine forms are apparently safe, being chiefly found on barren ground with a sparse vegetation where fires do not run. The highest altitude to which any of this genus reaches was on Mount Alta, where *Veronica buchanani* was collected at 7,500 feet. The following is a list of those collected at this time:—*Veronica haastii*, *V. buxifolia*, *V. pimeleoides*, *V. buchanani*, *V. canescens*, *V. linifolia*, *V. salicifolia*, *V. ligustrifolia*, *V. macrantha*, *V. bidwillii*, *V. raoulii*, *V. tetragona*, *V. hectori*, *V. colensoi*, *V. lævis*.

*Pygmea ciliolata*, Hook. fil.

A hoary moss-like plant, 1 inch high, forming compacted patches on the ground. Branches with the leaves on $\frac{1}{5}$ inch diameter. Leaves densely imbricate, $\frac{1}{8}$ inch long, obovate and rounded at top, entire, ciliate on the margins and nearly glabrous on both surfaces, 1-veined. Flowers $\frac{1}{10}$–$\frac{1}{8}$ inch long, terminal on the branches. Sepals shorter than the corolla tube.

*Hab.*—Mount Alta, 6,000 feet alt.—*Buchanan* and *McKay*, 1881.

Plate XXXII., fig. 1, plant nat. size; 1 *a*, flower, enlarged $\frac{4}{1}$; 1 *b*, leaf enlarged $\frac{6}{1}$.

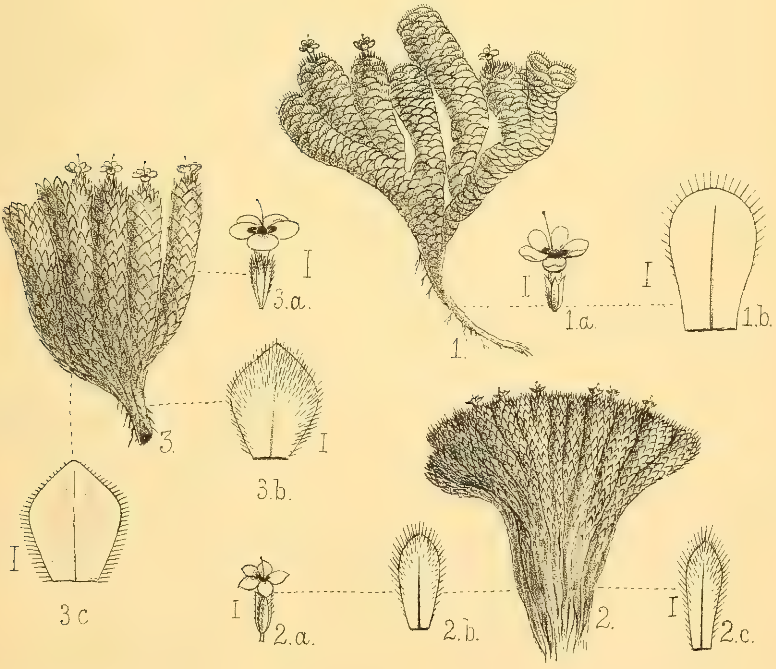
*Pygmea pulvinaris*, Hook. fil.

A white very hoary moss-like plant, 1 inch high, forming compacted patches on the ground. Branches with the leaves on $\frac{1}{8}$ inch diameter. Leaves densely imbricate $\frac{1}{10}$ inch long, narrow linear oblong, obtuse, upper half covered on both surfaces with white hairs, 1-veined. Flowers shortly peduncled, sepals linear, obtuse, nearly as long as the corolla tube.

*Hab.*—Mount Alta, 6,000 feet alt.—*Buchanan* and *McKay*, 1881.

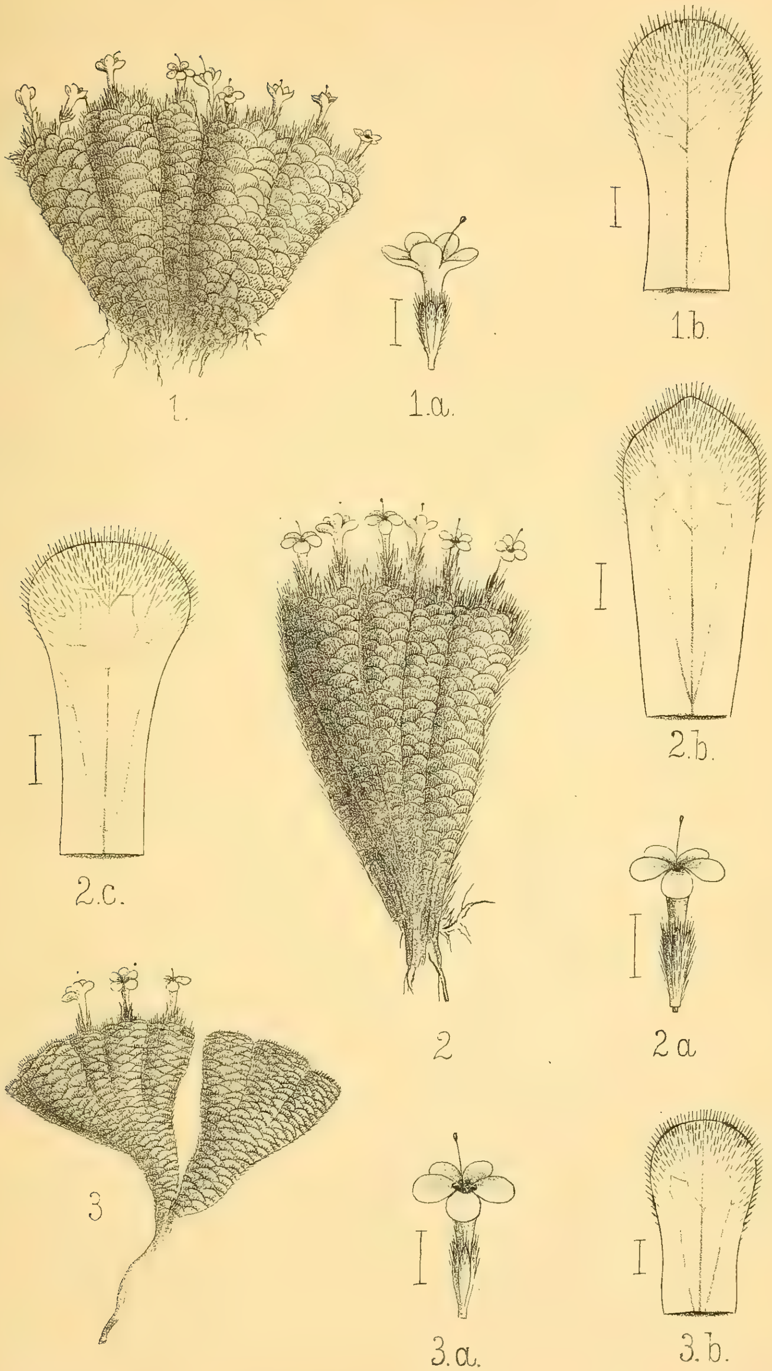
Plate XXXII., fig. 2, plant nat. size; 2 *a*, flower enlarged $\frac{4}{1}$; 2 *b*, *c*, leaves enlarged $\frac{5}{1}$.


VERONICA MUELLERI, *Buchanan, n. sp.*




1. PYGMEA CILIOLATA, *Hook. fil.* 2. PYGMEA PULVINARIS, *Hook. fil.*
3. PYGMEA THOMSONI, *Buchanan, n. sp.*

J.B. del. et lith.




1. *MYOSOTIS UNIFLORA*, Hook. fil. 2. *MYOSOTIS PULVINARIS*, Hook. fil.
3. *MYOSOTIS HECTORI*, Hook. fil.

J.B. del. et lith.

*Pygmea thomsoni*, Buch., n.s.

A small scarcely hoary moss-like plant, 1 inch high, forming compacted patches on the ground. Branches with the leaves on $\frac{1}{6}$ inch diameter. Leaves coriaceous, densely imbricate, $\frac{1}{8}$ inch long, quadrately obovate, obtuse, entire, ciliate on the margins, and on the upper part of the outer surface, 1-veined. Flowers $\frac{1}{8}$ inch long, terminal on the branches, sepals linear, obtuse, shorter than the corolla tube.

*Hab.*—Mount Alta, 6,000 feet alt.—*Buchanan* and *McKay*, 1881.

Plate XXXII., fig. 3, plant nat. size; 3 *a*, flower enlarged $\frac{1}{4}$; 3 *b*, *c*, leaves enlarged $\frac{5}{1}$.

The three species here figured comprise all at present known of the Genus *Pygmea*. From their extremely small size and hoary appearance they may easily escape observation, and except when in flower they are difficult to distinguish from hoary mosses such as species of *Grimmia* and *Racomitrium*. They may be recommended as well adapted for garden rockeries, living specimens being easily transported for long distances.

*Myosotis uniflora*, Hook. fil.

Handb. N.Z. Flora, vol. i., p. 192.

A densely tufted perennial, forming rounded cushions, whole plant very hoary with white harsh hairs. Flowers buff or pale yellow, terminal, solitary.

Plate XXXIII., fig. 1, plant nat. size; 1 *a*, flower enlarged; 1 *b*, leaf enlarged.

*Hab.*—South Island: Mount Alta, 5,000 feet alt.—*Hector* and *Buchanan*, 1862; *Buchanan* and *McKay*, 1881.

*Myosotis pulvinaris*, Hook. fil.

Handb. N.Z. Flora, vol. i., p. 193.

A densely tufted perennial, forming rounded cushions, hoary, softer to the touch than the last species. Flowers white, terminal, solitary.

Plate XXXIII., fig. 2, plant nat. size; 2 *a*, flower enlarged; 2 *b*, 2 *c*, leaf forms enlarged.

*Hab.*—South Island: Mount Alta, 5,000 feet alt.—*Hector* and *Buchanan*, 1862; *Buchanan* and *McKay*, 1881.

*Myosotis hectori*, Hook. fil.

Handb. N.Z. Flora, vol. i., p. 193.

A densely tufted perennial, forming close rounded cushions. Leaves with a firmer and closer growth than the previous two species. Wool shorter and less soft. Flowers shortly peduncled, white, terminal, solitary.

Plate XXXIII., fig. 3, plant nat. size; 3 *a*, flower enlarged; 3 *b*, leaf enlarged.

*Hab.*—South Island: Mount Alta, 5,000 feet alt.—*Hector* and *Buchanan*, 1862; *Buchanan* and *McKay*, 1881.

The present three species of *Myosotis* occupy a prominent place in the alpine flora of New Zealand as showy plants; the soft rounded cushions when nearly covered with small white flowers would no doubt be much admired in the garden, but it is doubtful if they would retain that beauty as found on the mountain if translated to lower levels.

*Abrotanella inconspicua*, Hook. fil.

Handb. N.Z. Flora, vol. i., p. 140.

A minute glabrous prostrate dark green moss-like plant, $\frac{1}{2}$ inch high, branches rooting on the lower side. Leaves $\frac{1}{4}$–$\frac{1}{3}$ inch long, $\frac{1}{20}$ inch broad, linear, obtuse or acuminate, entire, closely sheathing at the base, 3-veined, ciliate on the margins at base, and forming fascicles at the ends of the ascending branches. Heads $\frac{1}{8}$–$\frac{1}{6}$ inch diameter, spherical, terminal, and nearly hidden amongst the upper leaves, involucral scales in several series, similar to the leaves, but shorter, and without cilia at base, receptacle rounded, florets 12–20 outer, females much smaller than the central males. Achene flat, narrowly winged. A most inconspicuous plant and easily overlooked.

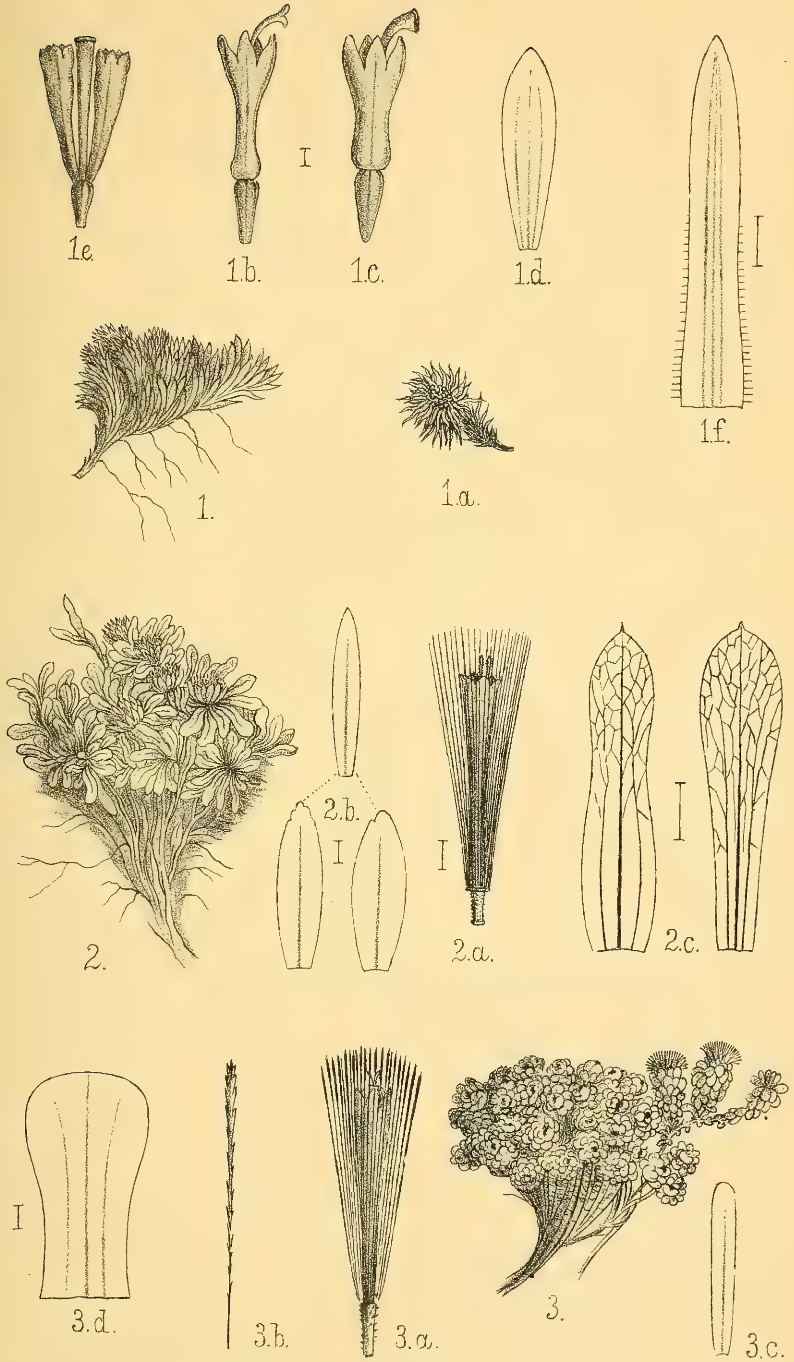
*Hab.*—South Island: Mount Alta, 6,000 feet alt. *Hector* and *Buchanan*, 1862; Black Peak, 6,000 feet alt., *McKay*, 1881.

Plate XXXIV., fig. 1, plant nat. size; 1 *a*, single head of flowers; 1 *b*, male floret; 1 *c*, female floret; 1 *d*, abnormal florets; 1 *e*, scale; 1 *f*, leaf.

*Raoulia m'kayi*, Buch., n.s.

A slender open-foliaged plant. Stems 2–3 inches long, prostrate. Branches $\frac{1}{2}$–1 inch long, erect or depressed. Leaves membraneous, spreading, $\frac{1}{2}$–$\frac{3}{4}$ inch long, narrow, linear-oblong, round on the tip, apiculate, covered on the upper third on both sides with white, loose, silky wool, veins reticulate. Heads small, $\frac{1}{8}$ inch across, involucral scales $\frac{1}{4}$ inch long, in 3 series of 8-9 each series, linear, or narrow-oblong, acuminate or obtuse, scarcely radiating at tip, inner series very narrow, the whole shining, pale-yellow, florets numerous, 50–60, receptacle flat, pappus hairs few, slender, pilose, not thickened at the tips. Achene glabrous, with a thickened areole at the base.

The silvery open foliage and scattered golden-coloured flowers of this small swamp-plant, as it is usually found on dark peaty bottoms, is very attractive. It is evidently in its general features, and in the pappus hairs not being swollen at the tips, allied to *Raoulia tenuicaulis*, Hook. fil., but the large reticulate leaves and numerous florets determine its claim as a new species of *Raoulia*, if the large foliage does not ally it more closely to *Gnaphalium*.




1. *ABROTANELLA INCONSPICUA*, Hook. f. 2. *RAOULIA MACKAYI*, Buchanan, n.s.
3. *RAOULIA PARKII*, Buchanan, n.s.

J.B. del. et lith.

Named in compliment to Mr. *A. McKay*, of the Geological Survey, as a successful collector, who discovered the present species on Black Peak Range, South Island, at 5,000 feet alt.

*Hab.*—In swampy places.

Plate XXXIV., fig. 2, plant nat. size; 2 *a*, floret; 2 *b*, scales; 2 *c*, leaves.

*Roulia parkii*, Buch., n.s.

A small densely tufted plant. Stems prostrate, ascending. Branches numerous, erect, with the leaves on $\frac{1}{6}$ inch diameter. Leaves closely imbricating, erecto-patent, $\frac{1}{8}$ inch long, spathulate and covered on both surfaces with closely appressed, pale greenish-yellow, or white, tomentum. Heads $\frac{1}{4}$ inch across, 14–16-flowered, scales in 2 series, inner, narrow, linear, obtuse, entire, or finely crenate at tip; outer, shorter and broader, finely crenate on the obtuse tip, receptacle concave or flat, naked; pappus hairs swollen at the tip and incised. Achene glandular.

This beautiful little alpine was collected on Mount Alta range, South Island, by Mr. *McKay*, at an alt. of 5,000 feet.

*Hab.*—Dry places. It is also found in the North Island.

Named in compliment to Mr. J. Park, assistant, Geological Survey.

Plate XXXIV., fig. 3, plant nat. size; 3 *a*, floret; 3 *b*, pappus hair; 3 *c*, scale; 3 *d*, leaf.

*Notes on the genus Raoulia.*—The genus *Raoulia* may be considered as one of the best represented in New Zealand, both as regards number of species, and abundance of plants. Not only do they enjoy an almost entire immunity from fire, but they increase and spread on the ashes of other plants, they flourish on the most barren ground, and cover poverty of soil and gravels with much floral beauty; on river flats and mountain sides they are equally abundant, proving useful as sand-binders, or in fixing springy hill slopes. They may be considered worthless as food, and, in fact, were they otherwise, it would be almost impossible for stock to break in on the hard, close, compacted masses of such species as *Raoulia eximia*, or *R. mammillaris*, the vegetable sheep of the shepherds. The species of this genus collected were *Raoulia australis*, *R. tenuicaulis*, *R. hectori*, *R. m'kayi*, *R. parkii*, *R. subserica*, *R. glabra*, *R. mammillaris*.

*Celmisia dallii*, Buch., n.s.

Leaves radical, rosulate, 6–8 inches long, $1\frac{1}{2}$–2 inches broad, sessile, coriaceous, linear-oblong, acute, serrate and apiculate on the serratures, closely covered on back with shining pale buff tomentum. Scape 8–10 inches long, glabrous, bracts few, alternate, large, leafy, coriaceous, $1\frac{1}{2}$–$2\frac{1}{2}$ inches long, $\frac{1}{4}$–$\frac{1}{2}$ inch broad with pale buff tomentum on back, same as leaves. Head $1\frac{1}{2}$ inches diameter, involucre of 2 forms. Outer, large, leaf-like, $\frac{1}{4}$–1 inch long $\frac{1}{8}$–$\frac{1}{4}$ broad, covered on the back with shining pale buff tomentum.

Inner, in several series $\frac{1}{2}$ inch long, $\frac{1}{16}$ inch broad, membraneous and glabrous, inner series ciliate on upper half and margins, the whole more or less viscid, rays in 1 series numerous, $\frac{1}{2}$ inch long, narrow, pappus $\frac{1}{5}$ inch long, scabrid. Achene linear, hispid.

*Hab.*—South Island: Nelson; on the Golden Downs near the head of the Aorere River—*J. Dall*; in compliment to whom as an explorer and collector it has been named.

Plate XXXV., fig. 1, plant $\frac{2}{3}$ nat. size; 2, back view of flower head, showing outer form of flower-bracts; 3, inner form of flower-bracts; 4, fertile floret; 5, rayed floret; 6, pappus hair; 7, stamens.

This singular plant approaches the genus *Senecio* closer than any *Celmisia* hitherto found in New Zealand, especially in the presence of large coriaceous leaf-like bracts on the scape. Its habit of growth, however, especially in the large radical and rosulate leaves, relate it more to *Celmisia.* It may be necessary if other species with this remarkable double form of flower-bracts be discovered that a new genus be constructed for their reception.

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## Art. XLVIII.—*On some Plants new to New Zealand, and Description of a new Species.* By John Buchanan, of the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 21st February,* 1882.]

### *Pteris longifolia*, Linn.

Specimens of this fern have lately been forwarded to the Museum by Mr. Lascelles, of Napier. They were collected by him in the Tarawera country under circumstances which preclude the possibility of its having been introduced.

This is a fern widely distributed over the globe, having been collected in many countries, and named by each collector with a different name. Hooker gives for it in his "Species Filicum" eighteen synonyms of different authors.

It may be mentioned that the New Zealand plant has the pinnæ serrated, which may claim for it the position of a variety.

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### *On a Genus of* Orchidaceæ *new to New Zealand.*

The following short description of a new Orchid, which proves to belong to an Australian genus not previously represented in New Zealand, is taken from Bentham's "Flora Australiensis," vol. vi., p. 324. The plant was collected by W. T. L. Travers, Esq., near the Mungaroa Swamp, and was sent by him to the Museum for examination.


CELMISIA DALLII, Buchanan, n. s.

J.B. del. et lith.

*Epiblema grandiflorum*, R. Br.

Stem erect, 1–15 inches high, with one long narrow leaf and two short sheathing leaves. Flowers 3–4, pedicillate in a short raceme, dark purple, bracts shorter than the ovary. Sepals and petals alike, $\frac{1}{2}$ inch long, narrow-linear, acute, finely veined. Labellum as long as the sepals. Anther erect, or slightly bent forward, the cells distinct, with a short recurved point.

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*Brachyglottis rangiora*, Buch., n.s.

A small branching tree, 8–12 feet high; branches, petioles, leaves below, and inflorescence, covered closely with white or pale buff tomentum. Leaves large, 6–8 inches long, ovate or oblong, irregularly sinuato-dentate along the margin, often tapering to an acute point, coriaceous, or stoutly membranous, young leaves generally lobulate and dentate, covered on both sides with soft pale buff tomentum. Panicles as large as the leaves, spreading, drooping, or erect, covered with appressed tomentum. Heads numerous, sessile, $\frac{1}{7}$ inch long, involucral scales 7, in one series, linear, obovate, obtuse or acuminate, or pilose on top. Florets 9, of which 5 are fertile.

This is a very distinct plant from Forster's *Brachyglottis repanda*, differing in its smaller size, coriaceous leaves, which have generally deeper sinuations and more acute angles; the flower-heads are also constantly sessile. Its geographical distribution is also distinct, being apparently limited to the lands of both islands abutting on Cook Strait. The Maoris also distinguish the two plants by different names, the present plant being known as Rangiora, while the northern plant described by Forster, is called Wharangi-ta-whita. Both plants are poisonous to horses.

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## ART. XLIX.—*On new Species of New Zealand* Diatoms. By JOHN INGLIS.

Plate XXII.

*Description of a new Species of* Nitzchia.

[*Read before the Philosophical Institute of Canterbury*, 1*st July*, 1880.]

*Nitzchia nova-zealandia*, sp. nov.

Frustule: front view linear, narrowing at the truncated extremities, opposite side of each end obliquely sloping. Valve: linear on side view and sigmoid, attenuated towards the extremities, and rounded at the ends; one row of puncta round the margin of the valve. Puncta: there are twenty-four puncta or beads to ·001 of an inch.

I have been unable to make out any striæ or keel under Beck's $\frac{1}{10}$th immersion. The valves of *Nitzchia nova-zealandia* resemble *Homœocladia sigmoidea*, but the latter is frondose and the frustules are sigmoidal on the front view, while the former is free and sigmoidal on the side view.

I found this Diatom in quantities during the months of April and May, in a spring at Ngapari on the side of North Moeraki Downs, facing the river Ashley.

I am indebted to Professor Hutton for the verification of this description.

Plate XXII., fig. 1: *a*, front view; *b*, suture; *c*, side view.

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## *On the Identity of* Amphicampa *with* Himantidium, *and Description of a new Species.*

[*Read before the Philosophical Institute of Canterbury, 4th August,* 1881.]

About four years ago I found, quite accidentally, in a drain in the Cust Valley swamp a small pocket of diatomaceous earth, which on examination much resembled *Amphicampa mirabilis*, Ehr., described in the Micrographical Dictionary as a doubtful genus of fossil *Diatomaceæ*. The other species named is *A. eruca*, and both are represented as found fossil at Tizar, Mexico.

Professor Hutton found fossil valves in Waikato and elsewhere, and Mr. George Gray recognized them in gatherings taken from the River Avon.

In the month of May last I gathered a considerable quantity of a filamentous Diatom from a spring at Ngapari, Fernside, which, after treating in various ways, I resolved into the hitherto so-called genus *Amphicampa* (both sides sinuated). That genus, however, appears to have been considered "free," while in the form which I gathered it is filamentous, and cannot be separated generically from *Himantidium*. The present species is, however, certainly not *A. eruca*; and as *A. mirabilis* is figured with $\frac{7}{6}$ bends, while my species varies from $\frac{4}{3}$ to $\frac{6}{5}$, I assume it to be a new species.

*Himantidium maskellii*, sp. nov.

Frustule: front view rectangular; length about four times the breadth, straight, forming a lengthened tenacious filament, showing lines of dots at the points of suture corresponding to the striæ on the side view. Valve: elongated, slightly arcuated, and attenuated towards the extremities, which are boldly rounded; both edges are sinuated; length about seven times the breadth. The convex edge has invariably one more bend than the concave. The valves vary in the number of the bends from $\frac{4}{3}$ to $\frac{6}{5}$. Striæ: parallel and transverse, and there are 23 to 27 to the ·001 of an inch.

*Hab.*—Ngapari, Fernside, and River Avon, North Canterbury; Waikato and Cabbage Tree Swamp, Auckland (fossil)—*Hutton;* Cust Valley Swamp, North Canterbury (fossil).

Plate XXII., fig. 2: *a*, front view filamentous; *c*, side view.

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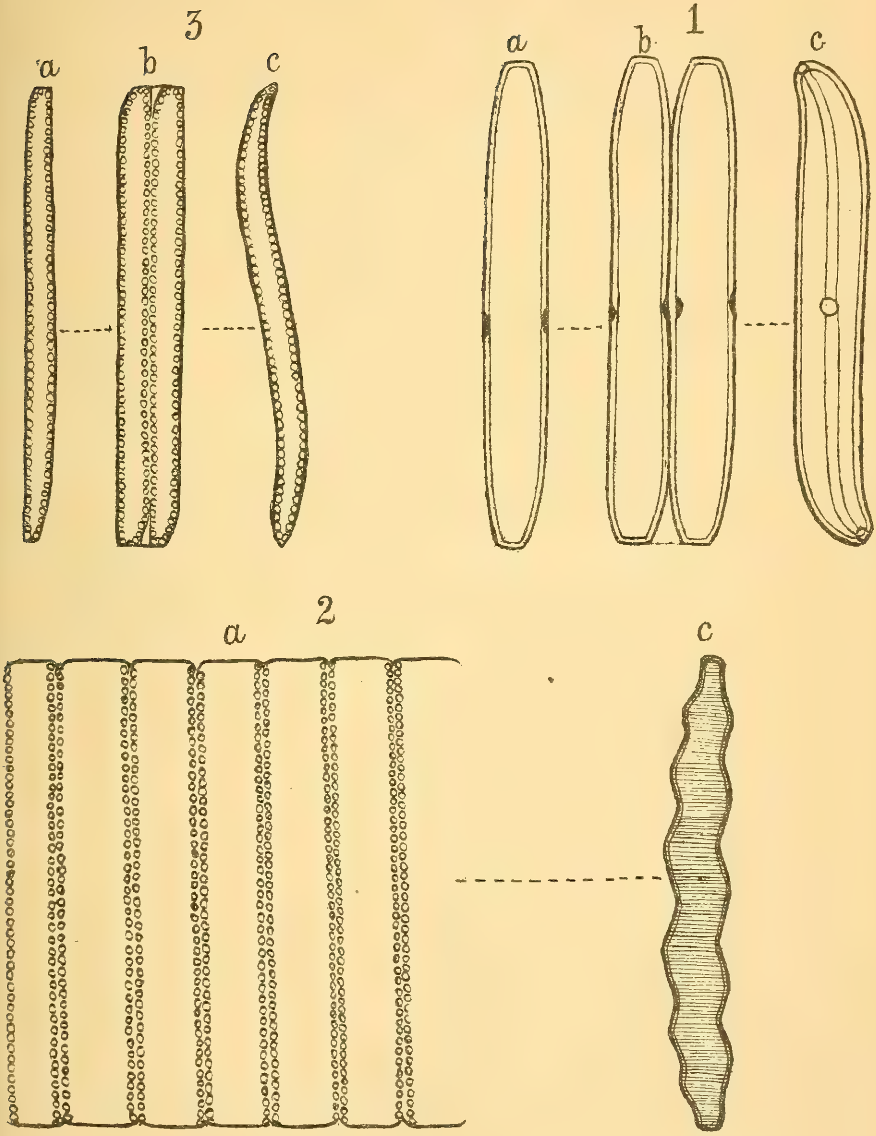


NEW ZEALAND DIATOMACEÆ.

G.I. del.

## *On a new Species of* Pleurosigma.

[*Read before the Philosophical Institute of Canterbury*, 13*th October*, 1881.]

*Pleurosigma crookii*, sp. nov.

Frustule: front view linear, narrowing towards the truncated extremities; length about eight times its breadth. Valve: side view, linear for the greater part of its length and slightly sigmoidal towards the rounded extremities, making the flexum only terminal; length, ·0025 to ·0040 inch. Colour light brown. Striæ obscure. Median line central, approaching concave side near extremity.

*Hab.*—Fresh-water, New Brighton.

The genus *Pleurosigma* has not been found hitherto in New Zealand. I believe I saw it a few months ago in a very small gathering which I obtained from Ngapari, Fernside, but as the frustules were so few in number I could not examine them satisfactorily. The present species occurs in considerable numbers in the ditches which drain New Brighton swamp. Whenever the median line is not absolutely central, it approaches (in the species figured by Smith) the extremities, more or less nearly on the convex side. In the present species the line draws slightly nearer to the concave side; and the frustule is smaller than any described in Mr. Smith's work. I have therefore ventured to consider it a new species.

It would probably be a good test object.

Plate XXII., fig. 3: *a*, front view; *b*, suture; *c*, side view.

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## Art. L.—*Description of new Plants.* By J. B. Armstrong.

[*Read before the Philosophical Institute of Canterbury*, 3*rd March*, 1881.]

*Asperula fragrantissima*, n. sp.

The Strong-scented Woodroof.

*Diff. char.*—Perennial, matted. Flowers in clusters, pedunculate.

*Description.*—A small creeping perennial bright-green herb (black when dry) forming dense broad patches 1–3 feet across, scarcely raised above the surface of the ground. *Stems* wiry slender reddish 6–15 inches long, branching freely and sending down wiry roots. *Branches* slender, round, glabrous or glandular pubescent. *Leaves* sessile, entire, in whorls of 4 (2 opposite leaves and 2 leaf-like stipules) $\frac{1}{12}$–$\frac{1}{8}$ inch long or more, linear-oblong, obtuse, rarely sub-acute, not awned, glandular, dotted and slightly pubescent on both surfaces, rather succulent in texture, flaccid when dry. *Flowers* very numerous, creamy white tinged with rose-in-bud, very fragrant, in axillary clusters of 3–8, rarely only 1, on branched peduncles, which are $\frac{1}{10}$–$\frac{1}{8}$ inch long or more, glandular-pubescent and rather stout for the size of the plant. *Calyx* reduced to an extremely short tube and adnate with the ovary. *Corolla* $\frac{1}{10}$–$\frac{1}{8}$ inch across, campanulate, split to below the middle into 4, rarely 5, sometimes only 3, rather broad obtuse lobes, which are covered more or less on both surfaces with glistening frost-like particles. *Stamens* seated on the corolla, always the same in number as the lobes and alternate with them. *Styles* 2, shorter than the stamens, united almost throughout their whole length, with the tips divergent and surmounted by unequal sized pinhead-shaped stigmas. *Ovary* inferior, distinctly 2-celled glandular. Fruit not seen. Other characters as in genus.

*Hab.*—On dry banks at Fairlie Creek, County of Geraldine; 15 Dec., 1880.—*Mr. J. F. Armstrong.* Also in Selwyn County about 1868, by the same collector.

The discovery of a second species of woodroof in New Zealand is highly interesting. The present seems sufficiently distinct from *A. perpusilla*, Hk. fil. in the perennial habit, absence of awns on the leaves, the larger size and peduncled clustered flowers; the latter character, however, is liable to vary. The plant is evidently very local, and should be sought for in sub-alpine and upland localities. Like so many other species of the genus it is very difficult to determine when dried, and the above description has been drawn up from living plants. It is, to my mind, somewhat curious that this plant should possess, in common with the British *A. odorata* and other species from distant countries, such apparently unimportant characters as the frost-like particles on the corolla and the unevenness in the size of the stigmas. The flowers are exceedingly sweet-scented when fresh, and while drying the leaves emit a smell of newly mown hay, but in a less degree than the common British species. The plant is extremely pretty on account of the immense number of flowers it produces, and might prove a useful plant for rock-work if it should prove amenable to cultivation.

*Viola hydrocotyloides*, n. sp.

The Water-penny Violet.

*Diff. char.*—Stems creeping, hairy, perennial. Leaves reniform, hairy. Flowers solitary, axillary.

*Description.*—A small creeping perennial herb, with glandular hairy branches rooting at the joints, and spotted with purple. *Leaves* alternate, stipulate, coriaceous, petiolate, reniform, $\frac{1}{8}$–$\frac{1}{4}$ inch diameter, glandular and hairy, especially on the margins, which are coarsely obtusely crenate; *petioles* about half an inch long, rather stout for the size of the plant, slightly channelled, glandular, and hairy; *veins* netted, conspicuous; *stipules* deeply lacerated, large for the size of the plant. *Flowers* irregular, solitary, axillary, about $\frac{1}{8}$ of an inch long; *peduncles* about $\frac{1}{4}$–$\frac{1}{2}$ inch long, glandular, curved, spotted with purple, rather stout, with two opposite small linear sessile entire or serrate subacute bracts. *Sepals* 5, subacute, produced at the base and continued downwards as in most other species of the genus, glandular-pubescent. *Petals* 5, the two upper smallest, the three lower much larger, the central lower one gibbous or slightly spurred at the base, the tip incurved and held in by the two side ones; all pure white; *stamens* 5, hypogynous; *filaments* very broad, short, and membraneous; *connective* membraneous, broad, and continued above the anthers into a broad, slightly-hooded or flat appendage. *Anthers* apparently not spurred. *Style* declinate, very short and stout. *Stigma* oblique, slightly pitted. *Ovary* either glabrous or pubescent. *Capsule* $\frac{1}{4}$–$\frac{1}{3}$ inch long, 1-celled, either glabrous or pubescent, 3-valved, surmounted by the remains of the style. *Seeds* numerous, on parietal placentas. Other characters as in the genus.

*Hab.*—Stewart Island—*Rev. Mr. Stack*, 1879. Apparently an inhabitant of bogs on the outskirts of woods.

Flowers from November to March.

This curious and remarkable little plant was picked out of a tuft of a *Cyathodes*, brought from Stewart Island by Mr. Stack and presented by him to the Christchurch Public Garden. It appears to be perfectly distinct from all the other New Zealand violets in all its parts, and is readily distinguished when growing by the reniform hairy leaves, much resembling the foliage of some of our native species of *Hydrocotyle*, with which the plant also coincides in habit.

It is evident that the flora of Stewart Island is at present very imperfectly known, and some efforts should be made to explore the whole island thoroughly. Such an exploration might prove highly valuable and instructive in connection with the important study of the geographical distribution of New Zealand plants.

*Asplenium canterburiense*, n. sp.

The Canterbury Spleenwort.

*Diff. char.*—Fronds lanceolate sub-coriaceous, bi-pinnate, pubescent. Pinnæ lanceolate, or deltoid-cuneate, sori covering the whole under surface.

*Description.*—*Rhizome* short, tufted, clothed with black, acuminate, narrow-lanceolate scales. *Fronds* tufted, lanceolate, acuminate, erect, 2-pinnate, 3–8 inches long, 2–4 inches wide, rather coriaceous in texture, dark-green, clothed with minute pubescence on both surfaces. *Stipes* and *rachis* slender, pale coloured, minutely pubescent or slightly scaley and silky at the base. *Pinnæ* deltoid-cuneate below, linear-oblong-cuneate above, alternate or opposite, $\frac{1}{2}$–2 inches long, stipitate, acute; *pinnules* stalked, ovate-oblong, acute, with cuneate bases, lower deeply pinnatifid, upper confluent, entire or toothed; *segments* linear-lanceolate, acute; *sori*, one to a segment. *Indusium* linear-falcate, whitish-membraneous, some what vaulted, fixed in the centre of the segment and opening towards the central vein. *Sporangia* excessively numerous, ultimately spreading over the whole under-surface of the frond which when mature is a dense mass of rich brown-coloured sporangia entirely covering the involucres.

*Hab.*—Mount Arrowsmith and Mount Torlesse—*J. F. Armstrong*; near the Waimakiriri Gorge—*J. B. Armstrong.* First collected in 1864.

This is a peculiar and interesting little fern hitherto much neglected by fern collectors, and not at present in cultivation. It belongs to the series represented by *A. bulbiferum*, *A. colensoi*, *A. richardi*, and *A. hookerianum*, and is by far the most distinct species of the group, differing from all the others in the minute pubescence, the great abundance of sporangia, and the central sori. Any authors who are disposed to unite the previously described species of the group, will of course decline to admit this plant to specific validity; but such a course would be productive of so much confusion that it is to be hoped nothing of the kind will be attempted. In working up the species for my work on the native ferns, I find several new species in my *Herbarium* which shall be described in due course.

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## Art. LI.—*Description of new Plants.* By D. Petrie, M.A.

[*Read before the Otago Institute, 21st June, 1881.*]

*Cotula maniototo*, n. sp.

A minute densely-tufted moss-like species. Stems creeping, with short leafy branches.

Leaves sessile, linear-oblong, pinnatifid, with few linear segments on each side, silky on both surfaces, $\frac{1}{6}$–$\frac{1}{3}$ inch long, broader and more membraneous at the base. Heads small, bisexual, sessile on the tips of the lateral branches: involucral scales in two series, broad, entire, membraneous, outer more or less silky. Female flowers in one outer series, with narrow-oblong 2-lobed corolla, and 2-lobed stigma. Hermaphrodite flowers 15–20, with corolla dilated above, and 4- or 5-lobed. Stigma flattened at the top; achenes oblong, turgid, slightly winged.

*Hab.*—Maniototo Plain, Otago, in moist hollows containing water in wet seasons.

I have never seen this plant except on the Maniototo Plain and its borders. It ranges from Kyeburn Crossing to the Styx, a tributary of the Upper Taieri. It is a very inconspicuous plant, and might readily be overlooked, as was long the case with *Veronica canescens*, Buch., which occurs in the same locality and in similar situations. The species is an extremely distinct one.

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[*Read before the Otago Institute, 19th July*, 1881.]

*Carex wakatipu*, n. sp.

A cæspitose small species, much branched at the base.

Leaves usually broad, flat, much longer than the culms, slightly scabrid at the margins. Culms much shorter than the leaves, 3-angled, smooth, invested by the sheathing bases of the leaves. Spikelets 4–6, erect, lower shortly peduncled, upper sessile; uppermost male, others male at the top only. Bracts long and leaf-like. Glumes ovate-oblong, brownish, membraneous, bifid, with a rather long hispid awn, being a continuation of the strong green nerve. Utricles turgid, biconvex, nerved, shortly bifid at the smooth apex but scarcely produced into a beak. Stigmas 2.

*Hab.*—Ben Lomond, near Queenstown, 3–5,000 feet.

I have a good series of depauperized forms in some of which the spikelets are reduced in number, and conspicuously in length and stoutness.

*Carex goyeni*, n. sp.

A tufted strong-growing, dark-green, species. Culms stout, 3-angled, almost smooth, a foot high or less.

Leaves longer than the culms, flat, broad, keeled, scabrid at the margins. Bracts long, leafy, flat. Spikelets 7 to 9, stout, cylindric, erect, 1 inch long or less; the lower somewhat distant, peduncled; upper sessile, approximate; uppermost male in the lower half, female above, others female with a few male flowers at the bottom of the lower spikelets. Glumes nearly as long as the utricles, rounded-ovate, membraneous, brown, shortly awned. Utricles turgid, divaricating, pale, shining, nerveless, with a short bifid beak which is smooth or slightly scabrid at the margins. Styles 2, short.

*Hab.*—Head of Lake Wakatipu, 1,100 feet.

This species is easily distinguished by its robust habit, its broad flat leaves exceeding the culms, its short spikelets, and the absence of any entirely male spikelet. It is named in honour of Mr. P. Goyen, who has been for some time engaged in work calculated to throw considerable light on the alpine flora of the S.W. of Otago.

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[*Read before the Otago Institute, 22nd November*, 1881.]

*Carex longiculmis*, n. sp.

A tall cæspitose species, somewhat similar to *Carex trifida*, Cavanilles, but more slender lax and tall.

Leaves shorter than the culms, pale green, $\frac{1}{5}$ of an inch broad, usually flat, keeled, smooth save at the margins near the top, the lower part with an expanded sheath ending in a truncated ligule. Culms tall, rounded, 2–3½ feet high. Bracts long, leaf-like. Spikelets 5 or 6, erect, stout; one and sometimes two uppermost male only; others with a few male flowers at the base; lowermost 1–1½ inches long distant and shortly peduncled, the upper approximate, sessile, becoming progressively shorter. Glumes ovate-oblong, membraneous, brown at the edges, produced into a cuspidate awn, usually bifid at the apex, but sometimes acute. Utricle as long as the glumes, shortly stipitate, strongly nerved, usually deep-brown above, narrowed into a short bifid beak. Arms of style 3.

*Hab.*—Glory Cove, Paterson's Inlet, Stewart Island. Gathered January, 1880.

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## Art. LII.—*Notes on* Epacris microphylla *in New Zealand.*

By A. T. Urquhart.

[*Read before the Auckland Institute, 5th September*, 1881.]

In comparing the flora of New Zealand with that of Australia, the striking fact presents itself to us, that nearly all the species which are identical, and peculiar to the two countries, are plants bearing seeds specially adapted for dispersal by wind. Any evidence bearing on the interchange of species, by natural means, between Australia and New Zealand in the past, and more especially the present time, is of some value in assisting us in solving the problem of insular floras. In a partially occupied country positive evidence can hardly be expected; however, as the placing on record the time when a new species was first observed, independently of its possible mode of introduction, will be of great assistance to future botanists, my friend Mr. T. F. Cheeseman, F.L.S., suggested I should send a few notes on the discovery I made, about six years ago, of three plants of *Epacris* on the southern side of Manukau Harbour; which have since been determined by him as the Australian *E. microphylla*. It differs from any of our described species.

Shrub 2–3 feet in height, with virgate slender branches, stem often much branched. Leaves cordate, broadly ovate, shortly acuminate, tip slightly recurved, concave, spreading, 3 millimètres long. Flowers small, white, numerous, often one in each axil, almost sessile, or on peduncles 1 mm. long. Bracts and sepals obtuse, or almost acute, sepals 1½–2 mm. long. Corolla tube shorter than the calyx; lobes 5, as long as the tube. Anthers wholly included. Hypogynous scales short. Style short. Seeds indefinite, extremely minute. Commences flowering in February, and attains its maximum of bloom in July.

The spikes are visited by the bee (*Apis mellifica*) and a number of small insects (*Colaspis*). As some of the plants are now growing under slightly changed conditions, it is not improbable their visits are beneficial. It is a shrub of great fertility and constitutional vigour. Considering it has had to compete against a hardy indigenous vegetation, its increase has certainly been rapid, especially within the last two years. It now forms a dense mass sixty yards in circumference; the intermediate vegetation, *Leptospermum*, *Pteris*, and *Pomaderris*, is almost completely destroyed. From the main mass seeds are being disseminated in a line with the prevailing winds.

Probably the reason that *E. microphylla* has become so firmly established in its new habitat is that when the seeds (or seed) fell they met with favourable conditions; that is, they germinated in a moist loamy hollow, and being unpalatable to all kinds of stock escaped destruction.

As to how it was introduced, I can only satisfactorily account for it on the hypothesis that the seeds were carried over from Australia by aerial currents; it is not improbable that was the way *E. purpurascens* (discovered nearly forty years ago by the late Dr. Sinclair) reached Manurewa, four miles N.E. of the present station of *E. microphylla*. Upwards of 1,300 miles may seem an enormous distance for seeds to be transported across the sea, independent of oceanic currents; and I would have hesitated in asserting that that was the way *E. microphylla* was introduced, only that I cannot account for its having reached so isolated a district except by natural means.

It may be of interest to mention that there are two plants of *E. purpurascens* established on the southern side of the river Pahurehure, about 5 and 7 miles southwest of Manurewa.

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## ART. LIII.—*On the Sugar Values of Beet-roots grown in the Waikato District.*

By J. A. POND.

[*Read before the Auckland Institute, 5th September*, 1881.]

DURING the session of 1880 a paper was read before this Institute entitled "On the growth of Sugar-beet in New Zealand," by Dr. S. M. Curl.* In this paper the writer very ably reviewed the subject and placed much valuable data before us, but when speaking of the values of sugar in the different varieties of beetroot examined by him, he claimed to have found as high as 17·5 per cent. This excessive amount, and the fact that Parliamentary Papers had been published giving analysis of New Zealand grown beets, showing much less favourable results, and the absence of any details of examination, led me to take up this subject with the view of practical operations should the experiments justify it. About this period also, I had interested myself in the matter of sugar-beet, owing to some superior seed having been brought from Hamburgh by Mr. G. S. Graham, and finding it had been distributed amongst some of the Waikato settlers for planting,

* Trans. N.Z. Inst., vol. iii., art. xii.

I undertook the examination of the roots when they should be sufficiently grown. Mr. W. A. Graham, of Tamahere, who had taken a very great interest in the matter, had papers printed according to a plan drawn out by myself, and forwarded to those settlers who had undertaken to grow the roots. These papers were designed to obtain data for the future guidance of a company, should one be formed through any satisfactory result of these experiments, and were divided into columns requesting information, as follows:—

PARTICULARS OF WAIKATO BEETROOTS.

| From whom forwarded, and name of estate. | Character of soil, and whether drained, etc. | Whether manured or otherwise; if manured, state character of manure. | Whether from imported seeds, or from where obtained. | Give approximate of weight to the acre if possible. | Analytical Results. | |
|---|---|---|---|---|---|---|
| | | | | | °/° of beet sugar. | Notes. |

While the reverse of the paper was headed

"Special Notes" [Add here anything of interest to obtain complete details.]

and also my address, to which the roots when required or matured were to be forwarded.

The first instalment I received was from Mr. L. O'Neill, Hamilton, and came to hand on the 28th January. There were three roots, grown from seed imported by Mr. Lavers, and resulted as follows:—

| | | | | |
|---|---|---|---|---|
| No. 1.—Weight, | 2 lbs. | 2 ozs.; | percentage of cane-sugar | 10·95 |
| " 2.— " | 1 " | 2 " | " " " | 10·17 |
| " 3.— " | 0 " | 12 " | " " " | 13·55 |

On the 24th February, one month later, Mr. O'Neill again forwarded a parcel of four roots from the same crop. Taking the largest of them, weighing 2 lbs. 2 ozs., I found the percentage of sugar to be 14·25, the three others I aggregated with a like percentage of 14·25.

Finally, on the 24th August I received a parcel of five roots from the same grower, which had been removed from the ground and stored, some of which are on the table. Two of these I have examined, with the following results:—

| | | | | |
|---|---|---|---|---|
| No. 8.—Weight, | 2 lbs. | 7 ozs.; | percentage of sugar | 11·40 |
| " 9.— " | 2 " | 0 " | " " " | 14·25 |

The further examination of these roots I will speak of again, in relation to the specific gravity of the juice.

On the 18th of February I received three roots from Mr. Ralph, Huntley, marked sugar-beet. They were of a full red-coloured skin, but I have obtained no knowledge of the name of the seed or where procured. Result of analysis:—

| | | | | |
|---|---|---|---|---|
| No. 1.—Weight, | 5lbs. | 5 ozs.; | percentage of sugar | 4·31 |
| " 2.— " | | 12 " | " " | 7·50 |
| " 3.— " | | 9 " | " " | 11·87 |

This root No. 1 was a well-shaped one, of large proportions, very watery, but with a very low percentage of sugar. This is the lowest result I have obtained, and far below any other. At the same time its excessive size would lead to the conclusion that its value in sugar was low.

One more parcel I received of unknown seed, from Raglan, through Mr. Will, comprising five small roots, badly formed, the largest of which, weighing 1 lb. 12 ozs., yielded a percentage of sugar, 8·14.

I now proceed to note the results of the seed obtained by Mr. Graham from Hamburgh, and which had been distributed as already noted. There were three kinds in all.

No. 1.—Genuine white small Wanzlebenel Imperial.

,, 2.—Deppe's pure white improved Silesian Imperial.

,, 3.—Extra saccharine Red-top Imperial.

In the following notes I will simply call these varieties by their respective numbers—1, 2, and 3.

On the 10th March I received three roots, one of each variety, from Mr. R. Watson, Pukerimu.

No. 1.—Weight, 13 ozs.; percentage of sugar 13·57

,, 2.— ,, 1 lb. 1 oz.; and No. 3 (weight, 12 ozs.), I treated in the aggregate, with the result of 15 per cent. of sugar, this being the highest value obtained.

On the 2nd of April I received a parcel of five roots from Mr. E. B. Walker, Cambridge, the weights of which were between 1 lb. 1 oz. and 1 lb. 15 ozs. and were of the three varieties, but without anything to distinguish them. These I treated in the aggregate with the result of 13·57 per cent. of sugar. Taking the best proportioned root of the parcel, weight 1 lb. 10 ozs., I found it to contain 15 per cent. of sugar.

On the 10th August I received samples of the three kinds of root already named, from Mr. T. Goodfellow, Alexandra, which gave the following results :—

| | | | |
|---|---|---|---|
| No. 1.— | Weight, $1\frac{1}{2}$ lbs., | percentage of sugar | 12·66 |
| ,, 2.— | ,, $1\frac{1}{2}$ ,, | ,, ,, | .. 11·40 |
| ,, 3.— | ,, $2\frac{3}{4}$ ,, | ,, ,, | .. 9·82 |

These roots arrived with the crowns removed. I had, therefore, no opportunity of observing whether there had been any late growth of leaves, but from the freshness of the roots and the results above quoted, I should think they had been left in the ground, and not dug up at maturity and stored.

I have now given the results of the examination of roots grown in the different parts of the Waikato, and will not unnecessarily multiply the details for you, but take as a last experiment the result of analysis of roots grown upon Mr. Graham's estate at Tamahere. It was my desire to examine these roots while they grew, and, if possible, to note the time at which they became matured, and on that account, the crop having been sown late, I received samples of the three varieties on the 8th February, resulting as follows:—

| | | | | | |
|---|---|---|---|---|---|
| No. 1.—Weight, | 1 lb. | 1 oz.; | percentage of | sugar | 8·90 |
| „ 2.— „ | 1 „ | 6 „ | „ | „ | 7.50 |
| „ 3.— „ | 0 „ | 9 „ | „ | „ | 8·38 |

These roots were immature, and consequently the results were low. On the 26th March I received another parcel of the three kinds from the same estate, yielding as follows:

| | | | | | |
|---|---|---|---|---|---|
| No. 1.—Weight, | 1 lb. | 2 oz.; | percentage of | sugar | 10·55 |
| „ 2.— „ | 2 „ | | „ | „ | 11·87 |
| „ 3.— „ | 1 „ | 7 „ | „ | „ | 11·17 |

On the 7th of May I visited the ground and chose samples of the three varieties which were still in the ground, rather overgrown with weeds and certainly having been left too long in the earth, the leaves still growing vigorously, the result no doubt of the late rains which had then been falling. Still they were fine roots, averaging from 1 to 3lbs. They had been planted too far apart, and much space had been lost and room given for weeds to accumulate in. Being rather pressed for time I was unable to make a separate examination of these roots, and therefore I treated them in the aggregate with a result of 12·79 per cent. of sugar.

Finally, on the 29th August, I received samples of each variety fresh from the ground where they had still been allowed to remain, though fully four months had elapsed since they had reached maturity. These roots had been growing vigorously, a large crop of young leaves shooting up at the expense of the sugar stored up in the root. The result of the analyses, though low, has surprised me at the amount even yet left in the roots.

| | | | | | |
|---|---|---|---|---|---|
| No. 1.—Weight, | 2 lbs. | 9 ozs.; | percentage of | sugar | 7·42 |
| „ 2.— „ | 2 „ | 4 „ | „ | „ | 6·47 |
| „ 3.— „ | 3 „ | 5 „ | „ | „ | 8·65 |

Three of this parcel of roots were forwarded by Mr. Graham to Dr. Hector, Wellington, for analysis, with the result appended.

"*Results of Analysis.*—Three roots of Sugar-beet for sugar. Received 13th September, reported on 23rd September, 1881.

| | | | | | |
|---|---|---|---|---|---|
| No. 1.—Weight, | 1 lb. | 2 oz.; | sugar per cent. | .. .. .. | 8·42 |
| „ 2.— „ | 1 „ | 10 „ | „ „ | .. .. .. | 8·01 |
| „ 3.— „ | 2 „ | 10 „ | „ „ | .. .. .. | 6·94 |

"These are fairly good yields. "W. Skey."

In reference to the methods of analysis and the sampling of the roots, I may remark that in every case, to ensure a true average, I have punctured the root from crown to apex, taking the core for purposes of analysis, as it is a well known fact that the sugar is not found in equal proportions throughout, the root being richer in sugar in the lower than in the upper portion. Having thus obtained a fair average of the root, I have accurately weighed and then pulped the assay portion in a mortar with distilled water, and inverted the sugar in the ordinary manner with dilute sulphuric acid, making my quantity up to a known amount, from which I have charged the burette in the ordinary way.

Fearful of the conversion of the woody fibre into glucose, and a consequent false increase of the results, I have frequently checked this process by filtering off the diffused juice from the pulp, well washing the latter, and then inverting the sugar contained, but in all these cases the pulp still retains a small amount of saccharine matter, but the difference between these two methods is so small as not to cause much disparity, and here I will give one experiment to show the difference. A root of the Red-top Imperial, weighing 2¾ lbs., was taken, and two cores from the puncture tube fairly chosen, to the weight of 2 grammes each, pulped, and the one inverted with the pulp, the second filtered, the pulp washed and the filtrate inverted; the percentage of sugar being 9·82 in the first portion, and 9·50 in the second. The difference I attribute to the sugar still left in the pulp. The methods by which I have determined the percentages of sugar, have been with Fehling's copper solution, and Knapp's mercuric cyanide solution, both volumetric analyses, the former being in my opinion the most accurate. To ensure precision, I have frequently inverted pure anhydrous cane sugar, and estimated my standard solutions with it, and therefore feel justified in saying that the analyses given by me in this paper are reliable.

In addition to the chemical analysis we have the specific gravity, this being a very reliable guide to the value of sugar present, and this I have obtained after expression of the juice on several occasions by means of the balance. Before concluding this portion of my paper on the chemical manipulations, it will be interesting in a few cases to note the relative proportions between the chemical values and the specific gravities.

The root already mentioned as having been received from Mr. Walker, Cambridge, and which I estimated to contain 15 per cent. of sugar, was grated until it had lost weight equal to 200 grammes, the juice from which being expressed equalled 128 c.c., added water to the pulp and macerated, pressed to near dryness and made up the amount with water to 200 c.c. Found the specific gravity of the pure juice before adding water to be 1·08087, and the percentage of cane sugar in the 200 c.c. to be 14·35, the difference being the amount of sugar still retained by the pulp. Again a root from Mr. O'Neill was grated, 1 lb. of which yielded 14¼ ozs., weight of juice, and 1¾ oz. pulp. The specific gravity equalled 1·0528, and the percentage of sugar in the juice was 11·4.

One more experiment I will give, that of a root weighing 2lbs., of which 14ozs. was grated, yielding 12ozs. juice and 2ozs. pulp; the specific gravity of the juice being 1·0653, and the percentage of sugar present 14·25.

There is one point in connection with this subject which deserves more than a passing notice, and that is in reference to the presence of chlorides, and especially that of chloride of sodium—common salt—this being so detrimental as to result in a loss of 5 per cent. of sugar for every 1 per cent. of the salt. When making my examination for sugar I have also tested for the presence of chlorine, but only to find a trace in any of the Waikato beetroots with the exception of those now before you, which, having been left in the ground at least four months too long, are heavily charged with chlorides. One interesting feature is in the absence, beyond a trace, of chlorides in the roots received from Raglan, already mentioned, and this though grown in the vicinity of the sea. I may state that I have not estimated the amount of chlorides, but simply as a qualitative test.

The distribution of the seed in the Waikato alone was in consequence of its distance from the sea and the very favourable situation and comparative absence of chloride of sodium from the pumice soil, but its cultivation in other portions of the Auckland district fairly deserves a trial.

The great objection to the presence of salt, either from the proximity to sea air, fertilization of the ground with it, or from an abnormal amount being naturally present, is owing to the impossibility of freeing the sugar from this substance, and in consequence the estimation of chlorides is only second in importance to that of the sugar present. So inimical is this salt that M. Baruchson says:—"In some instances the undue proportion of this salt in sugar has nearly rendered the sugar unsaleable; and so generally is this recognized abroad, especially in Germany, that the manufacturers in contracting with the growers of the root stipulate that it shall not be grown on certain soils, and often even name the manure which shall be used." It is owing to this substance, and the want of sufficient care in eliminating the molasses that beet-sugar at one time was strongly objected to on account of the taste, and even here I have heard complaints of the same character. On this subject Grant, in his "Beetroot Sugar" remarks:—"There was formerly a prejudice in the minds of many people against beet-sugar; but it is perfectly well ascertained, that, if properly refined, it cannot be distinguished from the best sugar of sugar-cane, either by taste, appearance, or chemical analysis: the two are identical." Again, on page 24 he remarks: "The cost of producing from the beet a pure white sugar, entirely free from unpleasant smell or taste, is but a trifle more than is required to produce a lower grade. In Germany refined loaf sugar is produced directly from the beet. In France the brown is first produced, and then refined. Within the last two years, however, sugar has been produced of such purity and whiteness, that it has been sold directly for consumption without refining; and there is no question that the peculiar odour of the beet may be entirely got rid of in the manufactory." I will quote one more authority on this subject, and that one of the highest we could have. I allude to Crookes, who says in his work "Manufacture of Beetroot Sugar":—"Crystalized beetroot sugar is perfectly identical in composition with cane-sugar, and is indistinguishable from it by the sight, the taste, or by chemical tests."

Proceeding from the foregoing facts to summarize my results, I find that the value of sugar obtained from the whole of the roots examined by me last season under 3½ lbs. in weight is a percentage of 11·66, but this average includes the immature ones from Tamahere, made when they were but half-grown, and also these roots now before us, which, having remained in the earth so many months after coming to maturity, have deteriorated considerably. If then we exclude these, the average result of the rest shows a percentage of 12·45; but as some of the roots examined were practically too small for manufacturing purposes, I propose to exclude all under 1 lb. weight, and thus reduce the average to roots between one and three pounds weight, this being a useful size for manufacturing purposes, large enough to pass safely through the washing machine without being lost or clogging the bars, and yet not too large to materially reduce the percentage of sugar. By this exclusion the average is 12·29, my highest being 15 and lowest 9·82.

In arriving at these results, I do so after a series of experiments extending over the past seven months, in which time I have made upwards of eighty analyses and examined more than sixty beetroots grown in different parts of the Waikato, many of them raised under very unfavourable conditions: some I found over-run with weeds, of others cattle had destroyed the leaves, while the majority were planted too far apart, and in almost all cases not sufficiently earthed-up, in consequence of which a portion of the sugar contained in the root, exposed to sun and air, becomes converted into other substances. Yet, notwithstanding all these disadvantages, the average of all the analyses made by me, with the exception of one root weighing over 5 lbs., was 11·66, while the exclusion of those which would under no circumstances be permitted to enter a sugar factory brought up the total to 12·45, an average return so favourable that it would result in a very large profit were it achieved in the countries where beet-sugar factories are established.

That these results are not exceptional is, I think, shown by the wide area over which I have obtained my supplies for examination; and that it will be fully equalled on the large scale is shown by the unskilled manner in which some of these roots were planted and tended, and also by the request, which in many instances was adhered to, that no manure should be used.

So far from this, I feel convinced that with due attention, proper cultivation, and suitable manuring, a higher percentage will be obtained than from those which the past season's growth has furnished us with; and should a factory be established for the conversion of beet-sugar, I believe the true economy of procedure would be in the purchase of roots at a fixed rate per ton, with an additional schedule price for every degree of sugar above a minimum, a practice which works beneficially amongst some of the German factories; especially would this be the case in the colonies, where the higher price of labour would naturally lead us to seek for the maximum of sugar from a minimum of root. It is not within the scope of this paper to dilate upon the value to this district should such an industry find a home amongst us, but the benefits would be so great and varied, while the returns which I have now brought before you give so large a promise of success, that I hope the early future may find such an establishment situated where it would be most profitably worked—in the centre of the Waikato district—where soil, temperature, and the absence of sea air proclaim its fitness for the growth of the beet; and to show the results of a factory in full working order, I will conclude by reading the result of eight years' working of the North German Sugar Company, as extracted from their books by Mr. G. S. Graham:—

| Process. | Year. | Quantity of Beetroot. | Percentage of Sugar. | Rate of Dividend. | Beetroot. Quantity manipulated per diem. |
|---|---|---|---|---|---|
| By hydraulic pressure. | 1870-71 | Cwts. 208,575 | 9·13 | 32 o/o | Cwts. 1,400 |
| | 1871-72 | 128,680 | 9·29 | 30 „ | 1,400 |
| | 1872-73 | 274,595 | 9·00 | 24 „ | 2,000 |
| | 1873-74 | 328,035 | 9·00 | 24 „ | 2,000 |
| By diffusion. | 1874-75 | 194,370 | 10·37 | 30 „ | 2,500 |
| | 1875-76 | 356,410 | 9·08 | 30 „ | 2,700 |
| | 1876-77 | 303,825 | 9·54 | 24 „ | 2,700 |
| | 1877-78 | 357,630 | 11·00 | Not ascertained | 2,800 |

ART. LIV.—*Notes on* Sorghum *Experiment.* By MR. JUSTICE GILLIES.

*[Read before the Auckland Institute, 8th August,* 1881.]

HAVING received from Commissioner LeDuc, of the Department of Agriculture at Washington, in May, 1880, sufficient seed of the Early Amber and Honduras varieties to sow about ¾ of an acre of each, I forwarded them to New Zealand with instructions for sowing and culture. The Commissioner informed me that these two varieties were those most likely to suit the climate of Auckland, which I explained to him. On my arrival in December, 1880, I found that a piece of ground, 1½ acres of light volcanic loam, which had been for several years in grass, had been carefully ploughed and prepared. The seed had been sown on the 28th and 29th of September (a month at least too early I now think) in drills running north and south 2 feet 6 inches apart. Instead, however, of planting in the drills a few seeds at the distance of three feet from each other, the seed had been sown continuously like peas, consequently it did not suffice for the ground prepared and the plants had come up much too thick in the drills. After sowing the weather had been unusually dry until December, so that on my arrival on the 7th December the plants were only about eight inches high. I had them immediately thinned out to a distance of 2 feet 6 inches between each two or three plants, and moist weather coming on the remaining plants began to grow well and litter or throw out 4 to 5 lateral shoots from the roots. The Early Amber covered $\frac{9}{20}$ of an acre; the Honduras exactly half an acre. Between the two varieties the unoccupied space, fully ½ an acre, was in October sown with maize broadcast for green food. By the middle of January the Early Amber was about 2 feet 4 inches high on an average, the Honduras 2 feet high, whilst the maize was 4 feet high. On the 4th of February a good many of the main stalks of Early Amber showed the seed top 5 to 6 feet high, none of Honduras, maize forming cobs. The crop now grew with great rapidity, but my absence from home prevented my recording the various stages of progress. On 1st April commenced cutting the Early Amber which then stood 10 to 12 feet high; weighed the cane and found the produce to be 2 tons 16 cwt. from $\frac{9}{20}$ of an acre; stripped the seed (roughly) and obtained 130 lbs. seed. On 15th April cut the Honduras which then stood about 12 feet high, and obtained from the half acre 3 tons 7 cwt. cane and 170 lbs. seed. The cane was cut about 9 inches from the ground and topped about 2 feet down and weighed immediately after cutting without stripping the leaves. Having no machinery for cleaning the seed, the weight of seed includes the husk.

Being, unfortunately, obliged to be absent from home when the crop was cut, I was unable to carry out my intended experiment of crushing and sugar making, but I hope to do so next year. One of my sons crushed a few stalks through a clothes-mangle, and boiled the juice down to the consistence of syrup, forming, when cold, a stiff toffy (to the delight of himself and his schoolfellows), showing the large amount of saccharine matter in the juice. This was from the Early Amber cane, which is much sweeter to the taste on chewing it than the Honduras.

I purpose planting one acre of Early Amber and half an acre of Honduras about the beginning of November next, and any person desiring to experiment on its growth in different soils and situations can have seed of each variety by applying to Mr. Lavers, seedsman, Queen-street.

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## Art. LV.—*On an abnormal Growth of New Zealand Flax.*

By the Rev. Philip Walsh, of Waitara.

[*Read before the Wellington Philosophical Society*, 21*st January*, 1882.]

On the 8th of August last, I found a very remarkable abnormal growth on a flax-bush (*Phormium tenax*). On one of the flower-stalks, of which there were three, the terminal bud had developed a perfect fan of leaves about two feet long, which at the date mentioned were quite green and fresh, the fan containing nine fully formed leaves, with a young leaf just shooting up in the centre.

The six uppermost lateral flower-buds had made the same abnormal growth, though in a lesser degree; two of them having formed small fans six inches and four inches in length respectively, and the other four having apparently done the same, though the leaves had fallen off, the greatly elongated stalks only being left.

The lower buds had flowered and seeded, some of the seed-pods still remaining.

The whole of the stalk was still green, in spite of the lateness of the season—August being a month in which, it is almost superfluous to state, all ordinary flax-stalks are dead and dry.

The two remaining stalks had made a similar growth to that described. They were, however, dead and withered when I found them.

The bush was one of a considerable patch of ordinary flax growing on the bank of the Papatiki, a small stream in northern Taranaki. It was growing in a clayey soil, about 300 or 400 yards from the sea beach.

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## Art. LVI.—*On the New Zealand Olives.* By T. Kirk, F.L.S.

[*Received by the Wellington Philosophical Society, 13th March,* 1881].*

Few New Zealand plants have proved greater sources of perplexity to local botanists than the olives. With a certain amount of similarity in the foliage, they possess diœcious apetalous flowers which are very inconspicuous, and as they are for the most part produced on lofty trees, it is not easy to procure good specimens of each form in its various stages. A limited amount of dimorphism on the foliage has increased the difficulty, and it has been erroneously supposed that the characters afforded by the fruit were of little value.

Another source of perplexity has arisen from the application of the native name "maire" to all the species alike, as well as to the sandalwood (*Santalum cunninghamii*), some forms of which closely resemble *Olea lanceolata* and *O. montana* in foliage and general appearance, the resemblance extending even to the venation; the flowers and fruit, of course, differing widely in structure.

In "Flora Novæ-Zealandiæ" and the "Handbook" three species of *Olea* are described—*O. cunninghamii*, *O. lanceolata*, and *O. montana*: a fourth species, *O. apetala*, was added by the writer in 1867.† Together they form the section *Gymnolæna*, restricted to New Zealand and Norfolk Island, and characterized chiefly by the absence of the corolla. I purpose offering a few remarks on the habit and characteristics of each. All the species agree in having opposite or subopposite petioled, coriaceous, glossy leaves: diœcious apetalous flowers, produced in more or less distichous racemes: each flower being jointed to the pedicel, each pedicel to the rhachis, and each rhachis to the branch. The pedicels are minutely bracteolate at the base, and the calyx is unequally 4-cleft. The style is invariably bifid, and staminodia are frequently produced in the female flowers, especially in those of *O. cunninghamii*. The fruit is a red or crimson coloured drupe; occasionally two perfect seeds are developed in the same fruit.

### *Olea apetala*, Vahl.

In favourable situations this forms a small tree 20 feet in height, but in exposed situations it is little more than a bush; most frequently it forms a shrub 10 or 12 feet high and branched from the base.

The branches are spreading, and often tortuous; in old specimens the bark is very thick, deeply furrowed, and corky.

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* Title read at Annual Meeting, 12th February, 1881.

† See Trans. N.Z. Inst., vol. iii., p. 165.

The leaves exhibit a marked dimorphism at different periods of growth; those of the young state, especially when growing in the shade, are broadly ovate, from 3″–6″ long and from 2½″–3″ across, petioled, acute or sub-acute, narrowed below, coriaceous and of a deep glossy green resembling those of *Camellia japonica*, but with the margins entire. The mature leaves are much narrower in proportion to their length, 1½″–3″ long and from 1″–1¼″ broad with the midrib prominent on both surfaces, elliptic acuminate, brownish and rough to the touch beneath.

I have not seen male flowers, but the female flowers are produced in vast abundance, the racemes being fully 1½″ long, 15–18-flowered, glabrous, stout; stigmas spreading short and thick. The drupe appears to be obscurely trigonous, but I have only seen three or four old specimens.

It is worthy of note that in this species the leaves of the young tree are much broader than those of the mature state. In the other species the young leaves are invariably the narrowest. In *O. apetala* the broad leaves are often retained until the tree is fully grown, but this is never the case with either of the other species.

This species has been collected on the Fanal Islands, Arid Islands, Great Barrier, Little Barrier, Taranga Islands, and at Bream Head.

*Olea cunninghamii*, Hook. f.

This is much the largest of the New Zealand species, often attaining the height of 70 feet, with a trunk 3–6 feet in diameter at six feet from the ground, while the principal branches are often of large dimensions. The leaves are rough on both surfaces; in the young state they are linear, 6″–10″ long, ⅜″–⅝″ wide, acute, gradually passing into the mature form, 3″–6″ long, 1¼″–1¾″ broad, oblong lanceolate or broadly lanceolate, obtuse or acute. Racemes tomentose, rather shorter than those of *O. apetala*, pedicels short, spreading at right angles to the rhachis; pistillate flowers with two sessile staminodia. Drupe ½″–⅔″ long, ovoid, narrowed upwards, red.

This species occurs from the North Cape to Cook Strait, but is most plentiful in the southern part of the North Island, attaining its greatest dimensions in the south-eastern portion of the Wellington district. At Pakuratahi I measured five trees growing within a short distance of each other, with the following results:—

| | Height of Tree. | Trunk. | Girth at 5 feet from the base. |
|---|---|---|---|
| No. 1. | 70 feet | — | 20 feet 7 inches |
| „ 2. | 50 „ | 12 | 13 „ 4 „ |
| | (With six large arms averaging from 15 to 20 feet long, and 5 feet in circumference at the middle.) | | |
| „ 3. | 60 „ | 35 | 4 „ 8 „ |
| „ 4. | 50 „ | 35 | 6 „ 4 „ |
| „ 5. | 60 „ | 30 | 20 „ 0 „ |

Above 6 feet from the ground the trunk tapers very gradually, and holds its girth well up to the crown. No. 5 was a magnificent tree; after making all deductions for bark and waste, it must contain over 500 cubic feet of convertible timber.

*Olea lanceolata*, Hook. f.

This makes a round-headed tree of smaller dimensions than *O. cunninghamii*, being rarely more than 50 feet in height, with a trunk from 1 to 3 feet in diameter. Not unfrequently small specimens less than 20 feet high produce fruit in abundance.

The leaves are smooth and glossy in all stages; in the young state narrow-linear, 3″–5″ long; in the mature state linear-lanceolate or ovate-lanceolate, acuminate. Racemes slender, calyx deeply cleft, segments linear. Drupe trigonous crimson. There are two primary forms of this species:—

*a.* Bark of twigs whitish, prominently warted, leaves ovate, lanceolate, acuminate, segments of calyx linear.

*b.* Bark of twigs dark, scarcely warted, leaves linear-lanceolate, racemes more slender than in var. *a*, segments of perianth broader.

This is the most common species, especially in the north. It is also found at Wairoa, in the Nelson district.

*Olea montana*, Hook. f.

This species forms an excessively branched round-headed tree; branches slender. Leaves linear acute, in the young state 3″–5″ long, when mature 1″–3″ glossy. Racemes slender, finely puberulous, 1″ long, about 12-flowered. Calyx lobes shallow, broad, obtuse. Styles shorter than in *O. cunninghamii.* Drupe ovoid, narrowed at base and apex.

In specimens collected at Whangaroa (North) the branchlets are almost capillary, and the leaves less than $\frac{1}{8}$″ in breadth.

*O. montana* is rare and local north of the Rangitikei, in some localities being restricted to a few specimens, or even to a solitary tree, but in the southern part of the Wellington district it is common. It is especially plentiful in the valley of the Ruamahanga, where it attains a large size.

A solitary specimen at Karori is fully 60 feet high, with a trunk 40 feet in the clear. Girth at base 9′ 1″, tapering to 7′ 4″ at 6 feet from the ground, but above that holding its girth well up towards the crown. I have been assured that specimens are found on the lower flanks of the Rimutaka fully equal in dimensions to the largest specimens of *O. cunninghamii.*

It will be seen that *O. apetala* has the most restricted distribution, not being known to occur south of the Little Barrier Island. It extends, however, northward to Norfolk Island. *O. lanceolata* is the only species found on the southern side of Cook Strait.

*Santalum cunninghamii*, from the close similarity of its foliage to *Olea montana* and *O. lanceolata*, is often mistaken for them in districts where it is plentiful, but a cursory examination of the flowers or fruit is sufficient to prevent the error. On the other hand, *Olea cunninghamii* is the *Santalum cunninghamii* of Buchanan's list of Wellington plants, and its wood has been distributed from the Colonial Museum under the name of *Santalum*. It is, however, very rarely that sandalwood forms a trunk of 9″ in diameter; most frequently it is no thicker than a man's wrist, and south of the Taupo district it is usually reduced to a mere bush, 5 or 6 feet in height.

The following key to the species of *Olea* may be found useful:—

A. Leaves rough.

1. Leaves oblong or elliptic acuminate, racemes glabrous .. *O. apetala.*
2. ,, lanceolate, racemes tomentose .. .. .. .. *O. cunninghamii.*

B. Leaves smooth.

3. Leaves lanceolate acuminate, perianth segments linear, acute *O. lanceolata.*
4. Leaves linear lanceolate, perianth segments broad, obtuse .. *O. montana.*

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## Art LVII.—*Notice of the Occurrence of* Triodia *and* Atropis *in New Zealand with Descriptions of new Species.* By T. Kirk, F.L.S.

[*Received by the Wellington Philosophical Society*, 13*th March*, 1882.] *

### *Triodia exigua*, n.s.

*Danthonia pauciflora*, Buchanan, Grasses of N.Z., t. xxxvi. B., not of *R. Brown*.

A small grass forming a compact swart, root creeping, leaves tufted 1″ long, filiform, rigid, involute, pungent, glabrous, mouth of sheath clothed with a minute pencil of hairs, ligule 0. Culms 1″–2″ high, slender, naked above. Panicle reduced to a single spikelet, or rarely two when the lower spikelet is pedicellate. Spikelets 2–3-flowered, empty glumes longer than the flowering, obtuse, flowering glumes 3-toothed at the apex, ciliate, nerved. Palea notched at apex. Caryopsis free.

*Hab.*—South Island: Broken River Basin, Canterbury, on terraces, 2,500–3000 feet; terraces of the Upper Waimakariri, 1,600–2,500 feet; Mount St. Bathans, Otago—*D. Petrie.*

Mr. Enys and myself collected a few specimens of this grass several years ago, but as the specimens were far advanced, little more than the outer glume remaining, it was not possible to make out its affinities. Last year Mr. Enys visited the locality and kindly sent me a supply of good specimens. I am also indebted to Mr. Petrie for good specimens from Otago. In his "Indigenous Grasses of New Zealand" Mr. Buchanan has wrongly referred Mr. Petrie's plant to *Danthonia pauciflora*, but it is clearly a *Triodia*.

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* Title read at Annual Meeting, 12th February, 1881.

*Triodia exigua* occurs in great abundance in the Broken River Basin, and on the Waimakariri terraces, forming a close sward to the exclusion of all other grasses. Its red anthers, as I learn from Mr. Enys, give a perceptible tinge to the pasturage, which catches the eye when riding. Nearly all the specimens in this locality have the panicle reduced to a single spikelet. Some of Mr. Petrie's specimens are more robust and exhibit two spikelets, the second, however, being often imperfect. Mr. Enys informs me that horses especially are very fond of it, notwithstanding its dwarf habit.

*Danthonia pauciflora* of Brown is a more robust grass with keeled leaves and culms with sub-erect or drooping many-flowered panicles which are usually more or less branched, while the flowering glume is never three toothed and the lodicules are never ciliated as in our plant. It has not been observed in New Zealand.

*Atropis pumila*, n.s.

A slender, tufted grass, 2″–8″ high. Leaves 1″–2″ long, spreading, filiform, involute, with a minute pencil of hairs at the mouth of the sheath. Sheath with a few loose hairs at the base. Culms erect, extremely slender, leafy for over one half their length. Panicle strict, linear-oblong, rarely exceeding 1″ in length, simple, or with one or two short branchlets at the base. Spikelets on short capillary pedicels, minute, 2–3-flowered. Outer glumes unequal, obtuse; flowering glume convex, obtuse, 5-nerved; nerves faint; palea ciliolate at the apex; Caryopsis oblong, free.

*Hab.*—South Island: common in Otago from 2,000 to 3,000 feet—*D. Petrie.*

I am indebted to Mr. Petrie for specimens of this grass, which adds another genus to our flora. It resembles some forms of *Danthonia nuda*, but its nearest ally amongst New Zealand grasses is *Glyceria stricta*, Sm.

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## ART. LVIII.—*A Revision of the New Zealand* Lepidia, *with Descriptions of new Species.* By T. KIRK, F.L.S.

[*Received by the Wellington Philosophical Society, 13th March*, 1882.]*

1. *Lepidium oleraceum*, Forst.

A. Rich., Flore de la Nouvelle Zelande, t. 35.

Hook. f., Fl. N.Z., i., 15; Handb. N.Z. Flora, 14.

*Hab.*—In sheltered places near the sea, North Island, South Island, Stewart Island, Auckland Islands *(Bolton).*

* Title read at Annual Meeting, 12th February, 1881.

This is the most robust of all the New Zealand species; the stems being sometimes as thick as a man's little finger. The leaves are sharply serrated, never pinnate or pinnatifid, sometimes the serration is confined to the apices. The racemes are always terminal, pods entire, wingless, style exserted. The leaves are more or less succulent, and the whole plant emits a strong, unpleasant odour. A form with the radical leaves ovate or oblong on naked petioles is occasionally found.

2. *L. flexicaule*, n.s.

Stems numerous, flexuous, irregularly branched from the base. Radical leaves 2″–3″ long, linear-oblong, pinnate or pinnatifid; segments irregularly serrate near the apex. Cauline leaves gradually smaller, linear spathulate. Racemes lateral, leaf-opposed, each with a solitary flower a short distance below its base. Flowers perfect, petals extremely minute, pods on short pedicels; oblong, notched at the apex. Style included in the notch formed by the wings.

*Hab.*—North Island: rocky places near the sea, Waitemata, Manukau, etc.

This species is characterized by the lateral racemes, which are terminal at first but become reduced to a lateral position by the growth of a stout usurping shoot which overtops them. The winged fruit has the style included in the notch, and the irregular somewhat obtuse serration of the leaves affords a strong contrast with the regular acute teeth of *L. oleraceum*. I have seen no South Island specimens, but have little doubt its distribution is equally extensive with that of the preceding species.

In its inflorescence this plant resembles *Senebiera didyma*, Pers.

3. *Lepidium sisymbrioides*, Hook. f.

Handb. N.Z. Flora, 14.

*Hab.*—South Island: Lake Ohau, *Haast;* Mackenzie Country, *J. B. Armstrong.*

I have not seen good specimens of this plant, which appears to be diœcious. In two small specimens given me by Mr. Armstrong, the leaves and stem are sparingly clothed with short appressed hairs.

4. *Lepidium solandri*, n.s.

Root stout, one- or many-headed. Leaves crowded, rosulate, linear-lanceolate, or obovate, 1″–1½″ long, with short, broad petioles, pinnatifid; segments often broad, clothed with scattered hairs, glandular. Stems spreading, sub-erect, naked, or with a few small entire leaves at the base. Flowers diœcious, petals 0, ♂ fl. stamens tetrandrous; ♀ flowers numerous, pedicels very slender, pod ovate-rhomboid with very narrow wings, hairy, emarginate, style longer than the notch.

*Hab.*—South Island: limestone rocks, Broken River Basin, Canterbury—*J. D. Enys* and *T. Kirk.*

This species is allied to *L. sisymbrioides*, from which it is distinguished by the naked stems, apetalous flowers, straight pedicels, and narrowly-winged pods.

In old specimens the root is four feet long, and fully one inch in diameter; much divided near the apex, so that the numerous heads form a compact hemispherical mass of leaves 6″–12″ across. The stems of the ♂ plant are more leafy at the base than the female, and produce fewer flowers. It is evidently the supposed *Lepidium incisum* stated in the Handbook to have been collected by Haast on " limestone rocks in the subalpine region of the Waimakariri."

5. *Lepidium tenuicaule*, n.s.

Leaves all radical, and with the stems more or less clothed with short whitish hairs: pinnate or pinnatifid, 1″–3″ long: segments laciniate and sharply serrate on the upper margin; teeth linear, acute, piliferous. Stems very numerous, prostrate, 6″–12″ long, extremely slender, flexuous, simple or branched, leafless, or with two or three minute entire leaves on the lower part. Flowers excessively numerous, perfect, on short, slender pedicels, stamens 4, pod small, shorter than the peduncle, orbicular, not winged, style minute.

*Hab.*— South Island: Cape Whanbrow.

This species differs from all other New Zealand forms in the prostrate habit and innumerable flowers, and the orbicular pods separate it from all except *L. australe*; the style in the fully-formed fruit is reduced to a mere point.

It was originally discovered by Mr. D. Petrie, and is produced in abundance after every disturbance of the silt which covers the cape, but decreases in quantity as the surface becomes consolidated.

6. *Lepidium australe*, n.s.

An erect, much-branched, leafy species, 10″–15″ high. Radical leaves 3″–6″ long, on rather long petioles, linear-oblong, narrowed below, pinnate; leaflets shortly petioled, incised and toothed on the upper margin, or rarely entire. Cauline leaves smaller, pinnatifid or entire serrate. Racemes terminal, spreading, flowers perfect, shortly pedicellate. Pods orbicular or ovate-orbicular, minutely emarginate, style minute.

*Hab.*—South Island: Cape Whanbrow—*T. K.;* near Cromwell—*D. Petrie.*

Allied to *L. tenuicaule*, from which it differs widely in habit, in the racemes being leafy at the base and in the somewhat wider pod, which is usually emarginate. The habit is the same as *L. oleraceum*, but the plant is much smaller.

Mr. Petrie has sent specimens from Otago which in some respects are intermediate between this species and *L. flexicaule*; but the specimens are too far advanced to allow of my forming a positive opinion.

7. *Lepidium incisum*, Banks and Solander.

Fl. N.Z., i., 15; Handb. 14.

I have seen no specimens of this plant, which appears to be extremely local. Mr. Colenso is the only living botanist who has met with it, and the habitat in which he found it has not proved productive of late years.

The Waimakariri habitat stated in the Handbook for this species must be erased, *L. solandri* being the plant intended.

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## Art. LIX.—*Notes on recent Additions to the New Zealand Flora.* By T. Kirk, F.L.S.

[*Received by the Wellington Philosophical Society, 13th March,* 1882.] *

*Capsella procumbens*, Fries.

*Hutchinsia procumbens*, Hook. f., Fl. Tasm.

I have received specimens of this species from Mr. D. Petrie, who collected them at Cape Whanbrow and Forbury Head, Otago. Those from the last-named locality are extremely small, scarcely an inch in height; and those from Cape Whanbrow do not attain the usual size of European and Australian specimens, the largest not exceeding 3 inches. The leaves are entire or toothed in all my specimens, never pinnatifid. The flowers equal the calyx; the racemes are elongated and open in fruit, and the pod is narrowed at both ends. It will doubtless be found in other localities, but may be easily overlooked.

*Myriophyllum verrucosum*, Lindl.

I collected this plant in ponds between Tauranga Harbour and the sea, but am not aware of its occurrence in any other part of the colony. It differs from *M. elatinoides* and *M. variæfolium*, in its more slender habit, and in having all the floral leaves pinnatifid. The flowers are small, with minute sepals, and the carpels are tuberculated.

*Azorella selago*, Hook. f.

This interesting plant was discovered on Macquarrie Island, by Fraser, as stated in "Flora Antarctica" ii., 285, but owing to its not having been observed on the Auckland or Campbell Islands, some doubt arose as to the correctness of the habitat, so that it was not included in the Handbook. Botanists are greatly indebted to Professor Scott, of the Otago University, for its discovery during his recent exploration of the island.

* Title read at Annual Meeting, 12th February, 1881.

The plant forms large matted patches on the ground. Stems 2″ to 6″ long, branched, densely tufted and matted together. Leaves distant or close set and imbricate, appressed, petiole membraneous, broadly sheathing, blade expanded and deeply cut into from 5 to 7 subacute one-nerved segments, less than ¼″ long.

My cursory examination of Professor Scott's specimens did not enable me to detect flowers or fruit, but in "Flora Antarctica" the umbels are described as terminal, 3-flowered. Calyx teeth acute. Fruit ovate, terminated by elongated styles, mericarps convex on the back, contracted towards the suture.

*Pozoa reniforme*, Hook. f.

I found this species growing plentifully on a moraine close to the snow-line in a deep valley of the Spenser Mountains, Amuri. Previously it was only known from the Auckland Islands.

*Cotula integrifolia*, Hook. f.

This plant is not uncommon in situations where water has stagnated but which have become dry on the approach of summer. It varies greatly in stature and luxuriance, but a complete series may be traced from minute, one-flowered forms with entire leaves, the plant less than 1 inch in height, to the most luxuriant form of *C. coronopifolia*. It can only be regarded as a transitory state of that species and is unworthy to take rank even as a trivial variety.

*Mentha australis*, Br.

This species remarkable even amongst its congeners for its powerful odour occurs in great abundance in the Wairarapa, especially at Carterton, but I fear that it must be regarded as an introduced plant. I observed it at intervals for three or four miles along the road, especially plentiful in ditches but occurring also in the adjacent forest.

It is an erect herb with pale green leaves and acutely angled stems; the flowers are produced in great abundance in axillary false whorls which may be pedicellate or sessile; the calyx is pubescent or hairy with long subulate teeth, the corolla tube is small, scarcely exceeding the calyx in length, and the mouth is deeply two-lobed.

Our plant fills the ditches by the road-side, where it attains the height of over 2 feet. In moist places in the forest it is much smaller. It is called "turpentine" by the settlers.

*Polygonum prostratum*, R. Br.

A much-branched prostrate suffruticose plant, the branches rooting from beneath in the present specimen, 6″–10″ high: the young branches and leaves sparingly clothed with rather long white hairs. Leaves lanceolate, narrowed into a short petiole, 1″ long, stipules sheathing, ciliate. Spikes axillary, or terminating short branchlets, sessile or shortly pedunculate, ½″ long: perianth small, becoming enlarged after flowering: stamens 6: nut convex, black, faintly reticulate.

*Hab.*—In several places by the Wairarapa Lake—*Harry Borrer Kirk.*

*Juncus pauciflorus*, R. Brown (not of T. Kirk).

Although somewhat local in distribution, this species occurs in several localities in both islands, and is generally known to New Zealand botanists under the name of *Juncus communis*, *β. hexagonus;* it is, however, distinct from that species, although similar in habit.

The panicle is lax, consisting of few slender branches, flowers few in number, and small: perianth segments acute, stamens 6, capsule ovoid, faintly angled.

The culms are usually slender, and the sheaths at the base very short. It appears to have been collected in New Zealand by Banks and Solander.

*Juncus brevifolius*, T. Kirk.

*J. pauciflorus*, T. Kirk (not of Brown).

In the "Transactions of the New Zealand Institute," vol. ix., p. 551, I described this small species under the name of *Juncus pauciflorus*, but as that name has been applied by Bentham to another species, I propose to call my plant *J. brevifolius.* It is distinguished from all New Zealand species by its rosulate leaves, slender naked erect culms, and sessile flowers. At present it has only been observed in swamps by the Thomas River, Canterbury, at an altitude of 2,000 feet.

*Centrolepsis monogyna*, Benth.

*Alepyrum monogynum*, Hook. f.

This moss-like plant occurs in swampy places, at an elevation of 3,000 feet in Arthur's Pass, where it was observed by the writer in 1877, when specimens were distributed under the MS. name of *Alepyrum viride.*

It forms large patches, scarcely ½″ in height when in flower. Leaves deep green, subulate, acute, dilated into a broad membraneous base, with a few short hairs at the back. Bracts sub-opposite, narrow. Flowers two, each invested by a semi-transparent scale which nearly equals the bract, and consisting of a single stamen and a single carpel.

*Carex leporina*, L.

*C. ovalis*, Good.

In November last I collected this common European species in a small valley in the Ohariu district, Wellington. The specimens were of greater luxuriance than any that had previously come under my notice, but differed in no essential particular from the type. The ovate sessile spikelets are collected into a short erect head, so that it can be easily distinguished from any of its New Zealand congeners.

*Hierochloe alpina*, Rœm. and Schultes, var. *submutica.*

*H. submutica*, F. Muell.

*Danthonia buchanani*, J. Buch., "Manual of Indigenous Grasses of New Zealand," p. 87, t. xxxv. (not of Hook. f.)

This form is intermediate between *H. redolens* and *H. alpina*, but is most closely related to the latter. The New Zealand plant agrees with that of Victoria in habit, and especially in the lower glumes being scarcely ciliate, but differs slightly in having longer awns, which appear to be always developed.

The panicle is more open than in *H. alpina*, the branches are longer and extremely slender, distant, usually drooping. Spikelets 3–6. Leaves broad, flat.

*Hab.*—Common in mountain districts, especially on the west coast of the South Island.

Bentham in "Flora Australiensis" unites *H. redolens* and *H. alpina*, and considers our plant as a connecting form, which may possibly prove worthy of specific honours.

I fully agree with Mr. Buchanan in keeping *H. alpina* separate from the European *H. borealis*, but cannot understand his having mistaken our plant for a *Danthonia*, especially for *D. buchanani*, which, independently of its generic and sectional distinctive characters, is described as having a short contracted panicle and filiform leaves.

*Stipa micrantha*, Cav., R. Br.

*Streplachne ramosissima*, Trin. and Rupr.

I have already recorded the occurrence of this species in the colony, and now add that it was originally discovered by Mr. W. T. L. Travers, near Foxhill, in the Nelson District. Recently it has been found in great abundance on the Takaka ranges, Nelson, by the Rev. F. H. Spencer, who informs me that the culms are sometimes from 5 to 6 feet in length. Although formerly inclined to regard it as introduced at Lyall Bay, in the North Island, I am now convinced that it is indigenous in that habitat.*

The culms are usually from 2 to 5 feet long, hard, much branched, the branches being frequently arrested, rounded, bunches at the nodes, but usually they are long and spreading. Panicle from 6 inches to 2 feet in length, branches numerous, capillary, drooping. Spikelets small, outer glumes narrow, nearly equal. Flowering glume shortly stipitate, entire, awn $\frac{1}{2}$ inch long, articulated on the glume. Palea less than half as long as the glume.

The habit of this species resembles that of *Microlæna polynoda*, but the plant is much larger.

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* "Trans. N.Z. Inst.," vol. x., p. 378.

*Stipa setacea*, R. Br.

*Stipa petriei* of Buchanan's "Manual of the Indigenous Grasses of New Zealand," p. 171, t. xvii., 2, must be referred to this species, which, although local, has a wide distribution in Australia. None of the specimens kindly sent me by Mr. Petrie have the outer glumes so unequal as represented in Mr. Buchanan's drawing.

It is not improbable that this species is merely naturalized in Otago, and has no claim to be included amongst our indigenous plants.

*Davallia dubia*, R. Br.

In "Transactions of the New Zealand Institute," vol. xii., p. 346, this species is recorded as a native of the Canterbury Provincial District by Mr. J. B. Armstrong, but erroneously: specimens of *Hypolepis millefolium*, with the pinnules less divided than usual, having been mistaken for it.

*Asplenium mohrioides*, Bory.

*Polystichum mohrioides*, Presl.

I have had the pleasure of examining specimens of this southern fern, collected on the Auckland Islands by a sailor during the past year. As they differ slightly from Fuegian specimens, I append a full description.

Fronds tufted, 3 to 5 inches in length, scarcely more than an inch in width; stipes very short, covered with soft brown scales mixed with hairs; frond oblong or oblong-lanceolate, pinnate, pinnæ in about twelve pairs, close set and imbricating, the lower shortly stalked, ovate, pinnate or pinnatifid, segments close set, crenate, obtuse; sori crowded, restricted to the upper part of the frond, indusium smooth, attached by the centre.

The young fronds are very chaffy, but the scales speedily disappear from the upper portion. The scales vary greatly in size, and are minutely ciliate.

Specimens from Magellan Straits are much more robust than our plant, and frequently attain 1½ feet in length, of which the stipes constitutes nearly a third. The texture is coriaceous, and the segments larger and less obtuse than in the Auckland Island plants.

In the chaffy habit and membraneous texture our specimens approach *A. cystostegia*, but the lax pinnæ and acute segments of the latter afford easy marks of distinction.

The distribution of this species is very remarkable. It has been collected in Chili, Magellan Straits, Tierra del Fuego, the Falkland Islands, Marion Island, and California.

ART. LX.—*Notes on Plants from Campbell Island.* By T. KIRK, F.L.S.

[*Received by the Wellington Philosophical Society, 13th March,* 1882.] *

HAVING had the privilege of examining the collection of Campbell Island plants in the Otago Museum, and comparing it with a set presented to me by the same collector, Dr. Filhol, also with a small collection made by Lieutenant Rathouis, of the "Vire," I find several interesting plants not previously known to exist on the island. I have therefore drawn up the following list of the plants comprised in the three collections, and added a few critical notes :—

*Ranunculas pinguis*, Hook. f. All the specimens with solitary flowers, and the leaves much more succulent than in alpine specimens from the South Island.

*R. aucklandicus*, Gray. Occurs in all the sets. Petals small, distant.

*Cardamine hirsuta*, L., var. *carnosa.*

*Stellaria decipiens*, Hook. f. In the Otago collection only : a mere fragment without flowers.

*Colobanthus muscoides*, Hook. f. A scrap mixed with *Tillæa—Lieutenant Rathouis.*

*Montia fontana*, L.

*Acæna sanguisorbæ*, Vahl. A form clothed with soft silky hairs.

*Tillæa moschata*, DC.

*Epilobium linnæoides*, Hook. f. In all the sets. This plant must be considered a form of *E. rotundifolium*, from which some of the present specimens cannot be distinguished.

*E. confertifolium*, Hook. f. A small form which may prove to be specifically distinct. It occurs at from 4,000 to 5,000 feet in Marlborough and Otago.

*Ligusticum latifolium*, Hook. f. In all the collections, but it is worthy of note that *L. antipodarum* is not represented in either.

*Stilbocarpa polaris*, Dcn. and Planch. Sir Joseph Hooker has pointed out the differences between specimens of this plant from the Auckland Islands and Stewart Island. Those from the Auckland and Campbell Islands have the leaves plaited and clothed with strong hairs. I have been much interested in observing that of three specimens from the Auckland Islands cultivated in the Wellington Botanic Garden, side by side with a strong specimen from Stewart Island, two have entirely lost these characters and exactly resemble the latter. There is, moreover, no difference in the inflorescence of plants from the two habitats, and both alike give off strong scions.

* Title read at Annual Meeting, 12th February, 1881.

*Celmisia verbascoides*, Hook. f. The occurrence of this grand Otago plant on Campbell Island is of considerable interest. The flowers are rather larger than in specimen from the Horse ranges.

*C. vernicosa*, Hook. f. The specimens have the ligulæ of the ray-florets whiet, not rose-coloured at the tips as represented in *Flora Antarctica.* In this respect it agrees with all the species of the genus, but differs in having disc-florets of a deep purple colour.

*Pleurophyllum speciosum*, Hook. f.

*P. criniferum*, Hook. f. Imperfect specimen only.

*Cotula plumosa*, Hook. f.

*Gnaphalium prostratum*, Hook. f. The specimens in the different sets show that *G. bellidioides* cannot be separated from this species. A complete transition may be seen from the short leafy branch terminated by a sessile head of *G. prostratum*, to the elongate slender peduncle of *G. bellidioides.*

*Dracophyllum urvilleanum*, A. Rich., var. *scoparium.*

*D. longifolium*, Hook. f. Otago collection only.

*Veronica benthami*, Hook. f.

*Caladenia bifolia*, Hook. f.

*Anthericum rossii*, Hook. f. Specimens of *A. hookeri*, from Lake Harris, exhibit a marked approach to the diœcious condition characteristic of *A. rossii.*

*Luzula crinita*, Hook. f.

*Isolepis aucklandica*, Hook. f.—*Lieutenant Rathouis.*

*Oreobolus pumilis*, R. Br.

*Carex appressa*, Br. A small form; the panicle less than two inches in length.

*C. trifida*, Cav.

*Poa foliosa*, Hook. f. The typical form recorded by Mr. Buchanan from the Snares and from the Chatham Islands, in the latter case incorrectly, *Festuca scoparia*, which is omitted from his list of Chatham Island plants, having been mistaken for it.

*Hymenophyllum multifidum*, Swartz.

*Hypolepis millefolium*, Hook. f. With some hesitation I refer a sterile specimen collected by Lieutenant Rathouis to this species; it may, however, prove to be a finely cut form of *Polypodium rugulosum.*

*Pteris incisa*, Thunb.

*Lomaria capense*, Willd.

*L. dura*, Moore. In all the collections and apparently attaining a large size.

*Aspidium aculeatum*, Swartz, var. *vestitum.* The specimens are of more rigid texture than any I have seen from either the North or South Island.

*Polypodium rugulosum*, Lab. A large viscid form of unusually stout texture.

*Lycopodium billardieri*, Br., *β. varium*. One specimen is an intermediate form; the others belong to the robust form commonly known as *L. varium*, Br.

*Dicranum billardieri*, Brid.

,, *setosum*, Hook. f. and Wils.

*Campylopus appressifolius*, Mitt.

*Ceratodon purpureus*, Brid.

*Polytrichum tortile*, Swartz.

*Hypnum serpens*, L.

,, *aciculare*, Lab.

,, *chlamydophyllum*, Hook. f. and Wils.

*Jungermannia monodon*, Hook. f. and Tayl.

*Marchantia tabularis*, Nees.

*Cladonia pyxidata*, Fries.

,, *gracilis*, Hoffm.

,, *furcata*, Hoffm.

,, *rangiferina*, Hoffm.

,, *aggregata*, Eschw.

,, *retipora*, Flœrke.

*Stereocaulon ramulosum*, Ach.

*Stica filicina*, Ach.

,, *variabilis*, Ach.

,, *fossulata*, Dufour.

*Polysiphonia dumosa*, Hook f. and Harv.

*Polyzonia cuneifolia*, Mont.

*Dumontia filiformis*, Grev.

*Codium tomentosum*, Agardh.

## IV.—CHEMISTRY.

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### Art. LXI.—*On the Preparation of Spontaneously Inflammable Phosphine.* By T. A. Mollet.

[*Read before the Philosophical Institute of Canterbury*, 13*th October*, 1881.]

Plate XXXVII., fig. 1.

Phosphuretted hydrogen, now generally known as phosphine, being one of the gases commonly made for experimental purposes by the practical student in the chemical laboratory, it is essential that the apparatus for its production should be so contrived as to avoid all risk of an explosion.

In the preparation of spontaneously inflammable phosphine it is usual to employ a glass flask, fitted with delivery tube, to contain the alkaline solution and phosphorus, from which the gas is generated. Before applying heat to the flask a current of coal-gas is passed through, in order to displace the contained air; and the chief fault of the apparatus rests in the fact that, unless this is continued for some time, it is impossible to expel all the air from the vessel. Instead of using gas to displace the air, ether is sometimes poured into the flask; but this is open to the same objection, letting alone the expensiveness of the liquid employed.

Another and more satisfactory method of producing the gas is to generate it in a glass retort completely filled with the alkaline solution, the mouth, of course, being immersed in the water of the pneumatic trough. By this means we at once get rid of every particle of air, and all chance of an explosion is done away with. There is, however, one fault to be found with this form of generator. A considerable quantity of solution must be used, and as most of this has to be heated to a high temperature, some delay takes place before the required gas is given off.

To avoid all these difficulties I have designed a piece of apparatus which is both simple and effective. An ordinary glass flask is taken and fitted with cork and delivery tube; but in addition to this, also passing through the cork, is a deflagrating spoon, which should be so adjusted that the bowl is about half an inch above the surface of the liquid when in the flask (pl. XXXVII., fig. 1). The pieces of phosphorus and the solution of caustic potash (or other suitable alkaline hydrate) having been placed in the flask, a small piece of dried phosphorus is put into the deflagrating spoon and ignited. The flask is now corked and the oxygen, present as an objectionable gas, combines with the phosphorus to form acids, which in no way interfere with the success of the experiment. Heat may be at once applied, and before the white fumes have quite disappeared the end of the delivery tube should be placed under water. The experiment may then be conducted as usual, care being taken when it is finished to withdraw the source of heat, and so allow the water to rush up the delivery-tube into the flask, which latter should not be opened till the water has ceased to flow. The phosphorus in the deflagrating spoon should be more than is required to combine with the oxygen in the flask, which if of moderate capacity will need a piece about the size of a pea.

This method of preparing phosphine will be found very useful, even in a well-furnished laboratory; but its utility will be more especially felt in places where coal-gas is unobtainable.

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## Art. LXII.—*On a new Form of Burette.* By T. A. Mollett.

[*Read before the Philosophical Institute of Canterbury, 13th October*, 1881.]

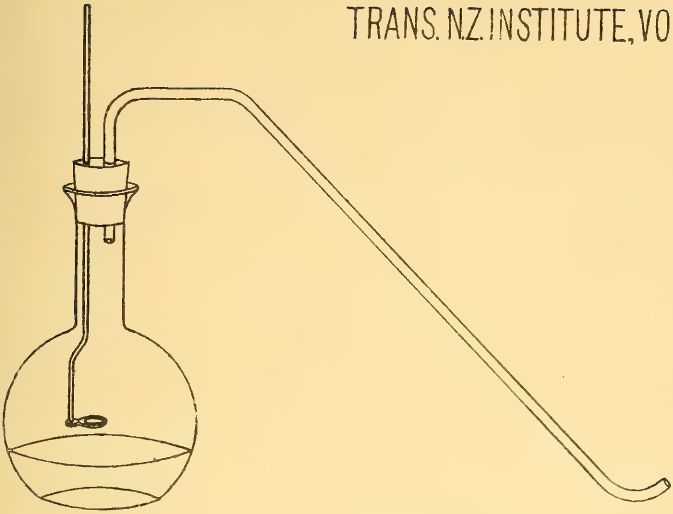
Plate XXXVII., fig. 2.

There being now so many forms of burettes from which to make a choice when about to conduct a volumetric analysis, it may appear wholly unnecessary to add another to the list. It will be well, however, to remember that one or two are practically obsolete, their form allowing of but rough and uncertain results. Gay Lussac's burette, which gives far better indications, is of too fragile a nature to be practically useful. Binks's also, though less liable to breakage, is not much handier in use than the previous one, and with it is open to another objection, *viz.*, special means have to be taken to ensure the correct reading of the level of the solution. Mohr's burette, of which several modifications have been introduced, is the one now generally employed; but when dealing with potassium permanganate it cannot be used. To remedy this defect a glass stopcock has been substituted for the caoutchouc tubing, and this form has now mostly superseded the others previously mentioned, as it also allows of the use of Erdmann's float. The glass stopcock is somewhat liable to fracture, and this form is not so easily cleaned as the original.

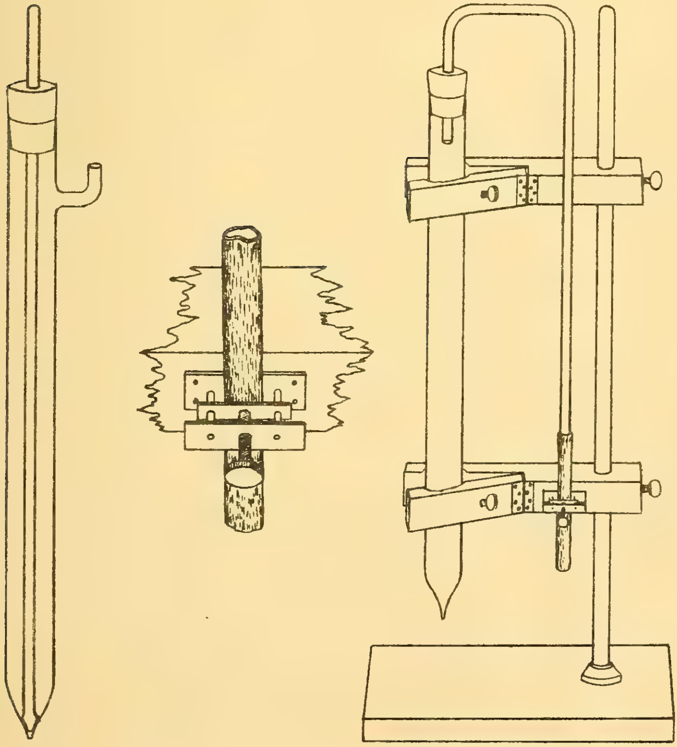
Some years back I devised a burette, an exact description of which I came upon while searching in the "Journal of Science,"* from which I make extract:—

"A new burette has been lately used in Paris. It consists of an upright tube drawn out to a fine aperture below, like that of Mohr, and supported in the same manner. The opening at the top is fitted with a perforated

* "Quarterly Journal of Science," vol. iii., n.s. (x.,o.s.), 1873, p. 182.



PHOSPHINE GENERATOR



NEW BURETTES

T. A. Mollet, del.

cork, through which plays a glass rod, reaching down to the bottom and ground conically, so as to fit watertight into the tapering delivery-end of the burette. A lateral aperture at the top serves to charge the instrument. This form is useful in working with solutions of permanganate of potash or other reagents which attack the indiarubber which in Mohr's pattern connects the delivery-tube to the body of the burette." (Pl. XXXVII., left-hand figure).

This pattern, owing to the central rod, does not admit of the insertion of an Erdmann's float. If the glass rod is broken it is next to impossible to obtain one exactly similar in gauge, and unless such an one is obtained the burette is useless, the graduations having been made when the original rod was in the tube. This is a serious objection which cannot be overlooked.

The burette which I now purpose to describe is readily cleansed, may be used with potassium permanganate, and allows of Erdmann's float being employed. This burette consists of a graduated tube, drawn out at the lower extremity to a moderately small aperture. The top of the tube is closed by a cork fitting airtight, through which passes a small glass tube. This tube, an inch or two above the cork, is bent at right angles into a horizontal direction and then again vertically but downwards. A short piece of caoutchouc tubing is slipped over the end of the small tube, which terminates a few inches above the delivery aperture of the larger one. A screw clamp fastened on to the burette-stand serves to pinch the caoutchouc tubing, and by varying, as required, the pressure on the latter the flow of liquid is regulated, or arrested entirely. By inserting a short length of glass tube into the free end of the caoutchouc (the pressure on which has been released for the time being) and applying suction the burette may be filled with ease, in a very short time, and without the production of a single bubble (pl. XXXVII., right hand fig.).

This form cannot be used in cases where the solution is required to stand for two or three days in the burette, to be used for a fresh analysis, as the air confined above the liquid is subject to the variations of temperature, which when rising would cause the solution to be slowly forced out of the delivery aperture.

It may not be out of place to remark that Mohr's burettes, the stopcocks of which have been broken off, may easily be converted into the new form and thus be rendered serviceable again.

Art. LXIII.—*Notes on Refrigeration.* By Professor A. W. Bickerton.

[*Read before the Philosophical Institute of Canterbury, 5th May,* 1881.]

Some weeks ago, Mr. Montgomery, Chairman of our College Board, requested me to give my attention to the means available for producing such a slight reduction of temperature as might render it possible to ship home the butter and cheese that was made in the Banks Peninsula and other grazing districts of Canterbury. He assured me that the question was of considerable importance, as there was a very large quantity of land exceedingly suitable for grazing purposes and not very well adapted for other branches of agriculture, yet the want of a market has hitherto prevented its being fully applied to this object. I was afterwards consulted by Mr. J. L. Coster, Chairman of the New Zealand Shipping Company. I have, therefore, thought it desirable to give a brief statement of the ideas that have suggested themselves in connection with the subject.

Temperature may be reduced by three essentially different modes: 1st, night radiation; 2nd, the expansion of compressed air at ordinary temperature; and 3rd, change of state—that is, solids becoming liquids and liquids becoming gases.

The liquefaction of solids is the basis of all the so-called freezing mixtures. The volatilization of liquids divides itself into two branches; the evaporation of water and the ebullition of such liquids as boil at an exceedingly low temperature, such as liquid carbonic acid, sulphurous acid, ammonia, ether, etc. Of these methods those that appear most likely to be useful are night radiation, evaporation of water, expansion of compressed air and freezing mixtures.

It must be understood that the problem to be solved is a very different one to the production of a daily supply of ice, for it is evident that if we could obtain a perfect nonconducting air-tight chamber that once had its temperature lowered, it would remain at that temperature for an indefinite time, and require no further attention unless there were an internal action such as chemical change or friction that would develope heat. There is no substance but allows the passage of more or less heat, but substances differ to an extraordinary extent in this particular. It would be a matter of experiment to discover the most suitable nonconductor, though I think it probable that well-carded wool of good quality would be the best. It would also be a matter for experiment to ascertain how tightly this would have to be packed to be most nonconducting.

Having ascertained the most effective material and the conduction of this material that offers the greatest resistance to the flow of heat, it would be necessary to investigate the temperature and other conditions under which butter and cheese may be kept for a sufficient time to enable their transit to be made. Doubtless, the question of time is a very important one, as it may be found possible to carry them with little trouble in a steam-ship, whilst the uncertainties of the tropical calms may result in complete failure with a sailing ship. A careful investigation into all these matters would doubtless well repay its expense.

In practically carrying out any method of reducing temperature, we are met with the difficulty that air, when cooled, will generally deposit moisture; yet a most important point in the keeping of cheese is that it should be dry. Therefore, in all our processes we must associate drying the air with its refrigeration. There are two different methods of cooling a chamber, and each of these methods will require a different mode of drying the air. These two modes are either by replacing the air by cooler air or by cooling the air already in the chamber. When fresh air is admitted the drying may be effected by passing the air to the bottom of the chamber down a thin copper tube inside the chamber. It will thus part with its heat to the chamber, becoming warmer and consequently drier. As this tube would be much cooler than the air in the chamber, dew would probably be deposited on the outside. Means should be taken to catch this as it trickled down the tube. This would tend to dry the air inside.

If we adopt the method of cooling the air already in the chamber, this will have to be effected at the top, and all that will be necessary to dry the air inside will be to make arrangements to lead away the dew that will be deposited on the coolers. These two methods are extremely simple, and I believe would prove perfectly satisfactory.

Before it could be determined which would be the best method for producing the refrigeration, careful quantitative experiments would be necessary. In this paper I shall only give the outlines of the modes of applying each of the principles already mentioned, leaving it to experience to decide which is best.

If freezing mixtures be used, it would probably be best that the air already existing in the chamber should be cooled, only introducing fresh air occasionally. To cool the air, holes should be made in the roof and large thin copper pipes closed at the bottom should be fitted into them. The mixture should be placed in another slightly smaller similar vessel and slipped down into the inside of the other upper tubes and stirred *in situ*. The heat required to allow the salts to dissolve would come from the inside of the chamber. The dew that was deposited on these tubes should be caught in receivers fixed on the bottom of the pipes. This action as already stated would tend to keep the air dry. As the air was cooled by contact, it would fall by convection and be replaced by warmer air.

In making freezing mixtures it is usual to dissolve in acid, but for this purpose I think water would be best, as the solution might be evaporated and recrystallized. In this way the salt may be used over and over again any number of times. It may be mentioned that as a means of reducing temperature on a considerable scale, it is impossible freezing mixtures could be economized. But during a great part of the journey it would not be difficult to prevent the temperature rising above 60° C., so that if not suitable for a long journey it may be a valuable adjunct.

If expansion of air, evaporation, or night radiation, or any combination of these processes, be used, then it is probable that it would be best to exchange the air inside the chamber by the cooled air, although it is not necessary to do so, as the cooled air may be passed along tubes with thin copper bottoms thus acting in the same way as the freezing mixtures.

In taking advantage of night radiation, a black bulb thermometer should be consulted, and when it stands low air should be passed through a vessel with a thin copper top, the other parts being nonconducting; the copper should be smoked on each side. Arrangements would, of course, have to be made to catch the water precipitated. The air by its own density would pass down its tube to the bottom of the chamber, and it may not be necessary to use any artificial means of propelling the air.

If air expansion be used, then the strong vessel into which the air is compressed having been allowed to cool, the air must be allowed to expand into a separate vessel to precipitate moisture; this may be either a non-conductor outside the chamber, or a conductor placed inside; the latter would probably be the most economical.

Evaporation should be taken advantage of when the wet bulb thermometer is much lower than the dry bulb. Of course a Daniel's Hygrometer would be a superior test; the cooling may take place in copper tubes covered with calico, kept wet by water dripping on it. This method may be used with any of the others already mentioned. The whole of the methods are so extremely simple that any intelligent man would quickly know how to use any one or any combination.

I was told that it was mentioned in a paper that the recent cheese and butter shipment was made under my instructions; but my connection with the experiment was a very simple one. It was proposed to keep the chamber cool by passing ordinary air through it. I explained that this could not possibly reduce the temperature below that of the air of the tropics, and suggested that artificial means of producing cold must be used in addition to ventilation, mentioning the methods spoken of above; but the ship started in a few days, so there was no time to make machinery, and not much time for experiment. I suggested that if the experiment must be thus hurried, whenever the temperature of the air was such as to render ventilation useless it was probable freezing mixtures would be the best to try this time, especially as from experiments I had made I could not recommend cooling by evaporation. This I believe was done. Mr. J. Anderson made some experiments in his boiler-room, and found a small quantity of freezing mixture sufficient to keep an experimental chamber 15 degrees below the temperature of the air of the room. I cannot say I am sanguine of the success of the experiment. The varying ripeness of the cheese and the difference of quality found in butter, even in Christchurch, would I fear prevent a great success, even were the confessionally perfunctory arrangements for cooling found to be sufficient. I believe, with Mr. Bowron, that the factory system, or some other means of guaranteeing uniformity, is an indispensable feature of any successful scheme of making Europe the market for the butter and cheese of Canterbury.

I may add that I personally know nothing of the time or the temperature at which butter and cheese will keep sweet; but if they will keep good at 63° Fahr., I do not believe it would be a difficult matter to keep the air in a good nonconducting chamber from rising above that temperature during an ordinary voyage.

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## Art. LXIV.—*On the supposed Paraffin Deposit at Waiapu.*

By William Skey, Analyst to the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 20th August, 1881*].

You may be aware that a considerable quantity of a soft, greasy, combustible mineral occurs about ten miles south of Waiapu associated with the petroleum rocks of that district, and forming a rather extensive deposit there, and that the nature and value of this has been, and now is, a subject upon which professional opinion is exceedingly varied. Opinions being in this way, at the suggestion of Dr. Hector I have prepared this paper for the purpose of bringing the whole question before you in a concise manner.

So far back as the year 1872, a sample of this mineral was handed to me by Dr. Heetor, who collected it, and the partial investigation of it which I then made, showed that, except for clay and sand, which was, of course, foreign to the mineral, it was in principal part oxygenated hydrocarbons; among which I considered dopplerite, or a mineral greatly resembling it, was largely represented. I promised a fuller report upon it as soon as I had time to continue my examination, but before I could well do this a sample of an article averred to be "solid paraffin," also from Waiapu, was forwarded to Dr. Hector by the Hon. G. Randall Johnson for analysis. This sample on examination proved to be very similar to the one already described, consequently made up in principal part of oxygenated hydrocarbons, and therefore a substance far removed from *solid paraffin*, and so very inferior in value to this mineral. But as I have said, professional opinion differs, and differs greatly in regard to these points. No doubt what have been taken for fair samples of it have differed somewhat in character, but still, as I conceive, hardly so much as to allow us to explain this divergence in the way indicated. It appears to me that this divergence of opinion is in greater part to be properly ascribed to the various methods of analysis employed in testing it.

The annexed table clearly shows the very great divergence there is in the results obtained by Mr. Dixon, of the Technical College Laboratory, at Sydney, Mr. Cosmo Newberry, Government Analyist, of Melbourne, and myself respectively :—

| | Dixon. | Newberry. | Skey. |
|---|---|---|---|
| Kerosene .. .. .. | 17·5 | — | |
| Intermediate oils .. .. | 9·8 | | 3·1 |
| Heavy oils .. .. .. | 35·0 | 73 | |
| Paraffin .. .. .. | 30·0 | | 9·3 |
| Carbon .. .. .. .. | 7·7 | — | — |
| Earthy matters .. .. | — | 24 | 26·9 |
| Water .. .. .. .. | — | 3 | 11·3 |
| Mineral .. .. .. | — | — | 49·4 |
| | 100·0 | 100·0 | 100·0 |

These results are certainly very discordant. It should be remarked, however, that Mr. Dixon's result could be got upon the sample I examined by washing out the earthy matter, drying the residue, and submitting it to a distillation which, towards the end, is destructive.

Mr. Newberry's results agree with mine pretty nearly as regards the earthy matter, but not, as you will observe, in respect to the water, while he has no representative of the 49·4 per cent. of carbonaceous matter which I find, and which is fundamentally different to either oil or paraffin, and also is of far less monetary value.

Assuming that the trial tests of this analyst have given results approximately correct, the analysis, when completed, will, he considers, give 63 per cent. of paraffin, as against 9·3 per cent. by myself, and 30 per cent. by Mr. Dixon. Mr. Newberry values the article at £28 per ton, after being cleansed; an estimate which is, I dare say, about right for this percentage of paraffin.

Assuming my result to be approximately correct, you cannot avoid coming to the conclusion that the substance which exists in largest quantity in this mineral, has been all along mistaken both by professional analyists and those interested in the article for paraffin.

The precise nature of this substance is more a matter of scientific interest than of anything else. I intend, so soon as I can spare the time, to determine this, but I think that for the present I have done all that is required for economic purposes. I show that about half of the carbonaceous part of this "mineral grease" (as Dr. Hector terms it) is neither paraffin or oil. You can judge for yourself of this matter by inspecting what I have just obtained from this grease as separated from oil and paraffin.* You may notice that it is solid, brittle, and infusible—characters which do not belong to either of the substances which, I think, it has been mistaken for, viz., paraffin or oil. It is besides highly absorbent of water, and swells very much in this liquid, passing thereby into a gelatinous form. The mineral grease or supposed "solid paraffin" yields nearly fifty per cent. of this substance. Mineralogically it belongs to the class of combustible minerals known as oxygenated hydrocarbons, and I believe contains several of these bodies. It is obviously formed out of some of the constituents of petroleum by oxydation and absorption of water. Copies of the reports of the analyses to which I have just referred, are laid upon the table for your inspection.†

* Sample was exhibited, as also one of the supposed paraffin mineral.

† Since this paper was read an examination of the Waiapu mineral grease has been made upon a large scale on the grounds of the Southern Cross Petroleum Company. The result of this, for comparative purposes, I here render centesimally:—

| | |
|---|---|
| Light oil .. .. .. .. .. | 5·4 |
| Kerosene .. .. .. .. .. | 13·2 |
| Lubricating oil .. .. .. .. | 4·0 |
| Paraffin .. .. .. .. .. | 7·9 |
| Balance not specified .. .. .. | 69·5 |
| | 100·0 |

It seems therefore that, as in my results, that constituent of the mineral which is the most valuable, and which has been asserted to be the most abundant, viz., paraffin, is present, but in minor quantity; the difference between my result and these, in respect to the paraffin, is only 1·4 per cent. The excess of oil over that which I indicated is doubtless derived by destructive distillation from the oxy-hydrocarbons present.

Art. LXV.—*On a Search for the Poisonous Principle of* Brachyglottis repanda *and* B. rangiora. By William Skey, Analyist to the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 11th February,* 1882.]

The leaves of *Brachyglottis repanda*, so well known to be poisonous to horses, etc., I examined some years ago for the purpose of determining the chemical nature of the principle to which this property is referable, but my efforts were unsuccessful, in spite of which I was enabled to report as the result of this investigation that the "poisonous part is not an alkaloid."

A few weeks ago, however, I was kindly presented by the Hon. Mr. Mantell with a small quantity of a substance which he had observed to exude from a freshly-cut shrub of *Brachyglottis rangiora*, a variety of the plant distinguished and named by Mr. Buchanan, and stated by him to be a native only of the provincial district of Auckland. This substance proved to be essentially a balsam, that is, a mixture of essential oil and resin, these together amounting to 99·42 per cent.

As in my former experiment, I failed to find anything in it having the character of an alkaloid, although I extracted, by means of warm water, a small quantity of a bitter substance from it, and found a little nitrogenous matter present.

Experimenting with the balsam in a tentative way, I soon found that it gives a very remarkable, indeed I may say an unique, reaction for a balsam with acids generally. In warm hydrochloric acid, for instance, it colours to a purplish red; even at common temperatures, if time be allowed, this comes about. But the most striking effect is produced by heating the balsam with alcohol acidified by any strong acid, a rich deep-blue liquid being thus obtained. Subsequently it was ascertained that the same effect is to be got by using the leaf or the fresh shoots of this plant in place of the balsam; even the old wood can give a feeble reaction of this sort. And it was further ascertained that the variety of this plant which covers many of the hills in the vicinity of Wellington (*Brachyglottis repanda*) also behaves in this way with acids.

It was considered that the substance giving this reaction is likely to be the poisonous part of the balsam, chromatic reaction being obtainable with a great number of organic poisons. I therefore at once took means to isolate both the oil and resin for separately testing. For this the balsam was put in a retort along with water, and heat applied thereto. The distillate contained an oil which was partly in solution and partly floating upon it; both the clear solution, as separated from the floating oil, and the pure oil, giving the same reaction as the balsam did in the acids and alcohol.

The residue in the retort, however, also gave the same reaction, although the distillation had been continued for eight hours; nor did it appear possible to eliminate from this residue the substance which is colourable in this way. To ascertain, therefore, whether or not this colourable substance is wholly volatile, I evaporated an ethereal solution of the balsam to dryness, and the thin film so obtained I submitted to a temperature of 212° Fahr. for two hours. The residue was not found capable of colouration by acids.

It was established, therefore, that the only part of the balsam which gives this chromatic effect is volatile, and as I was not able to separate any solid matter from this distillate I conclude that it is an essential oil. This oil is, I find, so rapidly changed in contact with air and water at an elevated temperature, that it is best separated from the balsam by dry distillation, out of contact with air as far as possible.

Separated in this way, its taste and other properties are besides best observed. It is then found to be slightly bitter and acid, warm to the mouth, with a fragrant odour; it is feebly soluble in water, readily soluble in alcohol, also in ether. An aqueous solution of it affords no precipitate with mercuro-iodide of potassium, nor yet with mercuric-chloride, but it gives a pale-yellow or white precipitate with the above-named salts successively applied. It also gives a precipitate with tannic acid, but none with alkalies, acids, or bi-chloride of platinum.

With oxalic or tartaric acid, even at a temperature of 212° F., it does not colour; but with all the mineral acids, or even acetic acid, it colours as has been already indicated, and this even at common temperatures. If the oil is, however, first warmed with any free alkali, it then does not become coloured by contact with any acid.

The blue or light purple compound formed out of this oil by acids,* assumes a yellowish colour when alkalized, but reacquires its normal tint when acidified. In contact with warm nitric acid or nascent hydrogen it also loses its blue colour, and in such a way that it appears impossible to restore it.

It has been found to be almost unalterable under ordinary conditions, standing as it does with seeming impunity a temperature of 212° F., but whether it has sufficient permanency to allow of being profitably used in the dye-house, has yet to be ascertained.

The nature of the change which is wrought upon the oil in question while it is acquiring the colour described, I cannot as yet ascertain. All I can yet be certain of is that it then splits into two or more substances. In this respect it resembles digitaline, that poisonous resin of foxglove which

* Both the balsam and this blue-coloured product of it were exhibited.

is coloured green by warm hydrochloric acid, and also to karakine, the crystallizable and most likely the poisonous resin of the karaka berry.* It differs, however, from both these principles in not being a glucoside as I have shown these to be.

The experiments which I have made with this colourable substance upon animals have not given results of a nature so decisive as to warrant me in ascribing to it the poisonous properties of the balsam, but I hope soon to be able to supplement this paper with an account of experiments which will settle this interesting point. Sufficient has, however, I think, been adduced to show that whether or not this colourable matter is the poisonous part of the plant, a very remarkable principle has been found to exist therein, and one which is well worthy of the attention of those who have the leisure and inclination to make organic chemistry their especial study. To coax the labours of these people in this direction, I shall send a sample of the balsam to some chemist of repute in the Mother Country for diffusion at his discretion.

I should state that the resin from which this oily matter has been removed showed no remarkable reaction to chemical tests; it may be divided into two resins by the use of alcohol and ether.

The following tabular statement represents the approximate composition of the balsam:—

| | |
|---|---|
| Essential oil | 31·70 |
| Resin soluble in alcohol | 67·42 |
| ,, insoluble in ether and alcohol | ·31 |
| Water and nitrogenous matter | ·57 |
| | 100·00 |

In this connection I may observe that the young shoots of all the common shrubs and trees which I have treated in this way with acids, for comparative purposes (some 50), give not a blue-coloured substance, as the *Brachyglottis* does, but a red-coloured one—*Erythrophyll* as I conceive, which is the red colouring matter of autumnal leaves.† The singularity of the fact therefore, that the wood, etc., of the *Brachyglottis* affords, under the circumstances described, a blue substance, is strikingly brought home to us.

* "Trans. N.Z. Inst.," vol. iv., art. 53.

† The base of this substance is also present in *Brachyglottis*, but in comparatively small quantity.

ART. LXVI.—*On a new Theory of the Mode by which Photographic Effects are produced with Silver Salts.* By WILLIAM SKEY, Analyst to the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 11th February*, 1882.]

THE photographic effect of the actinic rays upon argentic chloride has not within my knowledge been thoroughly explained; it is known what the ultimate effect is,—namely, to split this salt into sub-chloride of silver which remains as a pale-reddish substance, and chlorine which escapes; but the exact process or processes by which this comes about is not, I believe, understood, though many theories in regard to it have been produced. This being the case, I beg to lay before you a theory which I have formed on the subject, a theory which I have been led to entertain by a consideration of certain phenomena that have been hitherto unnoticed.

You may remember that in a paper upon certain argentiferous salts in relation to light,* I showed that the iodide of silver like the chloride requires the presence of water in conjunction with light, in order that photographic change be produced, and besides I showed "that the product of sunlight upon argentic chloride varies both in colour and composition according as to whether this substance is alkalized or not." "Thus in weak solution of potash the product is dark brown or black," and as to composition it is largely made up of argentic oxide (according to more recent investigations of mine), as it evolves oxygen when brought into contact with any acid—even carbonic acid; while on the other hand if free alkali is absent the argentic chloride passes into argentous chloride.

These facts, few and simple though they are, nevertheless appeared to me explanatory of the whole process by which the fullest photographic effect with this salt is reached.

Now, all the efforts made to attain this hitherto, all the equations made to represent the chemical action which is effected therein, have, as far as I know, been with the elements of water left out of cognizance or calculation, though, as we know, these are necessary to such action.

The formula which I append to express the theory I here propose, shows the processes by which argentic chloride is split into argentous chloride and chlorine by the influence of light. In them I assume that water is present and decomposed. For perspicuity, I take three equivalents of argentic chloride and one of water, thus:—

$$3\,(Ag\,Cl) + H^2O =$$

1st process—$Ag^2\,Cl + Ag\,O + 2\,(H\,Cl)$.

2nd process—$Ag^2\,Cl + Ag\,Cl + H^2O + Cl$.

* "Trans. N.Z. Inst.," vol. xii., art. lxi.

The first effect is to produce argentic-dioxide, argentous-chloride, and hydrochloric acid, by re-grouping the elements present in a portion of the argentic-chloride and water used; were free alkali present, no secondary effect would take place, as the newly-formed acid would combine with it; thus we should have, in course of time, most or all of the argentic-chloride represented by argentic-dioxide. But in the present case we suppose no free alkali present to absorb the hydrochloric acid just formed. This acid, therefore, is free to act upon the argentic-dioxide which has been simultaneously produced with it. Thus well-known chemical effects are produced, decomposition and recomposition ensue, and there is obtained argentic-chloride, water, and chlorine. If the impingement of light is continued, action does not end there, but the newly-made argentic-chloride is in its turn decomposed, a portion of it is passed by the first process described into a further quantity of subchloride, while of the remainder, in conjunction with water, compounds are again formed which, by their mutual action, set chlorine free. Thus the original argentic-chloride is gradually, and by two alternative processes, depleted of one equivalent of chlorine and the pure subsalt ultimately left on our hands. The final result is, it may be stated, in harmony with the fact first observed by Professor Vogel, that chlorine is one of the products of the action of light upon argentic-chloride.

The part which light plays in the photographic effect may be viewed as purely a mechanical one—thus, the molecules of this compound, together with those of water (which we have seen to be necessary for effect), are oscillated by certain of the rays which make up light to such an extent that they get to positions in which they are attracted less by their companion molecules than by the stranger ones with which they are thus associated. Therefore those combinations are effected which we observe.

The direct effect of light, in fact, decomposes both the argentic chloride and water, producing, as I have said, argentous chloride, argentous oxide, and hydrochloric acid; but secondary action between certain of these compounds prevents any accumulation of argentous oxide by decomposing it as fast as it is made.

I have only to add that, allowing this theory to be correct, the photographic effect in case of iodide and bromide of silver should be explainable by a theory similar in kind to it.

ART. LXVII.—*On the Percentage of Citric Acid obtained from Limes grown in Auckland and Tahiti.* By J. A. POND.

[*Read before the Auckland Institute, 15th November*, 1881.]

IN the course of my analytic duties I have frequently had to examine samples of lime-juice from the Pacific Islands, many of these samples being adulterated with fresh or sea-water. When making these examinations I have often felt the need of a standard sample with which to compare those I had to investigate, the only reports I had access to being those of West Indian and Sicilian juice.

Through the kindness of Captain Sinclair, of the schooner "Sybil," I received a box of fine ripe limes in April last, each fruit being carefully wrapped in paper. Of these I took forty, weighing 5 lbs. 12 ozs., and carefully grated off the skins, the weight then being reduced to 5 lbs. 4 ozs. These I submitted to expression, the result being forty fluid ounces, or a little more than 50 per cent. of the weight of the pulp, though a much larger return would be obtained with suitable power. The juice thus obtained was of a light sherry colour, cloudy, and of a specific gravity of 1·0412 at 62° Fahr. The ash I found a percentage of ·845, and its acidimetric value to be 7·752. About the same period I also received a parcel of limes from the Hon. F. Whitaker, grown on his land at Lake Takapuna. These limes were very much smaller than those from the Islands. Taking ninety I had them carefully peeled, and found the weight to be exactly 4 lbs, from which I expressed twenty fluid ounces of juice, still leaving a good deal in the marc, which would be obtained with greater power. The specific gravity of this juice at 62° Fahr. was 1·0454, the percentage of ash ·627, and its acidimetric value 8·13.

These values compare very favourably with those of European reputation, and are as follows:—

| | Palermo. | W. Indian. | Jamaican. | S. African. | Tahitian. | N. Zealand. |
|---|---|---|---|---|---|---|
| Specific gravity of juice | 1044·85 | 1041·30 | 1044·18 | 1044·90 | 1041·20 | 1045·40 |
| Per cent. of citric acid .. | 8·13 | 7·96 | 8·66 | 8·50 | 7·75 | 8·13 |
| Per cent. of ash .. .. | ·289 | ·321 | ·401 | ·364 | ·845 | ·627 |

When we consider that the lime grows well here, and from this to the North Cape, it will be seen to what advantage this tree might be cultivated. Requiring little care in the raising, and fruiting abundantly, for a large portion of the year the crop would be of magnitude, and the yield of juice with a suitable press would be fully fifty per cent. For lime-juice there is always a fair demand, while a large production would certainly warrant the erection of a factory in some central place for the manufacture of citric acid, an article always so largely and steadily in demand in all parts of the world as to remove any danger of sharp competition reducing its value.

If, in addition to the *Citrus limetta* and *C. limonum* the *C. bergamia* was also planted, the essential oil, which could be extracted by machinery at a very small cost, would also add to our list of exports, while the juice would be of value in the manufacture of citric acid. The position of Auckland in respect to the Island trade, and to the extent of land to the north so well adapted to the growth of this species, points to a successful industry in the manufacture of citric acid in this city at no very distant date.

## V.—GEOLOGY.

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Art. LXVIII.—*On the Formation of Lake Wakatipu.* By William Stuart.

[*Read before the Southland Institute, 19th August,* 1881.]

The Wakatipu Lake is deepest about half way between its two ends, near the Queenstown bend. The depth is very great, probably the bottom is below sea-level, at any rate it is below the level of the Waimea and Dipton Plains. During occasional visits to this lake, I have been "exercised" to use an old theological expression) to account for this. I know that some have tried to explain it by the theory that the lake bottom had been scooped out to great depth by glacier action. But this was difficult to imagine, Having had occasion during the last twelve months to visit the locality, I carefully examined the country, and came to the conclusion that, whatever may be the case with the neighbouring lakes, the Wakatipu has been formed in much the same way as several of the lakes on the southern side of the Alps in Europe—namely, by the subsidence of the great mountain chain on the side of which it lies.

That the Wakatipu country has been subject to upheaval and subsidence is clear enough, but the mode of the last subsidence is not so clear. At first sight it would appear, to judge from the plains on the east side of the Southern Alps, and from the fiords on the west (these latter being mountain valleys into which the sea has come), that the island had risen gently on one side of the central chain (as an axis), and had subsided heavily on the other, but a closer examination, I think, will show that this is not what happened. It looks rather as if the island—at any rate this end of it—had gradually sunk as from a hinge from the present east coast line, or more probably from a line far to seaward beyond it. That this end of the island did subside in the manner I describe, is proved, I think, by the existence of the fiords and the comparative shallowness of the sea on the west coast, and by the fact that the seaward moss (which is now gradually rising) shows the remains close to the surface of a submerged forest destroyed in a comparatively recent time. A subsidence in this way would be greatest furthest from the hinge, and least near it—the sea would consequently come over a fringe of land, and be shallow on the east, and would cover much land deeply on the west.

Now the alpine range, before the subsidence I am speaking of, undoubtedly stood at a much higher elevation than at present, at least 5,000, more likely 10,000 feet, as the deep fiords on the west side of Fiord County indicate. When the head of Wakatipu Lake was raised that height and the lower end a corresponding height, the lake must have contained a glacier. At any rate, it did once contain one, as the Kingston moraine testifies. Keeping in mind that the lake country subsided not from the central chain as an axis, but from the sea coast as from a hinge;—that in other words the lake did *not* rise at the lower end and sink at the upper, but that the *whole* of the lake sank, more of course at the head and less at the foot;—we can see clearly how the deep part in the middle came to be. This would simply be as follows:—The valley in which the lake lies, and which is about 80 miles long and narrow for its length, was the bed of a glacier. A glacier moves like a river and would doubtless also work down the valley in a parabolic curve (as our president has demonstrated in a paper printed in vol. vi. of the "Transactions" that the principal rivers here do), the shoulder of the curve being towards the upper end of the valley. Now the gradual lowering in height of the glacier (which I am assuming stopped short at Kingston) would have the effect of causing it to melt away at the lower end, and as the foot receded from the moraine, it would continue to deposit *debris* and make the valley at that part (already stopped up by the moraine) to decline gradually backwards. The future lake would be shallower at that end—more or less as the wearing away of the glacier was quicker or slower. At the same time the sinking of the curve higher up would tend to make the slope up to the moraine steeper. Whilst this was going on, the glacier would slowly melt and in course of time would disappear, water would take its place and the lake (at a much higher level, however, than at present) would come into existence, formed partly by the melted ice of the glacier, and partly by summer rains and melted snow off the ranges. The two rivers which run in at the upper end would gradually deposit a delta (the present Dart Hundred) and the ultimate effect of all these proceedings would be to make the lake deepest at the middle.

From the foregoing considerations, it seems doubtful that the Kingston Valley has ever been the outlet of Lake Wakatipu. It *was* of the glacier but not of the lake, which, if I am right in theory, must, as I have said, have originated by the sinking of the upper part of the valley below the level of the moraine. Most probably the lake always found an outlet, as at present.

In conclusion, I would remark that I am well aware I have suggested nothing new. But my object in writing this short paper is to excite an interest in a subject (the mode of formation of the large southern lakes) which, as these lakes lie it may be said at our very doors, it naturally falls to the Southland Institute to investigate.

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Art. LXIX.—*Description of new Tertiary Fossils.* By T. W. Kirk, Assistant in the Colonial Museum.

[*Read before the Wellington Philosophical Society, 21st January,* 1882.]

The species now described formed part of a small collection of fossils from the tertiary beds near Petane, Hawke's Bay, submitted to me for determination by Mr. A. Hamilton.

*Trivia zealandica.*

Spire hidden; transverse striæ passing only a short way up the sides of the shell; back smooth and polished.

Length ·5, breadth ·35 inch.

*Marginella propinqua.*

*Marginella propinqua,* Tate; Trans. Phil. Soc. of Adelaide, 1877–8, p, 94.

"Shell oblong-cylindrical, solid, light horn-coloured, transversely streaked with white, enamelled; aperture triangular, with a broad milk-white varix strongly denticulated on the bevelled edge; columella five-plicate.

"Length ·45, breadth ·22 inch." (Tate).

*Marginella hectori.*

Shell highly polished; spire moderate; aperture rather wide; columella with four plaits, the posterior one being the most prominent. Lip incurved, not denticulate.

Length ·45, breadth ·25 inch.

*Erato lactea,* Hutton; Man. of N.Z. Moll., p. 63.

*Helix greenwoodi,* Gray; P.Z.S., 1849, p. 165; Man. of N.Z. Moll., p. 16.

*Pleurotoma tuberculata.*

Shell fusiform, spire about half the length of the shell; whorls eight, angled posteriorly; a row of tubercles on the superior angle of each whorl, and a similar row of smaller ones filling up the suture; spirally ribbed; body whorl with about eleven ribs crossed by lines of growth. Aperture moderate, outer lip angled posteriorly.

Length 1 inch, breadth ·45 inch.

*Cardita lutea,* Hutton.

*C. lutea,* Hutton; Man. of N.Z. Moll., p. 159.

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## Art. LXX.—*On a Deposit of Moa Bones near Motanau, North Canterbury.*

By Alexander McKay, of the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 21st January*, 1882.]

During the past winter a flood occurred in Northern Canterbury which laid bare a deposit of moa bones near Motanau. This is exposed in the banks of a small creek which forms the boundary between the properties of Mr. Arkle and the Hon. William Robinson. Mr. Robinson having reported the discovery to Dr. Hector, I was sent to examine and collect from the deposit, and am now permitted to lay before the Society an account of what I saw and did.

Where exposed the bones form a closely compacted bed, varying from a few inches to 18 or 20 inches in thickness, and within a distance of 40 feet they occur in gravel, sandy clay, plastic clay, and peaty lignite, the progression as stated being from east to west, there being a slight dip of the bone-bed in that direction. In the banks of the creek the bone-bed is overlaid by a deposit of gravel, sand, clay, and loam, to a depth of 10 or 12 feet, and has at one time been covered to a much greater depth, as in the immediate vicinity there is evidence that the bones must since their deposition have been covered by at least some 50 or 60 feet of a deposit similar in character to that which at the present time is seen to overlie them. Mr. Arkle informed me that for many years past he had noticed bones in the bed of this creek, which he now recognizes to be moa bones; and to this gentleman is due the discovery of the bone-bed, which he observed immediately subsequent to the flood of last winter. Part of the deposit lying within his property, Mr. Arkle kindly gave me permission to make such excavations as I should deem necessary, for which I take this opportunity of thanking him.

The thickest part of the deposit appearing to lie on Mr. Robinson's side of the creek, I opened a paddock on that side. In doing so 5 or 6 feet of sandy loam was first passed through, in the lower part of which stumps of trees were encountered of which no indications appeared at the surface. Below this for the next 2 to 3 feet, a sandy bed with patches of gravel was encountered, after which a bed of variable composition (quickly changing from sand to plastic clay) overlaid the stratum in which the moa bones occur. The bone-bed over the area excavated varied from 1 foot to nearly 2 feet in thickness, and consisted of a closely compacted layer of bones, the interspaces between which were filled by a soft tough clay. The whole rested on a bed of well rounded gravel, the thickness of which could not, at this place, be ascertained. All the bones, as far as the bed was excavated, appeared to have been disarticulated before being finally deposited, as no two bones were found which lay in such a position as to warrant their reference to the same individual moa. Most of the tibial bones were not found lying in a horizontal position, but inclined at all angles and so locked in the deposit one by the other, or by the other larger bones of the leg, that the extraction of one of them almost invariably involved the destruction of one or more lying contiguous to it.

Although at first sight the bones appeared as a confused mass, yet there proved to be some order in the mode of their occurrence. In the eastern end of the paddock most of the metatarsal bones were found. Tibiæ were most abundant in the middle part, and femora at the western end. Where the bed was thickest the pelvic bones formed its upper part and were universally in a crushed and highly decomposed condition. Vertebræ, toe bones, and occasionally bones of the head, were found from top to bottom of the bed. In the clay bed which at the western end of the paddock overlaid the bones, vertebræ and toe bones were of frequent occurrence, and in this horizon was found a metatarsus with the toe bones complete. The metatarsus was lying horizontally in the clay bed, while the toes were sunk in the clay in a vertical position.

In the comparatively small area of this paddock, which was less than 30 square feet, there must have been present skeletons or portions of skeletons of no less than thirty birds. To all appearance the deposit is a most extensive one, the thickest part of it extending north-east from the northern bank of the creek; how far it extends in this or in the opposite direction on the southern bank of the creek, indications at the surface afford no means of determining.

On the southern bank of the creek the bone-bed is not so thick, and, following the water-course upwards, it passes into a bed of peaty lignite without bones, but a few feet beyond this bones are present in the lignite where it crosses the water channel, and is exposed at the base of a low cliff bounding the upper end of a deep gulch, which is rapidly being cut back towards the source of the creek. Followed till disappearing under the northern bank, the bones in the lignite increase from an occasional one till they form a bed about 8 inches thick, the lignite increasing to about double that thickness, but being without bones in its upper part. In the peaty lignite the bones proved quite as much crushed, and much more fragile than where they were imbedded in the clay; in fact, the vertebræ and other bones of open texture were little more than discernible in the lignite, while the leg bones were, though apparently in good condition, so brittle that scarcely any could be got out without breakage. As there appeared to be no difference in the species imbedded in the lignite and in the clay, I excavated but a small paddock in the lignite, and getting nothing more than I had already obtained in a better condition from the first paddock, I did not think it necessary to continue the work of excavation.

Of the moa bones collected, all of them seem to be referable to not more than two species; and of these the bones of *Dinornis elephantopus* certainly constitute nine-tenths of the whole.

The remains of other birds were very rare in the bone-bed, belonging, with the exception of a few fragments, to *Harpagornis moorei.* All the bones of this species that were strong enough to resist the pressure of the overlying deposit are beautifully preserved. The only part which has suffered damage from this cause is the skull, which, occupying an interspace between two large moa bones, managed to escape total destruction.

A curious feature in the mode of occurrence of these *Harpagornis* bones is that all those of the leg and wing were found with their greatest length vertical in the bone-bed. This was also noticeable in the case of most of the immature moa bones.

Finding that there was but small probability of finding the skeleton of an individual moa by itself, and equally little being the hope of securing the material to construct one, I had to be contented with making a selection of the larger leg bones and such vertebræ ribs and toe bones as were met with during the progress of the excavation.

I have already mentioned that the bone-bed was covered to some depth by a deposit of gravel, clay, and loamy soil, and that it rested on a bed of well-worn gravel the thickness of which could not be ascertained at the place where the bones were found.

From a little south of the Motanau River to Stonyhurst, a distance of seven miles, these gravels overlying tertiary strata form between the coast range and the shore line a table-land elevated 200 to 300 feet above the sea. On the seaward side this is bounded by a line of high cliffs washed by the tide at high water. Besides the Motanau River, there are three smaller streams which rising on the western break through the eastern ridge of the coast range and flow across these flats in narrow channels, which are now so deeply cut that until an elevation of the coast-line takes place, they have no power to cut them deeper. A number of smaller streams rising on the flats or commencing from the slopes of the neighbouring ranges, have near the coast-line cut deep channels quite to the base of the sea cliffs. The deep narrow gulches thus formed do not as yet extend across the whole breadth of the flats, but terminate abruptly in a cliff beyond which there is no defined water-course, and as a rule no permanent stream. North of Boundary Creek, which reaches the sea three miles north of Motanau, the surface of the flats undulates in low rolling downs, and one or two isolated hills stand above the general level. Close past the southern side of one of these hills runs the little creek in the banks of which the moa bones are found. Just abreast of the little hill the creek breaks the surface of the flat and plunges into the deeper channel, which it cuts through the gravels, and further down its course into the underlying tertiary strata. Along this and other creeks numerous sections show that a heavy deposit of well-rounded gravel of uniform size overlies the tertiary marine beds. The gravels are parted 20 or 30 feet from their base by sandy clays, which at many places contain trunks of trees or pass into beds of impure peaty lignite. This is the horizon of the moa bones. Above this lies an indefinite thickness of gravel and silt, variable on account of having been unequally denuded in different localities.

Professor Haast's researches at Glenmark appear to have led him to the conclusion that there the moa bones occurred in three different horizons. These in descending order are:—

1. The turbary deposits near Glenmark homestead, from which the great bulk of the collections in the Canterbury Museum were made.
2. The alluvial deposits of Glenmark Creek and the Omihi Valley.
3. Pleistocene deposits occurring in Glenmark Creek, one mile above the home station.

In trying to correlate the Motanau bone-bed with either of these it is at once apparent that this can only be done with No. 2 or 3.

The character of the deposits forming No. 2 agrees well, both as regards the material and the sequence, with the Motanau beds; but the alluvial deposits of the Omihi Valley show not the least sign of having been denuded further than by the excavation of the present creek beds, while the Motanau flats, especially towards the northern end, have been so far denuded that the surface forms low rolling downs with here and there a low isolated hill, of which an example stands close to the locality where the bones are found.

It is true that at Motanau these gravels are isolated from the fringe of gravels skirting the coast line near the mouth of the Waipara, and also from an extensive development of gravels on both banks of the Hurunui, and near Gore Bay, Cheviot Hills. At Gore Bay these gravels are in their lower beds alternations of silt and angular gravels, in which large angular blocks are of frequent occurrence. The upper beds are well rounded gravels, clay, and loam, as at Motanau, but here the total thickness is much greater, ranging from 300 to 500 feet.

Marine shells are found in the lower beds, while from about the middle of the beds I obtained broken moa bones and fragments of moa egg-shell. I have little doubt but that these gravels are the same as those in which the bones are found at Motanau. In the latter locality the presence of the lignite bed may indicate an unconformity between the higher and lower parts of the gravel deposit. This may be so and yet the younger upper beds may be of greater age than the alluvial deposits of the Omihi Valley. The Motanau moa-bone beds would therefore belong to the older beds in Glenmark Creek already referred to. These Glenmark beds belong either to the gravels of the plain south of the Waipara, or to the Upper Miocene beds forming gravels extending south from the Weka Pass to Mount Grey Downs, and forming part of the hills between Brown's Bridge and the mouth of the Waipara River. I should say they belong to the younger beds, and as in character they agree with the gravels of Gore Bay, Cheviot Hills, we might thus find a reason for correlating them with the Motanau moa-bone beds.

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## Art. LXXI.—*Further Notes on the Thermal Springs in the Hanmer Plains, Provincial District of Nelson.* By Julius von Haast, Ph.D., F.R.S.

[*Read before the Philosophical Institute of Canterbury, 4th August,* 1881.]

In a paper read before the Nelson Association for the Promotion of Science and Industry, on the 4th May, 1870, and printed in the "Transactions of the New Zealand Institute,"* I gave the results of a short visit to these springs on 20th February of the same year. Since then, during a stay of a few weeks at the same locality, from the end of December, 1876, to middle of January, 1877, I had ample opportunity to verify not only the observations previously made, but to add considerably to the stock of our scanty information as to the temperature of these remarkable springs, by a series of carefully conducted observations during a number of days, and I now take the liberty to lay the results thus obtained before you.

The barometric readings were obtained with an aneroid of Negretti and Zambra, and those of the thermometer taken from a set of maximum and minimum thermometers of the same firm, the instruments before starting having been compared with the standard instruments of the meteorological

* "Trans. N.Z. Inst.," vol. iii., p. 293.

station in Christchurch. During my first visit to the Hanmer Plains I was informed by one of the residents that the temperature of these springs altered considerably according to the seasons and the state of the weather, a fact confirmed by a communication of Dr. Hector made to the Superintendent of Nelson in October, 1870, and printed in the same volume of the "Transactions," * in which he gives the main results of his examinations of the same springs on 8th May, 1867. In comparing these observations it appears that the temperatures of the different springs recorded by Dr. Hector are much lower than those obtained by me, and although I am not able to recognize with certainty the different springs as indicated by him, there is evidently a great difference, his highest reading reaching only 90·5°. However, as his visit took place in the autumn, the temperature of the air being only 52°, it is possible that at least to some small extent this may account for his low readings. In order to obtain reliable results, my observations were always taken at the same spot, for maximum temperature of each spring the thermometer being lowered to the bottom, whence the bubbles of sulphurous steam rose up most conspicuously, and where, after several tests, I had found the water possessing the highest temperature. The surface temperature on the other hand was always taken in a similar manner, the instrument being immersed for five minutes at the same spot. In such a manner the readings were uniform throughout.

In case of a great difference of the readings with those previously noted, I always took a second observation in order to obviate any possible error. The appended list of thermometric readings of the thermal springs shows convincingly that even in not more than 24 hours the difference reached in some instances is as much as 13 degrees Fahr. The temperature of the springs was always highest during easterly weather. On the 2nd of January the centre of the principal pool used for bathing purposes reached 120 degrees; on the 5th of January, also, whilst a stronger easterly wind was blowing than on the 2nd of January, 116 degrees were recorded. The lowest reading, 93 degrees, was obtained on January 7th, when a strong north-wester was blowing.

These facts are in accordance with the experience of the inhabitants of the neighbourhood, who had previously informed me of this curious phenomenon.

It would be premature to attempt its explanation for the present, but the recorded facts point towards the necessity (if these springs are to be used for medicinal purposes for which, from the cures effected, they are qualified in a high degree), that at least the principal springs have to be

* *l.c.*, p. 297.

properly enclosed in tubes to a considerable depth. In such a manner the temperature will remain more uniform, the surface water, and the cold springs, which are now allowed to mix freely with those of a thermal character, becoming separated from them, and thus the curative properties will not only be secured in all seasons, but will actually be augmented.

This I presume can only be done, either by the Government of the Colony taking the matter in hand and spending a large amount of money on these springs for the benefit of suffering humanity, in the same manner as this is done by the Governments on the Continent of Europe with their thermal or mineral springs, or to give such facilities to a large company that it will be incumbent upon the promoters to devote a considerable amount of money to that purpose.

Besides the tubings and enclosing of the principal springs, proper houses for bathing, and accommodation for the visitors have to be built, and some amount of money ought to be spent towards embellishing that now rather dreary and bleak spot. Being surrounded by picturesque mountains, a delightful villegiatura would thus be created, equally welcome to the patient and to the resident of the town who seeks change of air and scene.

I have examined carefully the flora in the close vicinity of the springs, but have not found a single plant that has not been previously described, or does not occur in other localities in the Hanmer Plains where the ground is moist.

The most important inhabitant of the pools is a small water-beetle. It has several times given a small bite to my companion and myself when bathing. This was sufficiently acute to be as painful as the prick of a pin. Two were caught in the act and proved to be specimens of *Colymbetes rufimanus*, in no way different from those occurring in our small cold water-courses.

In my first paper I calculated the altitude of the principal spring, from a single observation, to be 1,162 feet, whilst Dr. Hector's calculation, also from a single observation, places it at 1,360 feet.

Mr. W. Kitson informs me that there is a trig. station (F.) 18 chains north of the pools, which is 1,219 feet above the sea-level. He estimates this point at 20 feet higher than the springs, so that their real altitude would be about 1,200 feet.

| Month. | Day. | Hour. | Locality. | Barometer. | Thermo-meter. | Wind and Weather. | Spring No. 1. | | No. 2. Centre. | No. 3. Centre. | Spring No. 4. | | No. 5. Centre. | No. 6. Centre. | Spring No. 7. | | Spring No. 8. | | Spring No. 9. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Centre. | Side. | | | Centre. | Side. | | | Centre. | Side. | Centre. | Side. | Centre. | Side. |
| 1870. Feb. | 20 | 11 a.m. | Springs .. | 29·01 | 70·3 | S.W. 2, slight rain .. | 104·0 | 97·2 | 78·3 | 106·8 | 103·0 | 98·1 | 68·9 | 102·2 | 110·6 | 94·6 | 99·7 | 97·8 | 99·8 | .. |
| 1876. Dec. | 30 | 9.45 ,, | Jollie Pass Hotel | 28·60 | 74·0 | Slightly overcast .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 2.30 p.m. | Hotel.. .. | 28·54 | 75·0 | ,, ,, .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 5.45 ,, | Springs .. | 28·65 | 74·0 | Overcast .. .. .. | 116·0 | 95·5 | 79·0 | 115·0 | 97·0 | 96·0 | 75·0 | 96·0 | .. | 94·8 | .. | 95·0 | 112·0 | 93·0 |
| 1877. Jan. | 1 | 2.40 ,, | Hotel.. .. | 28·54 | 73·0 | N.W. 2, fine .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | 2 | 9 a.m. | ,, .. .. | 28·48 | 65·0 | Very fine, C.C. 1 .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 11 ,, | Springs .. | 28·37 | 72·0 | Light east'ly oppressive | 120·0 | 96·5 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | 3 | 9.30 ,, | Hotel.. .. | 28·71 | 70·5 | Slightly overcast .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 4 p.m. | Springs .. | 28·63 | 73·3 | ,, ,, .. | 114·0 | 97·0 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | 4 | 9.45 a.m. | Hotel.. .. | 28·80 | 66·0 | Very fine, C. 1 .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 11.15 ,, | Springs .. | 28·97 | 68·0 | .. .. .. .. | .. | 97·5 | 82·0 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 6.30 p.m. | ,, .. .. | 28·89 | 63·0 | .. .. .. .. | .. | 98·0 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 7.45 ,, | Hotel.. .. | 28·72 | 62·0 | .. .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | 5 | 9 a.m. | ,, .. .. | 28·70 | 72·0 | Very fine, C.C. 1, E. 2 .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 5.45 p.m. | Springs .. | 28·86 | 76·0 | ,, ,, ,, E. 3 .. | 116·0 | 103·0 | 78·0 | 117·0 | .. | 102·0 | 84·0 | 96·5 | .. | 95·0 | 102·0 | .. | 106·0 | .. |
| ,, | 6 | 9 a.m. | Hotel.. .. | 28·61 | 70·5 | ,, ,, ,, N.W. 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 6.30 p.m. | Springs .. | 28·77 | 75·0 | ,, ,, ,, N.W. 3 | 107·0 | 94·5 | .. | .. | .. | 97·0 | 75·5 | 92·2 | .. | 91·5 | 98·0 | .. | 101·5 | .. |
| ,, | 7 | 9 a.m. | Hotel.. .. | 28·58 | 74·5 | Boisterous .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 6.15 p.m. | Springs .. | 28·72 | 70·0 | ,, N.W. 4 .. | 93·0 | 90·25 | 69·5 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | 8 | 9.15 a.m. | Hotel.. .. | 28·55 | 78·5 | Rain from N.W., clearing up. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 7 p.m. | Springs .. | 28·53 | 68·0 | Fine, light, easterly .. | 106·5 | 96·5 | 78·7 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | 9 | 9.15 a.m. | Hotel.. .. | 28·20 | 68·5 | ,, N.W. 2 .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 1 p.m. | Springs .. | 28·36 | 81·0 | ,, ,, ,, .. .. | 105·8 | 92·5 | 79·0 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | 10 | 9.30 a.m. | Hotel.. .. | 28·18 | 64·0 | Boisterous, N.W. 3 .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 6 p.m. | Springs .. | 28·54 | 63·0 | Fine, N.W. 1 .. .. | 105·0 | 93·0 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | 11 | 9 a.m. | Hotel.. .. | 28·60 | 62·0 | ,, light, easterly .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 5 p.m. | Springs .. | 28·62 | 58·5 | Easterly 2.. .. .. | 108·0 | 94·5 | 72·0 | .. | .. | 95·0 | 70·2 | .. | .. | .. | .. | .. | .. | .. |
| ,, | 12 | 9.15 a.m. | Hotel.. .. | 28·33 | 65·2 | Very fine, light easterly | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| ,, | ,, | 6.45 p.m. | Springs .. | 28·41 | 68·1 | ,, ,, | 106·0 | 100·5 | 81·0 | .. | .. | 100·0 | 78·0 | 96·2 | .. | 96·5 | 101·5 | .. | 103·5 | .. |
| ,, | 13 | 9 a.m. | Hotel.. .. | 28·21 | 79·0 | Fine, N.W. 1 .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | ,, | 6 p.m. | Springs .. | 28·44 | 75·0 | Light, N.W., oppressive | 102·5 | 98·5 | 77·5 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 14 | 9.45 p.m. | Hotel.. .. | 28·20 | 62·0 | ,, S.E., rain .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |

## Art. LXXII.—*Notes on the Mineralogy of New Zealand.*

By S. Herbert Cox, F.C.S., F.G.S., Assistant Geologist.

[*Read before the Wellington Philosophical Society, 17th September, 11th October, and 11th November,* 1881.]

The work of the Geological Survey naturally divides itself under various heads, to each of which one officer or other of the department devotes special attention, and it has fallen to my lot, while pursuing the general routine work of the survey, to be more especially connected with the mineralogical and mining branches than with any other.

This being so, Dr. Hector has suggested that it would be of interest to bring before the Society in a connected form the details which have been collected from time to time concerning the minerals hitherto discovered in New Zealand, and I propose to make the present paper the first of a series describing the New Zealand minerals, with such points of interest concerning them as suggest themselves to me, and I hope that where members have information of minerals existing in localities which I do not cite, they will be good enough to furnish the Society with notes of the same, as any description of this sort should be as complete as it is possible to make it.

Up to the present time the accounts of the minerals found in New Zealand have been somewhat fragmentary. In 1865, Dr. Hector published a list of the minerals found in the province of Otago, together with a description of the same in the "Jurors' Reports of the New Zealand Exhibition," 1865; and this description was very complete when it is considered that at that time the Geological Survey of New Zealand had hardly commenced. Since that time Professor Hutton has published a list of Otago minerals in his report on the geology of Otago, which does not include all the specimens mentioned by Dr. Hector. Professor Liversidge has also (Trans. N.Z. Inst., vol. x., p. 490) described a selection of minerals forwarded to him, and Professor v. Haast has mentioned some of the economic minerals found in Canterbury in his work on the geology of Canterbury and Westland, besides which the Colonial Museum and Laboratory Reports and the Geological Survey Reports contain mention from time to time of minerals forwarded for identification or collected by the Survey, but none of these are complete in themselves, so that I think there is sufficient reason for a work of this sort.

The system of classification which I propose to pursue is the one adopted by Professor Warrington Smyth, of the Royal School of Mines, London, and it is on this system that the minerals in the Colonial Museum have been arranged. This is as follows:—

METALLIC MINERALS.—Class I.

*Brittle and fusible with difficulty.*

| | |
|---|---|
| Titanium | Chromium |
| Tantalium | Uranium |
| Tungsten | Manganese |
| Molybdenum | Columbium. |

METALLIC MINERALS.—Class II.

*Brittle, easily fusible and volatile.*

| | |
|---|---|
| Arsenic | Tellurium |
| Antimony | Bismuth. |

METALLIC MINERALS.—Class III.

*Malleable, not reducible by heat alone.*

| | |
|---|---|
| Zinc | Cobalt |
| Cadmium | Nickel |
| Tin | Iron |
| Lead | Copper. |

METALLIC MINERALS.—Class IV.

*Noble metals, reducible by heat alone.*

| | |
|---|---|
| Gold | Silver |
| Platinum | Iridium |
| Mercury | Osmium, etc. |

NON-METALLIC MINERALS.—Class I.

Water.

NON-METALLIC MINERALS.—Class II.

Carbon and Boron.

NON-METALLIC MINERALS.—Class III.

Sulphur and Selenium.

NON-METALLIC MINERALS.—Class IV.

*Haloids and Salts* } Salts of Ammonia, Potash, Soda, Baryta, Strontia, Lime, Magnesia, Alumina, Yttria, and Ceria.

NON-METALLIC MINERALS.—Class V.

*Earths.*—Silica, Alumina, Magnesia, and their hydrates.

NON-METALLIC MINERALS.—Class VI.

*Silicates and Aluminates.* }
Silicates of Magnesia and Lime, hydrous and anhydrous.
Silicates of Alumina, hydrous and anhydrous.
Aluminates of Magnesia and Glucina.
Silicates of Glucina, Zirconia, Thoria, and Yttria.

The present paper will be devoted to the metallic minerals.

## Metallic Minerals.—Class I.

*Brittle and fusible with difficulty.*

### Titanium.

*Brookite*, $\ddot{\mathrm{Ti}}$.—The occurrence of this mineral in a trap-rock (coarsely crystalline dolerite, belonging to the upper cretaceous period) at Otepopo, discovered by Dr. Hector in 1862, is mentioned in the Jurors' Reports of the New Zealand Exhibition, 1865, p. 264. No specimens are in this Museum, and Professor Liversidge does not mention it in his description of the New Zealand minerals in the Otago Museum submitted to him for examination by Professor Hutton.

*Ilmenite*, $\dddot{\mathrm{Fe}}$, $\ddot{\mathrm{Ti}}$.—This mineral is represented in the iron-sands of New Zealand, which contain variable quantities of Titanic oxide, but it more properly belongs to the ores of iron, under which it will be described.

Titanium has not up to the present time received any useful application in the arts, indeed all its properties appear to act deleteriously. Associated with iron, as in the well-known Taranaki iron-sand, it renders the ore so refractory as to make it practically useless, and in Norway and Sweden, where vast deposits exist in readily accessible places, they are unworked, although the ore could be placed in the English market for as little as 10s. per ton.

### Tantalium.

This metal has not yet been discovered in New Zealand.

### Tungsten.

*Scheelite*, $\dot{\mathrm{Ca}}\ \dddot{\mathrm{W}}$.—The occurrence of this mineral in rolled fragments, in the Buckle Burn (where it was originally discovered by Dr. Hector), Rees River, and Wakatipu Lake, as well as in small grains with arsenical pyrites at Waipori, is mentioned in the Jurors' Reports of New Zealand Exhibition, 1865, pp. 265, 414, and the specimen from Buckle Burn has again been described by Professor Liversidge (Trans. N.Z. Inst., vol. x., p. 503), but it was not till 1880 that the mineral was discovered *in situ*, when Mr. McKay obtained it in a reef on the west side of the Richardson Mountains.

It is found as irregular masses in a quartz reef 4 feet in width, and carrying a considerable quantity of mispickel, which occurs at the junction of the chlorite schists and blue slate, but belongs principally to the chlorite schists.

Scheelite, or the Tungstate of Lime, has a very limited application in he arts. It is used for the production of tungstate of soda, a substance which has of late years supplanted stannates as a mordant, and also for fireproofing fabrics.

The various oxides of tungsten also afford excellent pigments, and Mr. Skey discovered as early as 1863 that in many cases it could be used as a substitute for tin, notably in the manufacture of Purple of Cassius. The black oxide of tungsten has been proposed as a substitute for blacklead. From its weight, this mineral is frequently found as an associate of gold in alluvial workings, and is known by the diggers as "White Maori."

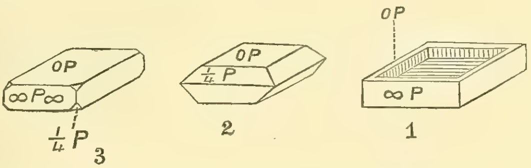
### Molybdenum.

*Molybdenite*, $Mo''$.—Specimens of this mineral occurring as flakes in a gneiss rock from Dusky Sound, were forwarded by Mr. W. Docherty for identification early in 1880, but very little of it has as yet been found.

It is used for the preparation of blue carmine for colouring porcelain.

*Wulfenite*, $\dot{Pb}\,\dddot{Mo}$.—A specimen of this mineral is in the Museum labelled as coming from the Dun Mountain, but I am unable to find any account of how it was received. It was called Mimetesite.

It occurs as crystals of a flat tabular form, belonging to the Tetragonal System, which are sometimes hollow.




consisting of (1) ∞P,0P; (2) ¼ P,0P; (3) ∞P∞, 0P, ¼ P.

In colour it varies from wax-yellow to greyish-yellow; it has a hardness of about 3. Yields a metallic bead of lead on charcoal, decrepitates violently and colours a bead of phosphoric acid greenish blue. Its occurrence is interesting, this being the first mention of it in New Zealand.

### Chromium.

*Chromite* $(\dot{Fe}, \dot{Mg})\,(\dddot{\underline{Cr}}, \dddot{\underline{Al}}) = (RO, R_2O_3)$.—This mineral which consists essentially of a combination of ferrous oxide and chromic oxide with variable quantities of magnesic oxide, alumina and silica, is largely represented in New Zealand. It has chiefly been found in the District of Nelson, where at the Dun Mountain it was for sometime extensively worked, about 5,000 tons of the ore having been exported. It was first brought into notice by Mr. T. R. Hacket who also in 1861 opened a mine in Aniseed Valley in the same district (Jurors' Rep. N.Z. Ex., 1865, p. 18). It occurs in various forms throughout what is known as the mineral belt of Nelson, a band of serpentinous and olivine rocks, which has been traced through the country from D'Urville Island to Little Ben Nevis, and also occurs as an isolated block in the Red Hills.

The ore is found :—

1. *Massive crystalline.*—In bands of a black crystalline character, varying in its degrees of coarseness, and in some cases showing distinct planes of the octahedron when fractured. No perfect crystals have as yet been found. As a rule the crystalline bands have hitherto proved less continuous in their character than those next to be described.

2. *Massive amorphous.*—In bands of a brownish-black colour, and affording a brown streak. It is softer than the last-mentioned variety, and as a rule occurs in larger and better-defined bands of ore, which also appear to be more continuous both in length and depth. It is not so valuable an ore as the massive crystalline variety, but, on account of its greater extension, would probably receive a greater share of attention should works be undertaken for its extraction.

3. *Crystalline disseminated.*—A very interesting example of this ore occurs on Little Ben Nevis, consisting of small segregations of chromite evenly distributed through a pale-green serpentinous rock. The segregations are from $\frac{1}{8}$ inch to $\frac{1}{2}$ inch diameter, and are spotted through the rock with great regularity, giving it the appearance of a conglomerate. When found under these conditions the chromite corresponds in physical characters with the massive crystalline variety previously described, and the ore-bearing rocks appear to run in belts much the same as the regular ore bands do, and follow approximately the same course. The surrounding rock being soft, a mechanical means of separation for the ore so as to increase the percentage of chromic acid should be simple.

4. *Granular disseminated.*—In this character Chromite occurs as a constituent of the rock Dunite, described by Professor Hochstetter ("New Zealand," 1863, p. 474, Eng. Ed.), as follows :—"It consists of a very peculiar kind of rock, of a yellowish-green colour when recently broken but turning a rusty-brown on the surface when decomposing. The mass of the rock is Olivine, containing fine black grains of chromate of iron interspersed ; it is distinguished from serpentine, for which it was formerly taken, especially by its great hardness and its crystalline structure. I have called it Dunite." These rocks occur in bands, which almost resemble dykes, and which are, perhaps, better developed in the Dun Mountain than elsewhere The quantity of Chromite which occurs in the rock is extremely variable from a few dispersed grains to sufficient to form more than half of the mass ; and specimens have yielded as much as 44·75 °/₀, $Cr_2 O_3$.

This ore occurs as a 10-foot band in the Dun Mountain Company's lease, and in the Roding River Company's ground a similar band is over 15 feet in width, and has been opened on vertically for 300 or 400 feet. The better parts of this rock will probably prove a valuable ore of chrome, and some of second class quality may possibly be sufficiently concentrated to render them of value.

Analyses of Chrome ores from the Nelson district show that an average percentage of 50·62 $Cr_2 O_3$ has been obtained from samples forwarded, and that half of these yield over 55 °/₀ $Cr_2 O_3$, proving the Nelson Chrome ores to be of considerable value. These analyses varied as follows from the different localities:—

| | | |
|---|---|---|
| Starveall ... ... ... ... | 44·21 | per cent., $Cr_2 O_3$. |
| Little Ben Nevis ... ... | 40·62 to 59·52 | ,, ,, ,, |
| Aniseed Valley ... ... ... | 41·16 to 42·65 | ,, ,, ,, |
| Maungatapu ... ... ... | 30·18 to 64·26 | ,, ,, ,, |
| Adams Lode ... ... ... | 51·61 to 64·63 | ,, ,, ,, |
| Croixelles ... ... ... ... | 43·44 | ,, ,, ,, |
| Wangamoa ... ... ... | 52·17 to 64·80 | ,, ,, ,, |
| Dun Mountain ... ... ... | 44·61 to 63·72 | ,, ,, ,, |
| Lake Harris Range, Otago ... ... | 61·24 | ,, ,, ,, |

Chromite has been found at Jackson's Bay, where it also occurs as a constituent of the rock Dunite. Specimens were first forwarded by Mr. D. Macfarlane, Government Agent there, in 1877.

It was also discovered by Dr. Hector, associated with Nephrite, in Milford Sound, and is mentioned in the Jurors' Reports N.Z. Ex., 1865, p. 265, as follows:—

"The large block of Nephrite, which weighs 200 lbs., and was brought by Dr. Hector from Martin's Bay, is speckled with this mineral (Chromite) in small grains. This interesting rock is therefore in all probability a local variety of the Dunite, which forms the matrix of the Chrome ore in Nelson."

Chromite of rich quality and granular structure has also been found at Milford Sound as a rolled fragment; it was associated with Steatite (Liversidge, "Trans. N.Z. Inst.," vol. x., p. 504) as well as another specimen from Moke Creek, Queenstown, and one brought by Mr. McKay from the Lake Harris Range, Otago, which yielded 61·24 °/₀ $Cr_2 O_3$.

### Uranium.

*Uranium* has not yet been found in New Zealand.

### Manganese.

This metal occurs in nature chiefly in the form of various oxides, the main divisions of which are the hydrous and anhydrous ores.

#### *Anhydrous Ores.*

*Pyrolusite*, $\ddot{M}n$.—H. 2 to 2·5, colour iron-black to dark steel-grey, sometimes bluish; streak black; opaque; rather brittle. This mineral was discovered on the east coast of the Auckland district, in 1873, a specimen which contains some minute crystals being forwarded for identification by Mr. Ormond. A specimen was also forwarded by Mr. J. C. Stovin, in 1878, from the Auckland district, but these are the only two instances on record of this mineral having been found in New Zealand. It is the most valuable ore of manganese, on account of its containing a larger proportion of oxygen than any other class of manganese ore, and on that account generating more chlorine when treated with hydrochloric acid, in bleaching processes.

*Hausmannite*, $\dot{\mathrm{Mn}}.+\overset{\cdots}{\mathrm{Mn}}$.—H. 5·5. Colour brownish-black; streak chesnut brown; opaque. Fracture uneven.

This mineral is mentioned as occurring in rolled pieces in the river Selwyn, and coating joints in rocks. (See Dr. Haast's collection, Jurors' Reports N.Z. Ex. 1865, p. 258), but we have no sample in the Colonial Museum.

*Braunite*, $\overset{\cdots}{\mathrm{Mn}}$.—Streak and colour dark brownish-black; fracture uneven; brittle.

The first specimen of this mineral was forwarded by Mr. E. Toomath, from the Malvern Hills, Canterbury; it is a massive variety.

Another specimen was forwarded from the vicinity of Wellington, by Mr. W. S. Hamilton, in 1873, and in 1879 a specimen was sent from the Bay of Islands by Mr. J. C. Stovin. This last specimen was unfortunately lost at the Melbourne Exhibition.

*Hydrous Ores.*

*Manganite*, $\overset{\cdots}{\mathrm{Mn}}+\dot{\mathrm{H}}$.—H. 4. Colour dark steel-grey to iron-black, streak reddish-brown, sometimes nearly black; opaque. Fracture uneven. This class of ore is largely represented in New Zealand. It is mentioned as occurring in veins in schists, and as rolled fragments in the alluvial drift at Kawarau and Clutha (Jurors' Reports N.Z. Exhibition, 1865, p. 265) and in 1865 it was forwarded for identification from the Pioneer Claim, Dunstan, Otago.

Mr. Skey again mentions in 1871 the occurrence of this mineral at the Tararu Creek, Thames, where it is found in small columnar crystals, lining a cavity in an earthy-looking rock, and in the Yankee Doodle Claim at the same place it is found plentifully in a rich leader (Geological Reports, 1870–1, p. 86). It has also been found at the Bay of Islands and the Island of Waiheke, in Auckland Harbour, in both of which localities it has been worked for some time, as well as on the Island of Kawau for a little while, and at Whangarei, Tory Channel, Waipu, Waimarama and Wellington.

This mineral is inferior in its character as regards the quantity of available oxygen, but the small quantity of siliceous matter generally present enhances its value somewhat for iron manufacture, in which it is used for oxidising phosphorus, etc.

*Psilomelane*, $\dot{R}\,\ddot{Mn}^2+\dot{H}$.—H. 5–6, massive and botryoidal; colour, iron-black passing to dark steel grey; streak brownish-black; shining, opaque.

This mineral is mentioned in the Jurors' Rep. N.Z. Ex., 1865, p. 258, as amongst Dr. Haast's collections. It was found in veins in the Upper Waimakariri.

It is also found at the Bay of Islands, where it occurs massive and forms the most valuable ore; at Kawau it is found both as a massive ore and also as botryoidal incrustations; and at Waiheke, Waipu, and Whangarei it also occurs, as well as at Ohariu, Wellington, associated with Manganite. It also occurs in large quantities in the island of Pakihi, Auckland, where it is found in numerous small veins, about 1 inch thick, running generally parallel to the cleavage of the slates, but sometimes at right-angles to it (Hutton, Trans. N.Z. Inst., vol. i., p. 168).

It is a valuable ore of manganese, consisting, as it does, of a mixture of MnO and $MnO_2$, but varies greatly in its composition, containing many impurities.

Analysis of Psilomelane from Bay of Islands.

| | |
|---|---|
| Manganese oxides .. .. | 75·46 |
| Ferric oxide .. .. .. | 11·76 |
| Siliceous matter .. .. | 2·74 |
| Water .. .. .. | 10·04 |
| | 100·00 |

*Wad.*—Composition various. $\dot{Mn}$. ($\dot{Ca}$. $\dot{Ba}$. $\dot{K}$.) $\ddot{Mn}.^2 + 3\dot{H}$.

This is a soft, earthy form of manganese, which varies greatly in its composition and general character, but includes all the softer hydrated manganese ores. It was first mentioned, in 1870, by Captain Hutton, as occurring in considerable quantities, associated with Calcite, in the Black Reef, at Tararu Creek, Thames (Geol. Rep. 1870–71, p. 5), and has also been found at Waiheke, Bay of Islands, Auckland, Napier, Whangarei, and Flaxbourne, and indeed occurs generally wherever other ores of manganese are found. It frequently forms an important ore of that metal, having a similar composition to Psilomelane, but containing a greater quantity of water, and varying more than that ore in the quantity of manganese which it contains.

Analyses of these ores show that they contain from 27·14 to 87·47 per cent. of oxide of manganese; from 12·05 to 28·1 per cent. of water, and from ·42 to 42·83 per cent. of silica.

The foregoing are the only ores of manganese which can be looked upon as of economic value, since their usefulness depends upon the amount of oxygen which they contain combined with the metal; and the black oxide,

$MnO_2$, which occurs pure in Pyrolusite, is the most valuable, on account of its parting readily with its oxygen to substances capable of combining with it, and on this property depends the value of the ore in the generation of chlorine for bleaching purposes, the decolourization of glass where sub-oxides of this metal form the colouring matter, and also in its recent application to the oxidation of phosphorus, etc., in the process of iron manufacture.

Manganese, however, also occurs in other forms, which require mention as minerals.

*Diallogite*, $\dot{Mn}\ddot{C}$.—The occurrence of this mineral is mentioned by Mr. Skey (Geol. Rep. 1870–71, p. 85) associated with Calamine from a claim high up the Tararu Creek, Thames, and presented by the manager of Russell's battery.

He says: "The Diallogite of this specimen contains a portion of carbonate of lime, but the amount has not yet been ascertained. It is coloured with oxide of iron, and crystallized in large rhombohedrons. The carbonate of lime forms lustrous transparent crystals attached to the former, but always external. These are always well shaped, but comparatively small. They are interspersed somewhat rarely with small rock crystals." I regret that I have been unable to find this specimen.

A massive, flesh-coloured, specimen of this mineral was also collected by Dr. Hector, November, 1881, in Makara Valley, where it occurs on Mr. Thos. Robinson's property.

*Rhodonite or Manganese Spar*, $\dot{Mn}\ \ddot{Si}$.—The occurrence of this mineral at Kawarau and Clutha is mentioned (Jurors' Rep. N.Z. Ex., 1865, p. 265), and at the Pioneer claim, Dunstan (Jurors' Rep., p. 413), and it has also been found in Canterbury and Waiheke.

*Hauerite*, $Mn''$.—In a paper read before this Society during the last session, I mentioned the occurrence of this mineral, as determined by Mr. Skey in rocks from the Wakatipu district, collected by Mr. McKay, and I have now to mention its occurrence in certain specimens forwarded by Mr. H. P. Washbourn from Collingwood, where it occurs in crystals composed of the cube and rhombic dodecahedron.

Dana only mentions this mineral as occurring at Kalinka in Hungary, in clay with gypsum and sulphur, in a region something like a solfatara, but the Mangan-blende or Alabandine which is a subsulphide of manganese, he states, occurs in veins in the gold mines of Nagyag in Transylvania, associated with Tellurium, carbonate of manganese and quartz. It is interesting, therefore, to note the occurrence of Hauerite in crystalline schistose rocks, and I was led by this to examine ores from other countries to see whether it ever did occur under similar conditions. The result of this examination has been to show that in the Bismuth ore from the granite district of Beaver County, Utah, this mineral is largely represented, and moreover, in a rock which very closely resembles the one from Collingwood.

Mr. Skey has tested this rock for Bismuth, but has not been able to detect the presence of this valuable metal; as, however, only two small specimens were forwarded, and these were taken from the outcrop, it by no means proves that a similar association may not occur here, and a careful examination of the rock in question may lead to valuable results.

### Metallic Minerals.—Class II.

*Metals brittle, easily fusible and volatile.*

#### Arsenic.

This metal has only been found in New Zealand in a native state, in the form of arsenical pyrites, and in one instance as Dufrenoysite, a description of which will appear under the lead ores.

*Native Arsenic.*—The first mention of this mineral in New Zealand is by Dr. Hector (Trans. N.Z. Inst., vol. ii., p. 368), where he states that it occurs at the Kapanga Mine, Driving Creek, Coromandel, associated with gold; and subsequently Captain Hutton, in his report on the geology of Coromandel (Geological Reports, 1870-1, p. 5) again mentions its occurrence in the same locality.

The specimens which I have seen are all reniform and massive, and have all been obtained from the Kapanga goldmine; they are all tarnished to a blackish-grey colour, and are sometimes deposited on calc spar. In some cases free gold can be seen on the surface of the arsenic.

Dr. Hector informs me that he had the good fortune to see a specimen extracted from the No. 5 Driving Creek Mine, which showed in a very characteristic way the manner of occurrence of this metal.

The specimen consisted of a geode or cavity, formed at the point of intersection of two slender quartz veins, which was lined partly up its sides by a coating of quartz. On this a mass of Calcite was crystallized, while both on and through the mass of these Calcite crystals arsenic had been deposited in a botryoidal form. On the surface of this was a deposit of Chalcedony, from which long slender quartz crystals had grown, and by a subsequent action the terminal facets of these had been coated by small globular patches of arsenic, as if sublimed, sprouting from which were beautiful crystalline filaments of gold.

Although, as is much to be regretted, this specimen was not secured for the Colonial Museum, having been presented to H.E. Sir George Bowen, still, specimens collected by Dr. Hector from the same druse are yet in the possession of the Geological Survey, and these demonstrate the interesting points of the description already given.

One of these specimens shows the tufanite (pyritous propylite) forming one side of the vugh or cavity, on which a layer about $\frac{3}{8}$-inch thick of fibrous crystalline quartz has been formed. At the base of the specimen a quartz leader about 3 inches wide and crystallized in small vughs near the centre is inserted through the lining of the cavity, which is formed by the junction of two small veins. This leader is traversed by small strings of crystals of Mispickel or Leucopyrite, and on the internal quartz coating of the cavity Calcite has crystallized at places in large rhombohedral forms, and at others the arsenic has been deposited in reniform masses.

On the faces of the Calcite crystals small globular patches of arsenic have formed, and stalagmitic incrustations of Calcite, with alternate layers of arsenic, have been built up on these, forming fine reniform masses. At one point, near the top of the specimen, minute quartz crystals can be seen, also Calcite forming hollow pseudomorphs of quartz, all the cavities of which are filled with the most beautiful filaments of gold; a few crystals of Mispickel are here visible.

The other specimen is of a massive reniform character, and is deposited on the quartz lining of the vugh without the interposition of Calcite as in the first specimen.

*Mispickel*, $Fe''+FeAs$, or arsenical iron pyrites, is by no means uncommon in New Zealand. It is mentioned by Dr. Hector, (Jurors' Rep. N.Z. Ex., pp. 265, 436), as occurring in magnesian felstone and diorite in Milford Sound, and also in alluvial drifts at Waipori and elsewhere, and is again referred to by Professor Liversidge, in his description of the minerals of the Otago Museum (Trans. N.Z. Inst. vol. x., p. 502). At page 257 of the Jurors' Reports, above cited, this mineral is mentioned in Dr. Haast's collection as occurring in diorite at the Malvern Hills.

Specimens have been collected by Mr. McKay from the Buckleburn, on Wakatipu Lake, as fine crystals imbedded in chlorite schists, and, as previously mentioned, it occurs in the auriferous leaders of the Kapanga mine, and is found in most other auriferous reefs. Specimens brought by Dr. Hector from Langdon's lower reef, near Greymouth, proved to be highly auriferous, the assay of the sample showing 69 ozs. 3 dwts. 12 grs. of gold, and 2 ozs. 9 dwts. 19 grs. silver, to the ton, a considerable proportion of it, however, being in a free state.

I collected specimens of the same mineral from the Perseverance mine, Collingwood, where it occurs in very characteristic rhombic crystals, in a white granular quartz, but contains very little gold.

As a rule this class of pyrites is the most highly auriferous, although at times gold also occurs largely in the more common form of iron pyrites.

### Antimony.

This metal has been found in New Zealand in the form of Stibnite, which mineral has a pretty wide distribution, and is associated with Kermes and Cervanite, as products of decomposition or change. It has also been found as Bournonite (a mineral which more properly belongs to the lead ores), in the Rolling River, Wangapeka, and again as a constituent of Richmondite, a form of Tetrahedrite, which occurs at the Richmond Hill Mine, Collingwood.

*Stibnite*, $\overline{\mathrm{Sb}}'''$.—The first mention of the occurrence of this mineral in New Zealand is by Dr. Hector (Jurors' Rep. N.Z. Ex., p. 265). The specimen was from the Arrow River, and was exhibited in the Otago geological survey collection at the Dunedin Exhibition. In 1867, Captain Hutton in his report on Thames goldfield, p. 9, published in the Geological Reports for that year, mentions the occurrence of crystals of Stibnite more than an inch long imbedded in tufa in one of the claims up the Waiotahi Creek, and Professor Liversidge (Trans. N.Z. Inst. vol. x., p. 502) describes a specimen of the same mineral from the Union Jack Reef, Mullocky Gully. Besides these, specimens of Stibnite have been forwarded to the Museum from time to time from Coromandel; Kaueranga; Napier; Queen Charlotte Sound; Criterion Claim, Thames; Tararu Creek; Greymouth; Pakaraka, Bay of Islands; Green Island, Otago; Shield's Reef, Reefton; Kelly's Reef; Canoe Creek; Collingwood; Inangahua; Westport; Pelorus Sound; Marlborough; Hokitika; Paparoa Range, Greymouth; Langdon's Reef, Greymouth; Dunedin; and Featherston; some by officers of the Geological Survey, and others by contributors whose names will be found in the Colonial Museum and Laboratory Reports. In describing the modes of occurrence of Stibnite, a natural subdivision presents itself between the crystalline and massive varieties.

*Crystallized varieties.*—We have specimens in the Colonial Museum of some fine interlacing crystals of Stibnite from Tararu Creek, where they occur as an accessory mineral in the auriferous reefs. Some specimens of these are very fine and are associated with crystallized quartz. From Kaueranga (Shortland), there is a very fine specimen of crystallized Stibnite, in which the crystals interlace in a most characteristic manner. From the Golden Crown Claim, Thames, there is a group of crystals of large size, the longest one measuring about 4 inches along its principal axis. The only forms of crystals which are represented from any of these localities are prismatic, consisting of the rhombic prism $\infty P$. and the brachy-pinacoid, $\infty\breve{P}\infty$; with pyramidal ends composed of the pyramid P. and several brachy-pyramids, mPn, which give the ends a rounded appearance and are not sufficiently defined for measurement. All these crystals are deeply striated vertically.

*Massive varieties.*—The massive varieties are more widely distributed and assume a greater economic importance since they are found as the principal constituents of lodes in various parts of the colony. Perhaps the most important of these is the ore from Stoney Creek, Waipori. It consists of a massive crystalline variety of Stibnite occurring in a lode 2½ feet thick, which has been traced for a distance of 200 feet, and is reported to be met with as outcrops for a much greater distance. The pure ore is mixed with about 30 per cent. of gangue in the lode (Rowe, Geol. Rep. 1879-80, p. 155).

A massive sub-crystalline variety from Endeavour Inlet, Queen Charlotte Sound, consists of a mixture of nearly pure Stibnite with quartz; and a series of analyses have given 69·4 per cent.; 36·36 per cent; 58·25 per cent.; 51·12 per cent; 44·28 per cent.; 19·01 per cent.; and 17·20 per cent. of Antimony, and they contain from 3 to 8 dwts. of gold per ton.

This ore was found scattered as large blocks through a surface deposit, and a reef was also found which carried Stibnite on its back, but passed afterwards into a poor auriferous quartz, and it is probable that the real source of the ore has not yet been found.

A very interesting occurrence of auriferous Stibnite has been discovered at Langdon's, near Greymouth. The first specimen of this ore was forwarded from Hokitika by Mr. McRae, and yielded 84 ozs. 9 dwts. 19 grs. of gold and 36 ozs. 4 dwts. 5 grs. of silver per ton. The large quantity of gold found in this specimen gave an air of probability to the supposition that telluride of gold was present; but when an examination for Tellurium was made none was found, and a large proportion of free gold was shown to exist.

Dr. Hector subsequently examined this reef, and in the Geological Reports, 1878-79, p. 19, he says:—"Following up the same creek, at an altitude of 400 feet above Langdon's reef, the lode from which the auriferous Stibnite is derived has been discovered, having a thickness of 9 feet, and dipping at 60° to the south-west. It is cased in a hard, blue, cherty slate, and has a banded structure, consisting of five distinct bands—

| | Ft. | in. |
|---|---|---|
| No. 1, next the foot-wall, is quartz containing Stibnite, dispersed in irregular masses .. .. .. .. .. .. .. .. | 2 | 0 |
| No. 2, compact Stibnite .. .. .. .. .. .. .. .. | 2 | 0 |
| No. 3, Stibnite, including quartz in the form of nodules .. .. .. | 3 | 0 |
| No. 4, fine-grained mixture of quartz and Stibnite .. .. .. .. | 0 | 4 |
| No. 5, breccia of slate .. .. .. .. .. .. .. .. | 1 | 8 |
| | 9 | 0" |

The following returns were obtained by assay of these samples:—

No. 1.—*Quartz and Stibnite.*

*a* contains 2 ozs. 10 dwts. 7 grs. gold per ton.

*b* ,, 2 ,, 0 ,, 6 ,, ,, ,,

No. 2.—*Compact Stibnite.*

| | | | | | | |
|---|---|---|---|---|---|---|
| *a* | contains | 5 ozs. | 16 dwts. | 16 grs. | gold | per ton. |
| | ,, | 0 ,, | 4 ,, | 1 ,, | silver | ,, |
| *b* | ,, | 0 ,, | 15 ,, | 2 ,, | gold | ,, |
| *c* | ,, | 32 ,, | 0 ,, | 17 ,, | ,, | ,, |
| | ,, | 1 ,, | 3 ,, | 3 ,, | silver | ,, |

No. 3.—*Stibnite and Quartz in Nodules.*

| | | |
|---|---|---|
| *a* | contains | no gold. |
| *b* | ,, | 10 dwts. 2 grs. gold per ton. |
| *c* | ,, | no gold. |

No. 4.—*Fine-grained mixture of Quartz and Stibnite.*

| | | | | | | |
|---|---|---|---|---|---|---|
| *a* | contains | 4 ozs. | 12 dwts. | 13 grs. | gold | per ton. |
| | ,, | 0 ,, | 3 ,, | 0 ,, | silver | ,, |

No. 5.—*Breccia.*

Contains no gold.

In No. 2 (*c*), the gold was visible in the stone, running as a thin vein through the centre of the specimen, and, a large proportion being free, it can readily be separated by washing.

*Kermes (Antimony Blende)*, $Sb'''_2 \dddot{Sb}$.—This mineral occurs generally with the Stibnites, as a cherry-red encrusting earth on exposed parts of the specimen.

*Cervantite*, $\dddot{Sb}$, $\ddddot{Sb}$.—Occurs incrusting Stibnites at most localities.

### Tellurium and Bismuth.

The other members of this group have never yet been discovered in New Zealand, with the exception of traces of the latter metal in the Richmondite of Collingwood, but the striking resemblance of some of the rocks of that district, and the occurrence of associated minerals which are common with the Bismuth ores of Beaver County Utah, make it by no means improbable that we shall yet have to add that valuable metal to the list of those which occur in New Zealand.

### Metallic Minerals.—Class III.

*Malleable, not reducible by heat alone.*

### Zinc.

This metal is met with in New Zealand, chiefly as the sulphide or Zinc Blende, but in one instance the mineral Calamine, or carbonate of zinc, has been obtained.

*Zinc Blende*, $Zn'$.—The first mention of the occurrence of this mineral in New Zealand is by Dr. Hector (Trans. N.Z. Inst., vol. ii., p. 368) where he refers to its occurrence on the Thames goldfield, associated with gold in some of the reefs, and it was originally discovered by Captain Hutton in a claim situated upon the Tararu Creek, in the Thames district, where it occurs in moderate sized dark-coloured crystals, having a pyramidal (tetrahedral) form, and is associated with iron pyrites, acicular crystals of quartz, Galena, and traces of copper. Its matrix is a pure amorphous quartz. Specimens of blende were subsequently forwarded by the same contributor from Mine Bay, Great Barrier Island.

In the same year Mr. Davis (Geol. Reports, 1870-71, p. 61), mentions its occurrence at the Silver Crown Claim, Thames; at page 85, Mr. Skey mentions its occurrence at the Thames, and at page 149, Captain Hutton also notes its presenee in the New Golden Crown Claim, in the same district. He also (at page 154) mentions the occurrence of this mineral in the Perseverance mine, Collingwood.

Besides these localities Zinc Blende has since been found in the reefs at Mount Arthur, whence the gold is extracted.

All the specimens of Zinc Blende which have come under my notice are of a massive character but vary somewhat in appearance. The specimens from the Thames goldfield, which are well represented by those obtained from the Little Agnes mine, Tararu Creek, are black resinous samples of the mineral, known as "Black Jack." That from Collingwood varies from Black Jack to a yellow honey-coloured Blende, containing from $59^{\circ}/_{0}$ to $65^{\circ}/_{0}$ zinc, and Captain Hutton thus describes its mode of occurrence:—"At about five feet above the lode, in the felspathic slate, is a band some five or six feet thick, of Zinc Blende and Galena. In the lower part of this band, the Blende is bluish-black, with a metallic lustre, while towards the upper part it is associated with Galena, which is sometimes crystallized, and here it is of a pale yellow colour, and a resinous lustre." (Geol. Rep., 1870-71, p. 150.)

In examining this locality last year, I was led to the conclusion that at one part of the mine at least this Zinc Blende and Galena formed a part of the lode since it occurred associated with quartz and Mispickel, had the grey felspathic slates for its hanging wall and black slates at the foot, which corresponds to the general position of the main Perseverance reef. Subsequently, however, I am informed a small shaft was sunk and the main reef discovered 6 feet below this Zinc Blende and Galena vein, as described by Captain Hutton, so that possibly these deposits are offshoots from the main reef. The other localities where Zinc Blende has been found do not merit special description, as in no other case has it been discovered in sufficient quantities to prove of commercial value.

*Calamine*, $\dot{Zn}\,\ddot{C}$.—Mr. Skey (Geol. Rep. 1870-71, p. 85) describes this mineral from Tararu Creek, Thames, as "lustrous transparent crystals attached to Diallogite, but always external; these are well shaped but comparatively small; they are interspersed somewhat rarely with small rock crystals." This is the only instance yet recorded of the occurrence of Calamine in New Zealand. Zinc also enters into the composition of Richmondite previously referred to.

### Lead.

The ores of lead which have hitherto been discovered in New Zealand are native lead, Galena, Dufrenoysite, Mimetesite, and Bournonite, as well as a doubtful case of Pyromorphite, and red oxide of lead.

*Native Lead.*—In the Geol. Reports, 1870-71, p. 85, Mr. Skey mentions the occurrence of native lead in the wash of a creek at the Thames. It occurs in the form of shot, but was found at the very commencement of the goldfield, so may possibly lay claim to being the native metal.

*Galena*, Pb′.—This mineral is widely distributed in the colony, but has not hitherto been worked. The first mention of its occurrence is by Mr. J. C. Crawford in his " Essay on the Geology of the Wellington Province," p. 5, where he mentions that specimens were brought by Professor Hochstetter's party from the Kaimanawa Ranges. In the Jurors' Rep. N.Z. Ex., pp. 404, 265, and 437, mention is made of the occurrence of Galena in the Nelson District, and also pretty generally throughout the colony, but in most instances associated with a great deal of quartz. Captain Hutton has mentioned its occurrence at Great Barrier Island ; Perseverance Mine, Collingwood ; and also at the Thames—this last district being again referred to by Mr. Skey and Mr. Davis. Dr. Hector refers to the silver lead ore of the Wangapeka, and I have mentioned its occurrence as thin veins in a large quartz reef at Richmond Hill, Collingwood ; in boulders in the rivers on the West Coast, south of Mount Cook ; and associated with pyrites at the Mount Rangitoto Mine. These comprise the principal localities at which Galena has been discovered, but the only one in which the ore has been yet found in sufficient quantities to promise well for opening a lead mine is at Bedstead Gully, Collingwood, where some rather important deposits were discovered in the workings of the Perseverance Gold Mining Company, but even these have received but little attention. Galena occurs in all degrees of coarseness from a very fine grained ore to a coarsely crystallized variety, and the samples which have been assayed for silver show a great variation in the proportions of this precious metal contained by them, but a notice of these will more properly be placed under the silver ores. The crystals observed have been uniformly cubes, the octahedron never being seen.

*Dufrenoysite*, $Pb' + \frac{1}{2} As^2 S^3$.—Great Barrier Island. The composition of the type mineral as given by Dana is

| | |
|---|---|
| Sulphur .. .. .. | 22·1 |
| Arsenic .. .. .. | 20·7 |
| Lead.. .. .. .. | 57·2 |
| | 100·0 |

But, in addition to this, the mineral from the Great Barrier contains a little antimony and traces of copper, silver, and iron. It occurs as a finely crystalline vein associated with Galena in larger crystals, the matrix being diorite, and was collected by Captain Hutton from Mine Bay, Great Barrier Island.

*Mimetesite.*—The specimen representing this mineral, which is included in the Melbourne Exhibition Catalogue as coming from the Dun Mountain, has proved on further examination to be Wulfenite, or molybdate of lead, and is accordingly described under Molybdenum.

*Bournonite*, $Pb'^{4}\,\cancel{Sb}''' + \cancel{Cu}'^{2}\,\cancel{Sb}'''$.—A specimen of this mineral was collected from the Rolling River, Wangapeka, Nelson, in 1867. No further specimens have been obtained. It occurs in quartz with Galena, is of a steel-grey colour, and has a metallic lustre.

It consists of sulphide of antimony and lead, with a little sulphide of copper and traces of iron and silver as sulphides.

### Tin.

*Cassiterite*, $\ddot{Sn}$.—It is from one locality only in New Zealand that any well authenticated discovery of tin ore has been made, and the specimens in question were obtained from tailings of certain auriferous cements at Lankey's Gully, Reefton, being forwarded for identification by Mr. A. D. Bayfield, of Nelson.

The Cassiterite occurs as small grains, associated with iron pyrites and an iron-black hematite (Black Maori of the diggers), and although up to the present time the extent and value of the deposit have not been determined, the discovery is at least of interest, and may lead to one of considerable importance.

It should be mentioned that during the year 1876 specimens purporting to have come from Tuapeka, and containing tin, were forwarded to the Museum through Mr. Blair, but this discovery has not been further confirmed.

### Cobalt.

Hitherto the presence of Cobalt in New Zealand has only been proved in very small quantities, and the localities at which it has been obtained are also comparatively few.

*Cobalt Bloom—Erythrine*, $\dot{Co}^{3}\,\dddot{\cancel{As}} + 8\dot{H}$—This mineral is mentioned by Dr. Hector (Jurors' Rep. N.Z. Ex., 1865, pp. 265, 437) as occurring in the schists and gneiss of the West Coast of Otago.

*Asbolite.*—This mineral, which is an earthy wad in which Cobalt frequently occurs, is mentioned by Mr. J. A. Pond (Trans. N.Z. Inst., vol. x., p. 456) as occurring in four distinct places in the Auckland district, but the localities are not cited. The highest return which he obtained was 2·42 per cent. Cobalt.

Mr. Skey has also examined many of our wads for Cobalt, but has only recognized that metal in a bog ore from Rapaka, Bay of Islands, where, however, it only occurred in minute quantities (13th Mus. and Lab. Rept., p. 27), and I also found traces of the mineral in some of the Kawau manganese ores (14th Lab. Rept., p. 33). Hitherto ores of this metal have not been found in New Zealand in payable quantities.

### Nickel.

This metal while being somewhat widely distributed in New Zealand, has not hitherto been found under circumstances which would render its extraction remunerative.

*Pimelite*, $2\,\dddot{\text{Al}}\,\dddot{\text{Si}} + 3\,\dot{\text{Mg}}\,\ddot{\text{Si}} + 10\,\dot{\text{H}}$, in which 3 per cent. of nickel oxide is known to occur, was first discovered in New Zealand by Dr. Haast, filling cavities in the amygdaloidal rocks of the Malvern and Clent Hills, and is mentioned in the Jurors' Rep. N.Z. Ex., 1865, p. 257. I cannot find any analysis of these specimens, so am unable to quote the percentage of Nickel present in them.

*Troilite or Pyrrhotine* (magnetic pyrites), $Fe'$.—This mineral, which is an inferior sulphide of iron, usually contains as a constituent portion of it both copper and nickel, and it is from the nickeliferous varieties of this mineral that the larger proportion of our commercial nickel is derived. I first discovered this mineral in January, 1876, in the river-beds south of Mount Cook on the West Coast of the South Island, and several specimens which I brought from localities some distance apart were found by Mr. Skey to contain Nickel although not in payable quantities. Specimens were subsequently forwarded from the Paringa River in the same district by Messrs. Thos. Ward and Co.

Pyrrhotine was again noticed in a series of specimens forwarded by Mr. W. Docherty, from Dusky Sound, in 1877, where it occurs in association with copper pyrites. Several of these specimens were tested for Nickel, in all of which it was shown to occur, but only in small quantities, the largest yield of this metal obtained being ·68 per cent., a return far too low to allow of remunerative extraction.

During the same year Mr. H. Washbourn forwarded a specimen of Pyrrhotine from Collingwood, where it occurs in a reef on the mineral lease of the Richmond Hill Silver Mining Company, and when examined for Nickel it yielded 2·98 per cent. of this metal, and traces of Cobalt. As Nickel is extracted from this ore in New Jersey, U.S., when only 3 per cent. is present, this should prove payable if the lode is continuous and sufficiently large.

*Silicate of Nickel.*—In the Trans. N.Z. Inst., vol. x., p. 454, Mr. J. A. Pond mentions the occurrence of Nickel in several specimens from different localities in the Auckland district, which are as follow;

1. Loose stones at Mahurangi, which are composed of silicate of magnesia, and in which Nickel occurs in small and variable amounts.

2. Portions of a large rock mass of serpentine, which is found cropping out in the direction of Hoteo, from Mahurangi, were found to contain ·49 per cent. Nickel.

3. Serpentine from small streams near Manukau North Head, contained ·47 per cent. Nickel.

4. Calcite from Matakohe, stained with hydrated silicate of Nickel.

5. Hard greenstone from Papakura Valley, gave a trace of Copper and ·26 per cent. Nickel.

6. Green unctuous clay from Waipu, gave ·11 per cent. Nickel.

7. Foliated serpentine from Coromandel, also gave a trace of Nickel.

During the past year I visited the locality from which No. 2 of Mr. Pond's specimens was obtained and collected specimens of a green siliceous rock which occurs in considerable mass on the Port Albert Road from Mahurangi. This rock Mr. Skey reports contains the oxide of nickel at the rate of 1·81 per cent., and appears to be in the form of a silicate. As it occurs as an isolated outcrop, it is impossible to say what its relations are, but seeing that it is free from sulphur and would thus obviate the necessity of roasting before treating in the ordinary way, a small percentage would no doubt pay for extraction, and it appears probable that richer deposits will yet be found in the district.

### Iron.

This metal is largely represented in New Zealand, where it occurs in most of the known and more valuable forms both as oxides, sulphides, carbonates, and silicates, besides some interesting samples of phosphate and sulphate and the titaniferous iron ores.

*Magnetite*, $\dot{\mathrm{Fe}}\ \dddot{\overline{\mathrm{Fe}}}$.—This mineral, which consists of a mixture of the ferrous and ferric oxides, does not occur in a massive form in New Zealand, so far as is at present known, but is disseminated through various rocks in minute octahedral crystals and grains. It is principally developed in the chlorite schists on the western side of the main range in the South Island, where in the neighbourhood of Mount Cook, large quantities are found disseminated through the bed rock in the form of minute crystals, which at places become so plentiful as to form beds, interstratified with the schists, from 6 inches to 8 inches in thickness. Similar deposits are found at Lake Harris, in the Wakatipu district, where the Magnetite occurs in small veins and octahedral crystals dispersed through the rock, associated with thin bands of Hematite and crystals of specular iron. It is also largely represented in the volcanic rocks of New Zealand, associated in many cases with titaniferous iron, and from these rocks the greater quantity of our magnetic iron sand has been derived.

*Hematite—Specular Iron*, $\overset{\cdots}{\mathrm{\bar{F}e}}$.—This mineral, which is the peroxide of iron, occurs associated with the same rocks (chlorite schists) as deposits of anhydrous hematite, which are of considerable value. This ore occurs as lenticular masses, which form a central band, extending from the upper part of Moke Creek, near the Wakatipu Lake, through Benmore and thence in the direction of Mount Gilbert. They are not, however, confined to this line, but occur throughout this schistose formation in the Wakitipu district, and appear to have their greatest development between Skippers and Moonlight Creeks. A six feet vein in mica schist occurs at Maori Point on the Shotover.

This mineral also occurs as small single crystals (generally rhombohedral) dispersed through a hard quartzose schist in the same district.

It is from the above deposits that the large boulders and minute grains of iron-black hematite are derived which are so generally associated with the auriferous deposits of our southern goldfields, and which are called by the diggers "Black Maori," by whom they are looked upon as an indication of gold, in consequence of their high specific gravity.

Analyses of several specimens of anhydrous hematite from Dunstan, Otago; Maramarua, Auckland; Otamataura Creek, Collingwood; and Wangaroa, Auckland, have been made at the Colonial Laboratory, and show that they contain from 61 per cent. to 68 per cent. of iron. The detailed results will be found in the Colonial Museum and Laboratory reports, or in the Manual of the Mineral Resources of New Zealand, in course of publication.

*Limonite—Hydrous Hematite*, $2\,\overset{\cdots}{\mathrm{\bar{F}e}}+3\,\dot{\mathrm{H}}$.—This mineral occurs throughout New Zealand, not, however, in most cases in sufficient quantities to be of any value. At two localities, both near Collingwood, large and valuable deposits are found under very different conditions. The best known of these deposits is that situated on the south-east side of the Parapara River, and about a mile from its mouth. The ore occurs in massive, earthy, botryoidal, mammillary, and concretionary forms. Its colour is various shades of brown, commonly dark and none bright; when earthy it is a brownish-yellow or ochre-yellow. When concretionary in character the ore forms hollow spherical masses commonly known as pot or bombshell ore. It occurs as a vein associated with crystalline metamorphic limestones which occupy a considerable area of country, and in the vicinity of the mouth of the Parapara River the degradation of the rocks has covered a large area with this hematite in boulders, some of enormous size. It also forms the matrix of a quartz conglomerate there. On breaking some of the masses of ore a kernel of undecomposed pyrites is frequently found, and crystals of iron pyrites of large size are very common in some places. From this, and the fact that its mode of occurrence and mineral character favour the conclusion, I am inclined to think that this deposit of brown hematite is nothing more than the gossan of some very large pyritous lode. It has been estimated that 52,893,058 tons of the ore are exposed at the surface.

The other important deposit of brown hematite was discovered by Mr. McKay in 1878, at Mount Peel in the Nelson district, and contains 54 per cent. of metallic iron. The ore, which is a dark-brown compact one, is associated with fine-grained breccias, dark slates weathering white, and heavy beds of compact blue crystalline limestone which overlie the great series of breccia beds and conglomerates which form the western part of the Mount Arthur range. Where the specimens were obtained the bed was about 50 feet thick, and isolated masses 10 feet to 15 feet across were also observed; while to the north of the Takaka a much greater development takes place, and diggers report the ore in this locality to be about a mile in width.

Besides these important deposits many specimens have been received at the Museum for identification or analysis, from the following localities:—Pitt's Island; Thames; West Coast; Makara, Wellington; Kawau; the Bluff; Raglan; Riwaka, Nelson; Big Muddy Creek, Manukau; Wharekawau; Wangaroa North; Manawatu Gorge; Paringa River; and Tawa Flat; and these have yielded from 29 per cent. to 60 per cent. metallic iron. The details of these analyses are included in the Colonial Laboratoy Reports and the Manual of the Mineral Resources before-mentioned.

*Chloropal*, $\dddot{\text{Fe}}\,\ddot{\text{Si}}^2$.—Professor Liversidge (Trans. N.Z. Inst., vol. x., p. 497) mentions the occurrence of this mineral in New Zealand, presented to the Otago Museum by Captain Fraser. The following is his description of the specimen:—"Of a yellowish-green colour; somewhat foliated cone-in-cone structure; sectile, soft; easily polished, even by rubbing with the thumb; adheres slightly to the tongue: when immersed in water gives off air-bubbles, and becomes translucent. Before the blowpipe does not decrepitate; blackens immediately, and fuses with difficulty on the edges, with slight intumescence, to a black glassy slag."

*Siliceous Hematites.*—Besides the foregoing ones, there are a few instances of hematites occurring in which the percentage of silica is so high as to make it advisable to class them under a different head. These ores are generally of a rusty-brown colour, of varying degrees of hardness, and seldom contain more than 20 per cent. metallic iron, and in some cases a good deal less.

Specimens have been received from the Dun Mountain, Nelson; Paringa River, Westland; and the neighbourhood of Wellington.

*Bog Iron Ore* is another form of hydrous hematite which is found at several localities in New Zealand. It is, generally speaking, of a porous character, and varies considerably in its composition. It has never yet been found in any considerable mass, and is seldom of much value on account of the phosphorus which most samples contain.

Analyses have been made of samples from Spring Swamp, Whangarei; Wainui-o-mata, Wellington; Carterton; Rangitikei; Stoke, Nelson; and Oroua Downs; in which the percentage of metallic iron varies from 19 to 51.

*Spathic Iron Ores*, $\dot{\text{F}}\text{e}\ \ddot{\text{C}}$.—The massive forms of these ores, which are essentially carbonate of iron, are very widely distributed in New Zealand, being, as a rule, associated with the cretaceo-tertiary and coal formations. Bands of clay ironstone, about 2 feet thick, occur in the Waipara District, and another band of sandy clay iron ore, 10 feet thick, is mentioned by Dr. Haast in the same locality (Geol. Rep., 1870-71, p. 11). Ironstone boulders are found in the Kakanui River which have been derived from the concretionary greensands. Valuable deposits of clay-band ironstone occur near Mount Somers and in the Malvern Hills, associated with coal, and further deposits are also found near the Abbey Rocks, Westland. Associated with the coal measures on the Twelve-mile Beach north of the Grey River, and thence inland, valuable deposits of spathic iron ore occur as lenticular masses and concretions in the shales. They are also notably developed in the Nine-mile Creek in the same district. They are again found at Jenkins Hill, Nelson, and at the Collingwood Coal-mine, where a bed of black-band ironstone also occurs, and another instance of its occurrence is at the Baton River, Nelson, in the cretaceo-tertiary formation.

In the North Island, beds of spathic iron ore have been found in the same formation, at the Miranda Colliery, inland of Taranaki, at the Manawatu Gorge, at Wangaroa and Raglan. In most of these localities the ironstones are fossiliferous, and contain numerous and well-preserved impressions of dicotyledonous leaves.

Further deposits of spathic iron ore also occur in the Mataura series, having been discovered by Mr. McKay, in the Cairn Ranges, Malvern Hills. They occur as strings and lenticular patches, with beautifully-preserved fossil ferns, and are of considerable importance.

Analyses of ores of this description have shown that they contain from 8·53 per cent. to 46·06 per cent. metallic iron, and the details of these will be found in the works above cited. They are all brown, sandy-looking ores, and are specially valuable on account of the ease with which they are reduced.

*Siderite*, $\dot{\text{F}}\text{e}\ \ddot{\text{C}}$.—The occurrence of this mineral in cavities of the contorted schist of Otago is mentioned by Dr. Hector (Jurors' Rep. N.Z. Ex., 1865, pp. 264–436), but we have no specimen in the Museum. Professor Liversidge again mentions the occurrence of this mineral at Dunedin (Trans. N.Z. Inst., vol. x., p. 494), as well as a magnesian ironstone from the Clutha.

*Sphærosiderite* occurs as an accessory mineral in many of our volcanic and dyke rocks. Thus Dr. Hector mentions it as occurring in basalt (Jurors' Rep. N.Z. Ex., pp. 264 and 436), and Dr. Haast mentions its occurrence in dyke rocks, and in the volcanic rocks of Banks Peninsula and the melaphyres of Mount Somers (Jurors' Rep., p. 258; Geol. Rep., 1873-74, p. 4, and Trans. N.Z. Inst., vol. xi., p. 504). It is generally found as small rhombohedral crystals, lining cavities in these rocks.

*Dendritic Iron markings* are of very frequent occurrence in all the harder and jointed rocks, some of them being of exceeding beauty. They are frequently mistaken for fossil ferns, which they very much resemble at times.

*Ilmenite (Titanate of Iron).*—This species includes several varieties due to the isomorphous characters of titanic and ferric oxides, so that the percentage of titanic acid present varies very considerably in different specimens. It is of very common occurrence as an accessory mineral in the volcanic rocks, where it occurs as small rhombohedral crystals, affording generally triangular or pentagonal sections when cut, and it enters largely into the composition of many of the ironsands of New Zealand, which surround so large a proportion of our coast. These ironsands are composed of a proportion of titanic iron, ranging from 2·4 per cent. to 74·2 per cent. of the whole, mixed with Magnetite and Hematite in varying proportions.

It is very difficult to group these in any definite order by the amount of titanic acid present, but it is noticeable that amongst those which occur on the southern beaches and also in the river beds the percentage is frequently high, ranging from 40 to 74 per cent. of titanic iron, and these have been principally derived from the basaltic rocks of the district.

On the other hand, the ironsands of the west coast of the South Island are practically free from $TiO_2$ in many cases, while the well known Taranaki ironsand only contains from 6 to 8 per cent. of titanic iron. There are, however, many ironsand deposits in Otago and Southland which contain from 2 to 8 per cent. titanic iron only, so that it is impossible to assign special areas over which any percentage will hold. Such, however, is not the case if we seek the rocks from which these ironsands have been derived, for we there find that the basaltic rocks have as a rule yielded an ironsand in which the percentage of titanic iron is over 50; that the granitic rocks seldom yield a sand in which the percentage of titanic iron is over 8; and that the trachytic rocks, like those of Taranaki, and which may be looked upon as mineralogically allied to the granites and syenites on other grounds, also yield an ironsand having a small percentage of titanic iron.

Where ironsands occur which are intermediate between the two extremes it is due either to a mixture of those derived from two distinct sources, or else the percentage of titanic iron has been increased by the presence of diabase or diorite dykes.

*Menaccanite.*—Mr. Skey mentions the occurrence of this mineral (titaniferous iron ore) from Brancepeth, Wairarapa (8th Lab. Rep. p. 15). It occurs with felspar, by which it appears to have been cemented together.

*Iron Ochre* occurs as a deposit from chalybeate springs and ferruginous waters in many mines both of coal, gold, and copper.

*Iron Pyrites*, Fe″.—This mineral is exceedingly widely distributed in New Zealand, indeed may be considered as general in its distribution. At Parapara, Collingwood, very perfect octahedral crystals are of common occurrence over part of the limonite deposit previously mentioned, and cubical crystals are of frequent occurrence in the chlorite schists and lepidomelane schists of the metamorphic region of the West Coast and Wakatipu Lake district.

It is of frequent occurrence as isolated crystals dispersed through the auriferous rocks of the Thames (tufanites), and also in many of the slates, and again forms an important element in the composition of many of the auriferous quartz reefs both north and south.

It also occurs as important lodes in the Collingwood district, where several of these are known to occur, and all that have been tested are more or less auriferous in character. These pyrites lodes are found—

1st. In felspathic slates which are associated with the auriferous reefs, the largest yet known being about 4 feet wide.

2nd. In the crystalline limestone; a reef in the Parapara River, above McGregor's Creek, being at least 8 feet wide, and composed of a fine-grained compact pyrites. As I have previously pointed out it is also probable that the limonite deposits of the Parapara are also the back of a large pyritous lode.

At Mount Rangitoto, in Westland, a pyrites lode, with which is associated about 20 per cent. galena, occurs, and this is frequently highly auriferous, containing from 5 to 13 ozs. of gold per ton. It is associated with schists and granites. The late Mr. E. H. Davis has described (Trans. N.Z. Inst., vol. iii., p. 287) a new form of iron pyrites, probably a pseudomorph, from the Chatham Islands. He says: "The system is oblique, nearly isomorphous with felspar, but having the clino-diagonal longer; the faces, which are smooth and brilliant, are $\infty P$; $OP$; $P$; $nP\infty$ hemidome, and $nP\infty$ clinodome."

*Marcasite* (*Radiate Iron Pyrites*), $Fe''$.—This mineral, which crystallizes in the rhombic system, is of very frequent occurrence associated with our brown coals. It generally occurs in radiate spherical or cockscomb-like groups, and from its proneness to decomposition has doubtless been the cause of many of the subterranean fires which have been of such frequent occurrence in our Otago collieries. It also occurs in many of the tertiary clays, and specimens were exhibited from Canterbury by Dr. Haast in the New Zealand Exhibition of 1865 (see Jurors' Rep., p. 257).

*Pyrrhotine*, $Fe'$.—The occurrence of this mineral has been previously mentioned under the nickel ores.

*Glauconite*—which is a hydrous silicate of the protoxide of iron and potash, is of frequent occurrence in certain schists, and also in the greensand series (Hector, Jurors' Rep. N.Z. Ex., p. 436). It occurs as rounded grains in several of the younger secondary beds, but is more markedly developed in the Weka Pass calcareous greensand series than any other, but in this formation has a somewhat wide distribution in the colony.

*Vivianite*, $\dot{Fe}^{3}\,\overset{.:\cdot}{\underline{P}}$, occurs as small prismatic crystals in Moa bones from the N. E. Valley, Dunedin, where they were originally discovered by Dr. Hector (see Jurors' Rep. N.Z. Ex., pp. 264, 436), and it has since been discovered in an earthy form imbedded in clay at Timaru; Pohangina River, Manawatu; Port Chalmers; and Taranaki. The crystallized specimens are of a deep indigo blue colour, and the earthy varieties are all bright cobalt blue.

*Copperas*, $\dot{Fe}\dddot{S}+7\dot{H}$, occurs at the Thames Goldfield, and also as a product of decomposition in some of the coal mines. Its occurrence was first mentioned by Mr. Skey (Geol. Rep., 1870-71, p. 87), as occurring in a crystallized form in the Long Drive Claim at the Thames, where it is found in all the old drives and workings where the enclosing rock is, or has been, pyritous, and the presence of this mineral as pointed out by Mr. Skey exercises a very prejudicial effect upon the quicksilver, causing it to flour. The specimens in the Museum are of a bright mountain-green colour; they are translucent and vitreous, and though crystalline in character do not occur in properly formed crystals.

*Delessite*, *Chlorophæite*, and *Green Earth*, which are all hydrous silicates of iron, with other impurities, occur as fine earthy minerals, of a dull olive-green colour, filling cavities in the melaphyres of the Mount Somers, Rangitata, and Malvern Hills districts. They were originally detected by Dr. Haast (see Jurors' Rep. N.Z. Ex., p. 257).

### Copper.

The occurrence of copper in New Zealand has been known since 1842, when the Kawau Mine commenced work on a lode of copper pyrites, and since then it has been found in various forms throughout New Zealand.

*Native Copper*, Cu, occurs:—1st. In plates associated with the copper deposits of the serpentine belt in Nelson. Specimens have been obtained at Aniseed Valley; Dun Mountain; and D'Urville Island. It has also been found at Moke Creek, Lake Wakatipu; at the Great Barrier Island; and at the Perseverance Mine, Collingwood. The presence of copper in the Dun Mountain has been known since 1853:—2nd. As grains disseminated through a granular serpentine at Aniseed Valley, Nelson, where the native copper forms an average of 5 per cent. of the rock mass, but the extension of the deposit has not been proved:—3rd. As fine grains in basaltic dykes which cut through trachydolerite breccias near the Manukau North Head, at which place it is of no economic value on account of the small percentage present, but is of great interest from its unusual mode of occurrence.

*Cuprite*, $\dot{\mathrm{Cu}}$.—This mineral, which, when pure, contains 88·9 per cent. of copper, is only known to occur in the serpentine belt of Nelson, where it is found in various degrees of purity, containing from 10 to 88·9 per cent. of copper. As pointed out by Dr. Hochstetter (New Zealand, p. 475), the richer deposits of ore form lenticular-shaped masses, which, when followed, may increase to a certain distance, but then disappear again in a thin wedge. The most notable discovery of this mineral which has yet been made is that known as the Champion Lode, in Aniseed Valley, which was found by Mr. Stratford, a few months ago. This deposit is reported to be 5 feet in width, and is exposed on the surface for some distance. It has not, however, yet been worked. Specimens of this ore, which consist of Cuprite and native copper, have yielded as high a return as 90 per cent. metallic copper. Some rich patches of the ore have also been found at the Aniseed Valley Mine, Dun Mountain, and D'Urville Island, in each case associated with copper glance, but no deposits of any great importance have yet been met with and the ore is in all cases more or less ferruginous. No crystals of this mineral have yet been obtained, but it always occurs in a massive form. Cuprite has also been discovered at Bligh's Sound, Otago (Hector, Trans. N.Z. Inst., vol. ii., p. 378), and at Tokomairiro (Hector, Jurors' Rep. N.Z. Ex., p. 436), and is also mentioned by Captain Hutton as occurring in small quantities in a lode at the Thames, a little north of Wainui (Geol. Rep., 1867, p. 9).

*Copper Glance*, $\mathrm{Cu}'$.—When pure, this mineral contains 79·8 per cent. of copper, and it has been found associated with Cuprite at most places where that mineral occurs in various parts of the Nelson serpentine belt. It is always in a massive form, and has not yet been shown to occur in deposits of sufficient extent to prove remunerative. The same remarks with regard to its occurrence apply as in the case of Cuprite.

*Bornite*, $\text{Cu}'^{3}\ \text{Fe}'''$.—Dr. Hector mentions the occurrence of this mineral at Kawau (Trans. N.Z. Inst., vol., ii., p. 375), and Professor Liversidge also mentions a specimen from Dunstan, Otago (Trans. N.Z. Inst., vol. x., p. 502).

*Chalcopyrite* (*copper pyrites*), $\text{Cu}' + \text{Fe}''$.—This ore, which contains theoretically 34·5 per cent of copper, but which in nature is seldom found to have more than 15 to 20 per cent. present, and frequently less, is the most permanent form of copper ore and the one from which the greater quantity of that metal is extracted.

This mineral was first discovered at the Island of Kawau in 1842, and was worked for several years, yielding on an average 12 per cent. of copper (Hector, Trans. N.Z. Inst., vol. ii., p. 375). When the mine was abandoned the lode was reported to be 15 feet thick and to consist of a compact yellow pyrites, averaging 16 per cent. copper, lying against a band of iron pyrites. An account of the character of the lode has been published by Dr. Hector (Trans. N.Z. Inst., vol. ii., p. 375). Copper pyrites has again been worked at Mine Bay, Great Barrier Island, where it occurs associated with peacock copper, blue and green carbonate, and black oxide, but is now abandoned. It occurs in a breccia lode, and has been reported on by Captain Hutton (Geol. Rep., 1868-69, p. 4).

Another instance of its occurrence is at Moke Creek, Lake Wakatipu, where it is found in a lode 4 feet wide (Hector, Trans. N.Z. Inst., vol. ii., p. 378), in which a solid vein of Chalcopyrite from 5 to 8 inches wide occurs, the rest of the lode containing only a little copper scattered through the gangue, and it is bounded by cupriferous schists. It again occurs in a lode near Waipori, in Reedy Creek, a branch of the Waitahuna, from which locality some very fine specimens have been obtained, yielding as much as 14 per cent. of copper.

Mr. Macfarlane has forwarded specimens of Chalcopyrite from a block of land on the Paringa River, Westland, which he reports that he obtained from a lode 3 feet wide. Half of this lode is made up of the solid ore, yielding 18·55 per cent. of copper, the remainder consisting of quartz with thin bands of ore of the same kind. Copper Pyrites has also been found at the Pioneer Claim, Collingwood. Besides these localities at which lodes are known to occur, Copper Pyrites has been found at various places, such as the Thames, associated with gold; as grains imbedded in quartzose schists of the Moorhouse Range, Canterbury; in the river beds south of Mount Cook on the West Coast; in a lode at Dusky Sound, which however did not prove of great value when opened up; at Lake Ohou; and at the Perseverance Mine, Collingwood, in small quantities.

*Peacock Copper*, which is only a variegated variety of Copper Pyrites, often occurs with that mineral.

*Malachite*, $\dot{C}u^2\ddot{C}+\dot{H}$.—*Green carbonate of copper* occurs as thin encrusting films on some of our copper ores, and also in the cupriferous schists of Moke Creek. It never, however, is found in a crystallized form, nor in sufficient quantities to be of any value.

*Azurite*, $\dot{C}u^3\ddot{C}^2+\dot{H}$.—*Blue carbonate of copper* occurs even less plentifully than Malachite, but under similar conditions as a thin encrustation on some of the Nelson and Great Barrier ores.

*Dioptase*, $\dot{C}u\ \ddot{S}i$, occurs as an encrustation on the Nelson copper ores, and also at the Wonder Claim, Thames (Skey, Geol. Rep., 1870-71, p. 85).

*Chrysocolla*, $\dot{C}u\ \ddot{S}i+2\dot{H}$.—Is very common encrusting the copper ores of the Serpentine Belt in Nelson, where they have been exposed to the action of the atmosphere, and is far more commonly met with than either the green or blue carbonates.

*Tetrahedrite* (var. *Richmondite*), $R'$, $\bar{R}'''$.—This ore has been obtained from a lode at Richmond Hill, Collingwood, and has yielded from some specimens as much as 1,792 ozs. of silver per ton of ore.

A complete analysis of this mineral is as follows :

| | | |
|---|---|---|
| Sulphide of | Lead .. .. .. .. | 36·12 |
| ,, | Antimony .. .. .. | 22·20 |
| ,, | Bismuth .. .. .. .. | traces |
| ,, | Copper .. .. .. .. | 19·31 |
| ,, | Iron .. .. .. .. | 13·59 |
| ,, | Zinc .. .. .. .. | 5·87 |
| ,, | Silver .. .. .. .. | 2·39 |
| ,, | Manganese .. .. .. | ·52 |
| | | 100·00 |

Its mineralogical characters have been described by Mr. Skey (12th Lab. Rept., p. 31). It is massive, nearly homogeneous ; cleavage irregular ; brittle, structure confusedly crystalline ; colour black generally, but in parts reddish; streak dark slate-colour; hardness about 4·5. Specific gravity 4·317. At a low heat (a little under redness) it fuses readily, and in parts intumesces considerably. The analysis gives the formula $Sb_2\ S_3 + 6$ (Pb, Cu, Zn, Fe, Ag, S) according to Mr. Skey. This forms a valuable ore of silver, in addition to the copper which it contains.

## Metallic Minerals.—Class IV.

*Noble metals, reducible by heat alone.*

### Gold.

This precious metal is widely distributed in New Zealand, and since 1857 no less than 9,659,266 ozs., having a value of £37,810,653, has been exported from the colony. Native gold occurs both in reefs, of which there are several classes, and in an alluvial form, it being from the alluvial workings that by far the greater quantity of gold has been obtained. The goldfields have been divided on the Geological Map into Northern, Central, Western, and Southern, and the gold from the different localities varies considerably in purity. That from Otago or the Southern fields and from Westland is pure or nearly so, being alloyed with less than 6·per cent. Ag., and a little copper. In Nelson it is alloyed with 10 to 14 per cent. of silver, while at the Thames or Northern goldfield it is generally alloyed with over 30 per cent. of silver, thus corresponding in composition to the Electrum* of Klaproth, which contains gold 64, and silver 36 per cent. There is also a marked difference in the associated minerals north and south, which, of course, is dependent upon the rocks from which the gold is derived. Thus in the Southern goldfield it is associated with Platinum, Zircons, and Garnets, as well as Black Hematite and Scheelite; in Nelson it occurs with the rare minerals Osmiridium and Platiniridium, and in the Northern goldfields Native Arsenic, Copper Pyrites, Galena, Zinc Blende, and Stibnite occur in the reefs, these being also more or less represented at Collingwood and at parts of the West Coast. The different characters of the reefs and mode of deposition are, however, the most marked and interesting in different localities.

In the Southern goldfield at Macetown and Cromwell these reefs are of a truly brecciated character (Hector, Geol. Rep. 1878-9, p. 24), being composed of angular fragments of slate and schist cemented by quartz, with which gold has been infiltrated in a very pure form. The gold in these reefs must have been introduced by mechanical means, but some has probably also been deposited from solution; but these reefs which occur in metamorphic schists have probably been formed subsequently to those in the foliated schistose rocks and slates, which belong to the next group, and from which they have derived their gold to a large extent. The reefs of the Reefton district, on the other hand, are true fissure reefs, and owe their origin to fractures produced by contortion, those which occupy the synclines widening as they descend, while those on the anticlines die out in depth or come to be nothing more than strings. Outliers of the same formation of reef occur at Cardrona. These fissures having been formed by the same action which induces cleavage elsewhere, during the plication of the strata on a large scale, have given rise to subterranean channels, in which the quartz and gold have been deposited from solution. The reefs thus formed consist of solid, compact quartz, and correspond more to the Australian reefs than any others. It is hard to assign any reason for the precipitation of gold in cases of this sort, and a field of research yet remains open for anyone who feels disposed to take it up.

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* Hector "Trans. N.Z. Inst.," vol. ii., p. 366.

The next class of reefs are those which occur in the vicinity of Wellington. The rocks here consist of ridges of slate and sandstone, probably of lower carboniferous age, and these have been traversed by a series of dislocations which cross the lines of stratification obliquely. The consequent displacement appears to have indurated the sandstones and altered the shales, when in contact with them, into friable cherty slates of a deep-blue colour, traversed by thread-like veins of quartz (Hector, Trans. N.Z. Inst., vol. ii., p. 368). These movements, when deep-seated, would doubtless be attended with the evolution of steam under great pressure, which would, by traversing the cracks, carry up with it in solution whatever minerals were present, and subsequently deposit them, not as they are now found, but as quartz with pyrites, which would be more or less auriferous according to circumstances. When by subsequent denudation these deep-seated veins were brought under the action of the atmosphere, a decomposition of the pyrites would ensue and free gold be left in the veins in the manner in which it now occurs. In addition to the gold derived from the auriferous pyrites, some must have been deposited at once in its native condition or have been subjected to re-solution and precipitation, as it is commonly found in a dendritic form.

The last class of gold-bearing reefs are those of the Thames and Coromandel districts, from which the greatest quantity of reef gold has hitherto been obtained. These are of extreme interest as regards their mode of occurrence. The rocks which form the matrix of these reefs are of volcanic origin, and consist of various classes of a felsitic rock, more or less decomposed, through which pyrites is very freely scattered. It appears to be more or less allied to the "propylite" of v. Richtofen, and has been called "tufanite" by Dr. Hector. These rocks rest unconformably upon the slates which form the basement rock of the Cape Colville Peninsula, and are in their turn overlaid unconformably by dolerite floes, and coarse volcanic breccias and tufas, with which are associated irregular seams and patches of coal. The whole series appears to have been tilted along a north-east line, the force which thus tilted the beds having produced a series of fractures, which, by the subsequent sinking of the hanging wall, have been opened and formed subterranean water-channels, thus affording an underground drainage to the country. Water percolating through these drains has deposited quartz and, under favourable circumstances, gold from solution, and this gold is found, sometimes disseminated through the compact portions of the stone as minute specs, and at other times entangled in a crystalline or dendritic form where the quartz is open in texture. In the latter cases, more especially in vughs in the reefs, the gold is frequently associated with Native Arsenic and Sulphides of Copper, Lead, Zinc, and Antimony.

The presence of gold in these reefs appears to depend upon a variety of circumstances which are not yet thoroughly understood; I may, however, mention a few essentials which have been observed. The first of these is that the reefs should be passing through moderately hard compact country, and where this is traversed by thin black pyritous veins which junction with the reef, the character of the country may be looked upon as more favourable. Where any reefs are found passing through this class of country they are generally more or less auriferous, and this is specially noticeable in the large reefs of the district. There are, however, in addition to the large reefs, innumerable small leaders, from $\frac{1}{16}$ inch thick up to a few inches, which, while following approximately the same strike as the other reefs, are as a general rule somewhat steeper; and where these junction with the main reefs in favourable country, very rich deposits of gold are frequently met with. Besides these hanging-wall leaders there are also many droppers from the foot-walls of the reefs in which also rich gold is often found, and they give one the impression of being leaks, if I may use the term, from the main reef, by which some of the gold has escaped.

The character of these deposits points most conclusively to the fact that the greater quantity of the gold in the reefs was deposited from solution, and the fact of the junctions of different leaders making the gold, leads one to believe that it was only where two streams, carrying the necessary ingredients in solution, met and mingled that any precipitation of gold ensued and a deposit of the precious metal was formed.

There are many other points bearing upon the behaviour of the reefs which are of great interest, but which it is not my province to discuss here.

That all the gold in these reefs is not derived from the same source, is I think, however, apparent, for that which is crystallized or occurs in dendritic forms, would owe its origin to super-heated steam, in the same manner as the last described set of rocks, and the description of gold with native arsenic from the Kapanga Mine, Coromandel, which will be found under the head of arsenic, offers a very striking illustration of this.

With regard to alluvial gold but little need be said. The principal alluvial fields are those of Otago and the West Coast, with some smaller but still important ones in the Nelson district, and the alluvial gold partakes of the same characters as that obtained from the reefs. Large nuggets are rare, indeed the largest which has been obtained is one from Rocky River, Collingwood, weighing 10 ozs., and another from the same locality weighed 8 ozs. These are mentioned by Dr. v. Hochstetter, (New Zealand, p. 100.)

Gold is also obtained from what are known as the Cement workings, at Tuapeka, and elsewhere. These cements consist of heavy gravels which have been consolidated, and are the remains of an old glacier or glacial river, which flowed across the country in quite a different direction from what the drainage now follows, and remnants of these old deposits yet remain. The cross-drainage which now prevails, has removed large tracts of these cements, and, by a process of natural sluicing, concentrated the gold in the beds of the creeks, some of which have proved fabulously rich. For a description of all these workings and the different characters of the alluvial deposits, I must refer the reader to the "Manual of the Mineral Resources of New Zealand," by Dr. Hector, now in course of publication.

### Platinum.

*Native Platinum*, Pt, Fe.—This metal has been found in a native state in small flat grains of a steel-grey or silver-white colour, associated with gold in alluvial deposits at Stewart Island, and with Zircons in the gold-wash of the southern goldfields. It is also found under similar conditions at the Collingwood goldfield, Nelson, but it has never yet been discovered in a reef (Hector, Trans. N.Z. Inst., vol. ii., pp. 185, 371; Jurors' Rep., p. 403).

*Platiniridium*, Pt, Ir.—Grains of this rare mineral have been obtained from the gold-wash of the Takaka diggings (Hochstetter's New Zealand, p. 107).

### Osmium and Iridium.

*Osmium-iridium*, Ir, Os, also occurs in the gold-wash of the Takaka diggings as small flat grains, which are of a brighter colour and less malleable than Platinum. They are mentioned by Dr. v. Hochstetter (New Zealand, p. 107) and Dr. Hector (Jurors' Reports, p. 403; and Trans. N.Z. Inst., vol. ii., p. 371).

### Silver.

But very little silver has yet been obtained in New Zealand except that alloyed with gold, in which form, at the Thames, it occurs abundantly, and as a component of the Tetrahedrite (Richmondite) of Richmond Hill, Collingwood, in which silver occurs in variable quantities up to 1792 ounces per ton. It also occurs in all the Galenas in greater or less quantities.

*Native Silver*, Ag, has been found as small rolled fragments in the Kawarau and Wakatipu Lake diggings, and also at Waipori (Hector, Jurors' Reports, p. 403, 436).

*Argentite*, Ag'.—Mr. E. H. Davis mentions the occurrence of a sulphide of silver at the Silver Crown Claim, Thames (Geol. Rep., 1870-1, p. 61), and a specimen is now in the Museum from that locality. It consists of a blackish-grey powder, and as Mr. Davis gave no description of its mode of occurrence I am unable to cite it.

*Pyrargyrite*, $Ag'^{3}\ Sb'''$; *Proustite*, $Ag'^{3}\ As'''$.—It is probable that one or other of these minerals occurs at the Thames, as Captain Hutton's mention of the occurrence of "red oxide of silver" at the Golden Crown Mine (Geol.

Rep., 1870-71, p. 5), is probably a misprint, no such mineral, as far as I am aware, being known. He also, page 148 of the same volume, without description, mentions the occurrence of "oxide of silver, and probably sulphate of silver," from the new Golden Crown Claim, but as neither of these minerals are mentioned in Dana's mineralogy, I am unable to say to what he refers.

### Mercury.

This metal has been found in New Zealand, both in the native state and also as Cinnabar, but only so far in small quantities.

*Native Mercury*, Hg, occurs at Waipori, in the district of Otago, where it is found in the alluvial wash of the district as small globules, and also alloyed with gold to form amalgam (Hector, Jurors' Rep., p. 404). Native mercury also occurs at the Ohaeawai Springs, near the Bay of Islands, but only in small quantities. It has been known since 1866, and in 1870 Captain Hutton described a visit to the locality (Trans. N.Z. Inst., vol. iii., p. 252), and the mode of occurrence has since been described by Dr. Hector (Geol. Rep., 1874-76, p. 5), as follows :—" The Ohaeawai Springs deposit a brown sandstone, which forms laminated beds 10 feet to 15 feet in thickness. This sand, which is an incoherent granular siliceous deposit, includes fragments of the surrounding vegetation, and thin layers of Cinnabar sand and globules of Metallic Mercury. The layer of sandstone containing mercury is only 4 inches thick, and is confined to a very limited area, and the attempts made to collect the mercury have not, hitherto, been profitable."

*Cinnabar*, Hg′.—This mineral occurs as rounded grains in the alluvial deposits of the Obelisk Ranges, Potter's Gully, Dunstan, Serpentine Valley, and Waipori, in Otago (Hector, Jurors' Rep., pp. 264, 436), and also in the deposits of the Ohaeawai Springs previously mentioned.

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## Art. LXXIII.—*On Crystalline Rocks.* By W. D. Campbell, F.G.S.

[*Read before the Auckland Institute, 11th July,* 1881.]

Crystalline rocks occur as altered sedimentary deposits, and comprise most of the eruptive rocks; the latter are to a great extent crystalline at the time of their formation, while the former were originally loose accumulations of various particles for the most part. Both kinds of rocks are subject to changes of condition which are termed metamorphism, by which the internal texture and composition have been altered gradually by chemical, electric and crystallographic action, by the withdrawal of, or addition, or substitution for some of the chemical elements, aided by heat and watery vapour acting under intense pressure. The changes in the sedimentary rocks are usually more apparent than in the eruptive, so that the term metamorphism has been more especially applied to these rocks.

TABLE OF CHANGES PRODUCED BY METAMORPHISM.

| Earthy. | Indurated, and in which cleavage is shown by slaty rocks. | Micro-crystalline, Schistose (foliated). | Crystalline. Foliated. | Crystalline. Massive. |
|---|---|---|---|---|
| Mud, Clay, Shale | Claystone, Clayslate or "Killas" .. | Argillaceous Mica-Schist, Talc Schist .. .. | Gneiss | Granite |
| Sand .. .. | Sandstone, Grit .. | Quartzite, Quartz Schist, Felsite (Petrosilex) | | |
| Calcareous Mud | Chalk, Limestone .. | Marble, Dolomite | | |
| Volcanic Ash and Tuff .. .. | Slates.. .. .. | Felstone Trachyte | | |

The completeness of the change may vary from the incipient form shown by indurated clay-slate rocks in cleavage, which always occur in a direction other than the plane of bedding. Some slaty rocks are apparently volcanic ash deposits. This structure of cleavage is more mechanical than chemical, and caused by great lateral pressure by which the component particles were flattened, producing lines of weakness at right-angles to direction of pressure. This structure has been artificially produced in some soft substances, by Dr. Sorby and Prof. Tyndal, and also by Messrs. Fox and Hunt, by passing galvanic currents through masses of moistened pottery clay (Page's Geology, p. 154). The contorted condition of fossils that occur in the slates show also the disturbance of the particles forming the slate.

Limestones pass from an indurated into a compact and microcrystalline texture, becoming granular when highly metamorphosed. The latter generally occurs associated with schist, or in the proximity of eruptive rocks. The whole of these varieties are popularly termed marbles. Crystalline marble has been artificially produced by heating chalk under pressure sufficient to prevent the escape of carbonic acid gas. Many accessory minerals, such as zircon, spinel, corundum, lapis lazuli, are found in crystalline limestones.

Arenaceous rocks, such as sandstones, are composed of rounded particles of quartz ; and grits of angular fragments and crystals, together with rounded particles of quartz ; these are converted by metamorphosis into quartzites, the component particles being cemented with siliceous material ; both kinds often contain felspar, which renders them capable of conversion into felstone rocks, and when mica is present, micaceous kinds are produced.

The alteration passes then into foliation, which is a segregation into crystalline layers of different mineral composition, the planes of separation being either along those of the bedding or cleavage. This structure is termed schistose. The various mineral layers blend into each other, and are composed chiefly of quartz, felspar, mica, and talc or chlorite, while veins of quartz ramifying through clay, slate, or other non-siliceous rock, render them convertible into argillaceous mica-schist or phyllite, mica-schist, granulite; or less siliceous kinds, forming talc, chlorite, hornblende, or actinolite-schist, or schorl rock.

Schistose structure has been found also to be occasionally produced in lavas, the vesicles in which have been compressed and attenuated in the direction of flow (Rutley, Q.J.G.S., vol. xxxvi., p. 285).

A further alteration of these rocks takes place into gneiss, which has a schistose structure, the quartz, felspar, and mica, and often hornblende, of which it is composed, being arranged in layers, the foliation constituting the chief difference from granite. Gneiss, and schistose rocks, with intercalated beds of crystalline limestone, form the laurentian rocks of Canada. The schist containing beds of graphite, or unoxidized carbon and apatite, (Dawson, Q.J.G.S., vol. xxxii., p. 285), denotes plant, and the limestone, animal life. Graphite occurs also at Pakawau, in Nelson, under similar condition in metamorphosed strata, and its presence denotes that no extreme temperature was attained during metamorphosis of the rock.

Gneiss has been found in many cases to merge into granite, so that the extreme of metamorphism may be regarded as granite, the fundamental rock throughout our earth; and its massive crystalline texture and its chemical combination of elements, namely, quartz, felspar and mica, must now be regarded as the ultimate crystalline condition, under great pressure, of sedimentary strata, either by slow consolidation after having been converted into a molten state, or by gradual chemical and structural change.

The quartz in granite often has cavities and enclosures of other minerals, principally rutile and chlorite; these cavities generally contain pure water, occasionally liquid carbonic acid, or a solution of chloride of sodium; they also contain bubbles, or rather vacuous spaces which show the contraction which the imprisoned fluid has undergone during the cooling of the rock. Dr. Sorby and others have endeavoured to calculate the amount of pressure shown by these contractions in volume. Spaces or beads of glassy or amorphous quartz, also occur, which denote that the quartz had first become viscous, and in consequence solidified without crystallizing. The liquefaction proved by the liquid cavities to have once been the condition of granite, has caused it in places to burst through adjacent rocks in an eruptive manner, when disturbed perhaps by an increased pressure, while other portions of the same mass may gradually blend into schistose sedimentary strata. Professor Judd has proved how granitic rocks in the Island of Mull, Scotland, and at Schemnitz, in Hungary, are directly connected with volcanic rocks, and both form portions of one and the same mass.

"One of the arguments against the igneous origin of granite is that its quartz has a s.g. of 2·6, identical with that of silica, derived from aqueous solution, while the s.g. of fused silica is only 2·2" (Rutley's "Petrology," p. 207).

Professor Haughton, in his annual address to the Geological Society of Dublin in 1862, in alluding to a table of the specific gravities of natural and artificially fused rocks, remarks:—"It appears to me that the column of differences greatly strengthens the arguments of those chemists and geologists who believed that water played a much more important part in the formation of granites and trap rocks than it has done in the production of trachytes, basalts, and lavas, and that they owe their relatively high s.g. to its agency."

The accompanying table from Dr. Page's "Geology" shows admirably the component parts of granite, the felspar occurring in two varieties, "orthoclase" and "oligoclase," the former being associated with white and black mica (uniaxial and biaxial).

A table of felspars is also shown for the sake of reference. It shows the crystallographic relations with the chemical.

| | | | |
|---|---|---|---|
| Granite | Quartz | Silica | Silicon, Oxygen |
| | Felspar | Silica | Silicon, Oxygen |
| | | Alumina | Aluminium, Oxygen |
| | | Potash | Potassium, Oxygen |
| | Mica | Silica | Silicon, Oxygen |
| | | Magnesia | Magnesium, Oxygen |
| | | Potash | Potassium, Oxygen |
| | | Lime | Calcium, Oxygen |
| | | Peroxide of Iron | Iron, Oxygen |

| Divisions. | Crystallographic Properties. | Varieties. | Chemical Character. | — |
|---|---|---|---|---|
| Orthoclase Felspar | Oblique system | Orthoclase, Sanidin | Potash (acidic) | In Granite, Gneiss, Syenite and True Volcanic Rocks only |
| Plagioclase Felspar | Doubly oblique system | Albite | Soda (acidic) | In Granite with Orthoclase and in many Diorites |
| | | Oligoclase | | In Granite with Orthoclase; In *Diabase* and *Diorite* |
| | | Andesite | Lime (basic) | In Trachytic Rock |
| | | Anorthite | | In old Lavas |
| | | Labradorite | | In Augitic Rocks (Dolerite Gabbro and Diallage) |

When granite and other rocks have penetrated superincumbent strata, the contact of the molten mass has usually produced a change in the neighbouring rocks, but of a different character to that widespread uniform character described under metamorphism. The difference has been brought about through its sudden character, and probably by the loss of a large portion of watery vapour, causing a vitrifying effect to be produced. Hornblende-slates are frequently formed along the contact margins of granite and clay-slates. (Q.J.G.S., vol. xxxii., p. 187, J. A. Phillips; Q.J.G.S., vol. xxxiv., p. 438).

Metalliferous veins are usually found to have been formed by the occurrence of intrusive rocks in the vicinity, the latter having been usually decomposed by acids and vapours, the introduced metals, or the metals from them, being deposited in veins.

Mr. J. A. Phillips in Q.J.G.S., vol. xxxv., p. 391, describes the district of Steamboat Springs, Nevada, where "fissures are being lined with siliceous incrustations which are being constantly deposited, while a central longitudinal opening allows the escape of gases, steam and boiling water; the water is slightly alkaline and contains carbonate of sodium, sulphate of sodium, common salt, etc." These springs have deposited cinnabar (ore of mercury) with the silica (both amorphous and crystalline, the latter containing the usual liquid cavities and ordinary optical and other characters of ordinary quartz). At other springs in the same district silver and gold have been found enclosed in sinter-like deposits. In Australia gold occurs in pyrites contained in diorites and granite, and gold mines are worked in these rocks. Mineral veins often show by their structure that the fissures (Q.J.G.S., vol. xxxii., p. 169) they fill have been widened repeatedly, probably by the force of crystallization, successive infiltration having filled the fissure with siliceous and other substances forming a banded structure. The metals when they occur may either have been deposited from solution or by sublimation. The tin-bearing bands of schorl rock in granite of Cornwall, have been proved to have been formed through the decomposition of the granite along the sides of leaders or veins. Granites vary from coarsely porphyritic granites to the fine grained elvans (quartziferous porphyry) in which mica is present. The porphyritic texture is due to the inequality in the crystallizing power of the various minerals, felspar and mica crystallizing more readily than quartz, the latter always occurring in consequence in more irregular forms than the former.

Hornblende and schorl are sometimes found replacing mica to a great extent, forming syenite and schorlaceous-granite, and when only a small proportion of quartz occurs the rock passes into syenite and schorl-rock. Granite frequently passes into felstone, micaceous felstone differing only from granite in texture. Trachytes are volcanic rocks, possessing precisely the same chemical constitution as felstone, and form their modern representatives; they occur largely in the central portions of this island. Both belong to the acidic group, and form far more extensive deposits than the basic, which are represented by melaphyres and basalts, and to these belong the Auckland Isthmus volcanic rocks, while intermediate forms termed trachydolerites (Scrope) predominate in some areas. This preponderance of siliceous kinds has caused some geologists to consider that they predominated in the older, and the basic in the more modern rocks. The eruptions from the greater number of the active volcanoes of the present day have apparently a basic character, but the recent investigations of the nature of the bed of the ocean show that while *Globigerina* ooze covers the ridges and plateaux down to 2,000 fathoms, lower deposits are covered with a red clay, formed of decomposed felsitic minerals with particles of highly vesicular felspar and pumice, and concretionary nodules of manganese, a large proportion of which must be derived from submarine eruptions; thus while comparatively circumscribed deposits of augitic lava are accumulated around the volcanoes, the more siliceous portions, comprising the ash and vesicular felsitic scoria, are accumulated separately on the bottom of the ocean. Lyell, in his "Elements of Geology," mentions that it can by no means be inferred that trachytes predominated at one period of the earth's history and basalt at another, for we know that trachyte lavas have been formed at many successive periods, and are still emitted from many active craters; but it seems to me that felspathic lavas have generally preceded augitic when a volcanic action has extended over long periods. Professor Judd has shown that in the extinct volcanic district of Schemnitz, in Hungary, lavas of an intermediate (acidic and basic) character preceded outbursts of extremely acid, and then of extremely basic character; the tertiary andesitic eruptions of Hungary forming an exact counterpart to those in the palæozoic in the British Isles.

Most of the older eruptive rocks have been affected by metamorphic action, many intensely so; the vesicular kinds have had their cavities filled with minerals, often of extraneous origin, forming zeolites and geodes of agate, or by segregation, zeolites forming often constituent portions of basalts. Chlorite, which always appears to have accompanied mineral changes, is generally present in considerable quantities in the older members of these rocks. There is also generally more lime, the potash and soda having been more readily dissolved out than the lime. The rock termed serpentine occurs with schists, and also as an intrusive rock, and apparently is usually the result of decomposition of olivine rocks—dimagnesian (ferrous, etc.) silicates—similar to the New Zealand dunite, or of materials derived from their disintegration.

One of the most interesting illustrations of the change produced by hydrothermal agency has been described by Professor Daubrée, who found that the water of the springs of Plombières, in the Vosges, which have a temperature of 160° Fahr., had formed zeolites in the concrete of the Roman aqueduct built for conveying the water, the concrete being composed of lime, fragments of brick and sandstone. The minerals found include apophyllite, chabazite, and opal.

In the following table the relations of the various eruptive rocks forming dykes, lavas, and scoria are shown :—

| — | | Compact. | Crystalline, granular. | Glassy, scoriaceous. |
|---|---|---|---|---|
| Acidic | Old .. | Felstone .. | Quartziferous Porphyry, Elvan | Pitchstone, Perlite |
| | Modern | Trachyte .. | Trachyte Porphyry .. | Obsidian, Pitchstone, Perlite, Pumice |
| | Inter | mediate Trachy- | dolerite. | |
| Basic | Old .. | Aphanite .. | Diorite .. .. | Tachylite |
| | Modern | Basalt .. | Dolerite .. .. | Tachylite, Pumice |

The characteristic ingredients of these leading varieties may be stated thus :—felstones have orthoclase felspar and quartz, the glassy conditions are pitchstones and perlites. Trachytes, their modern representatives, are composed almost wholly of a confused mass of crystals of sanidin without perceptible free quartz ; they are often porphyritic, the glassy form is obsidian. Hornblende is frequently present in these acidic rocks. The diorites comprise the hornblendic basic rock with orthoclase and oligoclase felspars. The dolerites, their modern representatives, have augite with sanidin and Labradorite felspars, tachylite forming the glassy condition ; it closely resembles obsidian. The ashy and tufaceous kinds are found consolidated into felstones and aphanite-slates ; microscopic examination shows these slates to contain crystals with fused surfaces, or with vitreous coatings, and isolated shreds of glassy matter in strings or bands (Rutley, Q.J.G.S., vol. xxxv., p. 338.)

The glassy varieties have been formed by rapid cooling of the molten mass, for when basaltic rocks have been experimentally melted, and cooled slowly, a state very similar to the original has been attained ; but when cooled rapidly, they have assumed a dark brittle glassy condition, resembling obsidian. The perfectly amorphous condition of common glass is seldom attained in the natural rock, minute crystals of pyroxene and felspar being generally more or less scattered through the glassy matrix. The glassy condition being a particularly unstable one, the obsidians and rocks with allied glassy structures like perlite have been altered into pitchstones, which sometimes show under the microscope a base of homogeneous glass without a trace of double refraction; in some cases the glassy structure is destroyed by crystallization, and a micro-crystalline base formed, possessing the double refraction characteristic of felstones, so that what was once glassy lava is now a felsite with a crystalline structure. (See also Rutley's Petrology, p. 169.)

It may be mentioned as illustrative of the changes which glassy forms undergo that water extracts potash and soda from glass, together with portions of silica, the decomposition taking place with greater ease in proportion as the glass is richer in these alkalies and more minutely divided, and the temperature of the water higher. The pearly stratum with which specimens of antique glass found buried in the earth are covered, consists almost wholly of silica.

In thus briefly reviewing the general relations of the various kinds of crystalline rocks, the chief leading characters of the more important groups have been referred to only, the numerous varieties diverging from these groups forming intermediate forms of more or less subordinate interest. The consideration of the changes that rocks undergo, leads us to a certain extent into speculative ground, where different interpretations of facts are tenable. The chief differences of opinion occur with reference to the relations and formation of granite. Though these uncertainties may encircle the subject at the present time, we may expect before long to have a clearer knowledge, as petrographic research has been making rapid strides in the last few years.

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## ART. LXXIV.—*Notes on a Pseudomorphous Form of Gold.*

By W. D. CAMPBELL, F.G.S.

[*Read before the Auckland Institute, 5th September,* 1881.]

Plate XXXIX.

THE occurrence of gold in pseudomorphous crystals has not been hitherto observed, I believe, so that this specimen, which was obtained from a white clay, taken from a leader in a drive of the Evening Star Claim, at the Waiotahi Creek, Thames, is of great interest. It is reniform-shaped, about ½ inch in length, and covered with minute crystals and filaments studded sparsely with minute irregular-shaped grains of a yellowish-brown mineral, insoluble in acids, which are probably zircon. It is, apparently, the same mineral alluded to by Captain Hutton, in his second report, page 29, on the

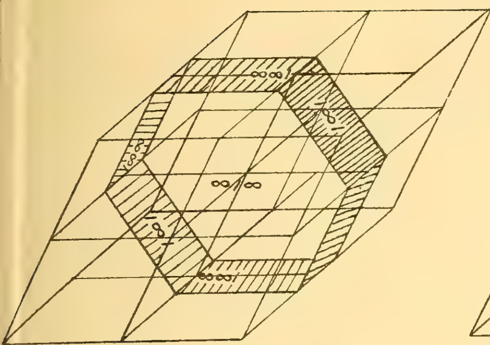
Thames Goldfields. The bed-rock in this locality is a soft, grey-coloured felspathic tufa, with pyritous leaders, weathering white and decomposing into a white clay. On page 40 of the report alluded to, an analysis of this rock is given in No. 4.

The form assumed by the gold is apparently that of botryogen, a bisulphate of iron, which has been formed by the decomposition of pyrites. The measurement under the microscope of the angle of the oblique prisms is nearly 120°, the typical form of botryogen is 117° 34′; the latter angle is used in constructing figs. 1 and 2 in the diagram. Two crystalline forms are apparent, the one oblique prisms with the acute angles modified by the positive orthodome faces of the form 1 ∞ 1 (see fig. 1), the other oblique prisms with edges replaced by faces of the form 11∞ and ∞1⅔. In fig. 3 is shown a portion of the specimen, enlarged. This occurrence of gold in the form of casts of botryogen indicates that the deposition of gold in this district has extended over a great period of time, involving these changes, or of its redeposition in this form. In either case it is important evidence towards the more complete knowledge of the occurrence of gold in this district.

The following particulars are attached for convenience of reference of the crystallographic symbols:—

| Tennant and Mitchell. | Naumann. | Dana. | |
|---|---|---|---|
| 1∞ ∞ | ∞P∞ | ii | The ortho-pinacoid faces } of the oblique prism. |
| ∞1∞ | OP | O | ,, clino ,, ,, } of the oblique prism. |
| ∞∞ 1 | OP | O | ,, basal ,, ,, } of the oblique prism. |
| 1 ∞ 1 | P∞ | i | The positive orthodomes of right prism on oblique rhombic base. |
| 11∞ | ∞P | i | The faces of the oblique rhombic prism, 1st order. |
| ∞1⅔ | ⅔P∞ | ⅔i | The chinodomes of oblique prism on rhombic base, 2nd order. |

I am indebted to Dr. Purchas, the finder of the specimen, for the opportunity of making the above description.



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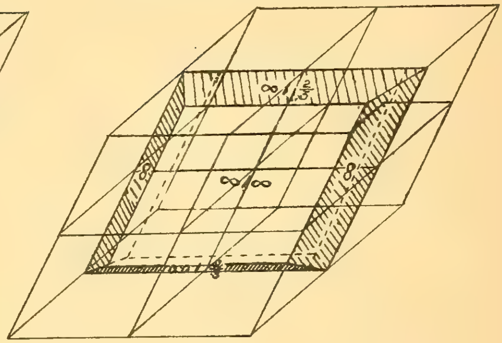

II

III

PSEUDOMORPHOUS GOLD.

W.D. Campbell.

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## Art. LXXV.—*A Study of the Causes leading to the Extinction of the Maori.*

By Alfred K. Newman, M.B., M.R.C.P.

[*Read before the Wellington Philosophical Society, 22nd January,* 1882].

The increase or decrease of a race living in our midst must necessarily be a subject of vital interest to each of us, and a study of the causes leading to such change is, I think, worthy of investigation. That the Maoris as a whole are very rapidly decreasing, needs but little proof. Everyone who has lived long in the colony must admit the fact. The early statistics are of course very loose; but the number of the observers and their general unanimity of statement, forms a mass of evidence which there is no denying. According to tradition, the Maoris came hither in thirteen canoes from Hawaiki, about five centuries ago. There is no evidence whatever to show that they found any race inhabiting these islands, and no faith can be placed in the vague tradition that these lands were inhabited by a dark race, the Ngatimamoe. The crews of these canoes were the first human beings who obtained a footing here. Finding a suitable climate and abundance of food, the race began to multiply and spread first over the northern half of the North Island, then gradually moving south, crossing over Cook Strait and overrunning the South Island and thence to Stewart's Island. Later on a number found their way to the Chatham Islands, forming a provincial branch—the Morioris. Various remains in the shape of old axes, and of ruins of old hill-forts, showed that these islanders were constantly engaged in intertribal wars, and that they were cannibals. The evidences of their having existed everywhere in these lands in what we may call pre-pakeha times, are very abundant. It is also abundantly proved that their advent to these islands was not above several centuries back. By the term "pre-pakeha" or "prehistoric," I mean here the years immediately before the discovery of these islands by the first pakeha, Captain Tasman, in the year 1642. Mr. Colenso, quoting from a very rare book, says that Tasman describes how his ships were in one place attacked "by 8 canoes" and that "22 more boats put off from the shore," these latter being double canoes. Parenthetically, I might here remark that Tasman says the warriors wore "each a large white feather in his hair." This was a mark of chieftainship. I saw similar feathers nearly two and a-half centuries later in the heads of the released Maori prisoners who had been ennobled by Te Whiti at Parihaka in 1881. The existence of 22 double canoes and 8 canoes in any one spot, is sufficient evidence of a large population. When Cook visited this place in about 1769, he saw very few boats. Dr. Forster in Cook's Second Voyage guessed the number of the Maoris at 100,000, "although," as Colenso says, "he never saw any of the populous parts of the North Island." Colenso quotes other estimates: Nicholas, in 1814, thought there were 150,000. Colenso thinks Forster's estimate far too low, because Forster only saw the sea coast, not going inland, and saw none on the whole *west* coast of the North Island, and therefore thought it uninhabited.

Amongst other authorities, I find that Cook, on one occasion, wrote there were 400,000 Maoris. In 1824, Major Cruise says there were nearly 3,000 present at a meeting at the Bay of Islands, and at another time a "vast number" of canoes. It would now be impossible to find anything like that number of people or canoes. The Rev. W. Williams, in 1835, estimated their numbers as not exceeding 200,000, and divides them thus:—

| | | | |
|---|---|---|---|
| Northern part .. .. | 4,000 | Thames .. .. .. | 4,800 |
| Hokianga .. .. | 6,000 | Bay of Plenty .. .. | 15,600 |
| Waikato .. .. | 18,000 | East Coast, to Hawke's Bay .. .. .. | 27,000 |
| Kapiti, and northern shores of Cook Strait | 18,000 | | |

Major Druse, writing in 1819, or a year or two previously, says that at one place he saw 50 canoes, each armed by fifty or sixty fighting men—at least 2,500 fighting men. Where now should we find such a concourse? Te Whiti, in 1881, at his greatest gatherings, could muster somewhat less than 1,000 fighting men. In about 1835, the numbers of the Maoris were estimated at 120,000, and in 1840 at 114,000. Governor Grey's figures in 1849 are 120,000, and Mr. McLean's in 1853 are 60,000. McKay asserts that from about 1820, the date of introduction of the musket, to close of Te Rauparaha's wars, in about 1840, no less than 60,000 perished. Colenso, Taylor, and others, have made similar statements, all showing the existence of a dense population. The numerous remains of old hill-forts show a former large population (see "Old New Zealand"). In places in the Auckland Province, and between Hawera and Patea, these ruins are existing in great abundance; now, scarcely any natives are to be found there. Terry, writing in about 1842, says that Williams very much underrated them, and based his estimates very largely on the tribes connected with the Church Missionary Society. Terry says there were 150,000 in the North Island alone. Another writer, in 1840, guesses the number at 80,000. This is the *lowest* estimate of early date that I have been able to find, and even this *lowest* makes their numbers double those now living. Colenso says that the missionaries knew, on excellent data, that in 1834 there were 7,000 fighting men from the Bay of Islands northward; that number has dwindled to less than 1,500. Colenso took the greatest pains to number accurately the natives in Hawke's Bay and part of Wairarapa, in 1847-48, and counted 3,704, and ascertained that there were 45 tribes and sub-tribes: *seventeen* years later he reckons them at 2,000. Judge Fenton showed that, in fourteen years (1844-58), there was a decrease in the Waikato of 19 per cent. In 1858, the same learned authority, on good data, apportions them thus :—

| | Males. | Females. | | | |
|---|---|---|---|---|---|
| North Island .. .. .. | 29,984 | 22,993 | = | 52,977 | 55,970 |
| South Island .. .. .. | 1,326 | 957 | = | 2,283 | |
| Stewart's Island and Ruapuke | 110 | 90 | = | 200 | |
| Chatham Islands .. .. | 247 | 263 | = | 510 | |

Mr. Alexander McKay's census for the South and Stewart Islands in 1868 is :—

| | | | | |
|---|---|---|---|---|
| Adult Males .. | 951 | Adult Females .. | 711 | 2,353 |
| Male Children .. | 375 | Female Children .. | 316 | |
| | 1,326 | | 1,027 | |

In census of 1881 the figures are—

| | | | | |
|---|---|---|---|---|
| Adult Males .. | 697 | Adult Females .. | 526 | 2,061 |
| Children, Males .. | 424 | Children, Females | 414 | |
| | 1,121 | | 940 | |

Colenso again in 1863 estimated the entire population at 49,000. It would be mere waste of time to supply a further list of figures all more or less accurate, but none strictly so. According to the census of 1881, which is fairly correct, there are 24,370 males and 19,729 females = 44,099, but of this number upwards of 400 are half-castes.

These statistics with a host of others might be adduced to justify the widespread belief that the race is rapidly dying out. Every intelligent observer has had before his eyes continually, ample proof of their astonishingly rapid disappearance. Here, within a 5-mile radius of this very lecture-room, since this colony was founded exactly 42 years ago, see how the Maoris have disappeared. There are now within that area only 37. There were, 42 years ago, a *pa* at Ngahauranga, one at Kaiwarra, a few families living near the site of Dr. Featherston's house, a few at Mr. Izard's; about 50 people at the bottom of Hobson-street; about 20 at Wordsworth-street, and 60 at Te Aro (Heaphy). A very few years before that there were three pas on Miramar peninsula; in one bloody battle between two of these pas, there were 500 killed on one side, and 70 on the other—even allowing for exaggeration in the two last figures, it shows a large population where now no Maori exists. So too wherever we revisit after a lapse of 20 years we find the same thing—the abolition of the pas, or their tenancy by a fraction of their former population. I know one ready objection to this statement is, that the natives are not dead, but only gone farther inland. This argument in the case of the Maoris in the South Island, is clearly disproved by the fact that it has long been possible there accurately to count every native, no matter how far back they may go. Altogether apart from the mere question of statistics, I am quite positive that this objection in this island is perfectly groundless. Take this island: the natives round this city have almost died out; at the Hutt, but a remnant exists; the *pa* at Waiwhetu is gone; there are no natives in the Wainui-o-mata valley; or up the Hutt valley. In the Wairarapa many *pas* have vanished, and but a remnant remains in the others. My own knowledge of Hawke's Bay, extending back about twenty-five years, assures me that recent statistics even do not prove sufficiently clearly the rapidity of extinction. In that short time I know of several populous *kaingas* quite deserted. I know that formerly, twenty years ago, there were a large number of natives in the district where now but very few exist. All along the east coast, from this spot to Napier, they have greatly dwindled. If we go up the other coast we find the same thing. About twenty years ago there were 300 living at Porirua and near neighbourhood, now there are 53. At Waikanae some forty years ago there were 500 fighting men besides women and children, now there are only 20. There was a *pa* at Paikakariki, now one family dwells there. Farther up is Otaki, where the population has greatly dwindled, and so we may go up through Horowhenua, with a fraction of its former population, onwards through the now almost deserted Manawatu and Rangitikei, to Wanganui, and right along the coast to Parihaka and Taranaki. How many warriors could now be put in the field as compared with those who encountered our troops under General Cameron. Clearly the natives have "gone farther back" than Hawke's Bay and Taranaki. If we start at the North Cape and travel downwards from the Three Kings, we have seen by statistics but a fraction of their numbers now exist north of Auckland, and a journey southwards to the Waikato and Thames will reveal the same scantiness of population. Judge Fenton showed us how they decreased in the Waikato in a few years, and all observers admit that the natives are fewer in the centre of this island and about the East Cape than they were twenty years ago. The proof is overwhelming, the natives have not gone farther back—*they have died.*

The Maoris and the weaker Morioris in the Chatham Islands are almost extinct. Bishop Selwyn preached to 1,000; now the entire population, Maoris and Morioris, is 126.

Without going into the still disputed question as to which great division of the human family the Malay race belongs, according to the best evidence it seems clear that the Maoris are a part of the race which stretches west from Singapore to Madagascar, perhaps to South Africa, and west to Java, the Marquesas, the Sandwich Islands to Otaheite, over most of the Pacific Isles to Easter Island and New Zealand. Through all this vast range of land we find a decaying race.

De Quatrefages, in his work on "The Human Species," writes:—Captain Cook, just a century ago, estimated the Kanakas in the Sandwich Islands at 300,000. In 1861 there were 67,084—about 22 per cent. of the original number. From another source I find that the Kanakas in 1832 were 130,817, and in 1872, 56,897. In the Marquesas, Porter guessed the population in 1813 at 19,000 warriors, giving a population of 70,000 or 80,000. In 1858 M. Jouan found 2,500 or 3,000 warriors, and about 11,000 other people. Cook and Forster estimated the population of Tahiti at upwards of 240,000. In 1857 the official census gave only 7,212, that is to say, a little more than 3 per cent. of the original population. De Quatrefages also adds that this decrease of population extends to *all* the islands of Polynesia, and instances Bass Island, where Davis counted 2,000 people in the beginning of the century, and where Moerenhaut found only 300 in 1874. I believe it is the same with the Papuan race in Fiji and other islands. In the "Malay Archipelago" Wallace tells us that the Dyaks and other branches are dying out, owing to the frequency of deaths and the infertility of the race. The large stone ruins of Easter Island tell of a bygone dense population, where now but a beggarly remnant exists.

It would be mere waste of time to go on accumulating further evidence; everywhere the evidence is clear and abundant that not only in New Zealand but all over the broad Pacific the race is steadily dying out. This steady diminution of the race is not a peculiarity of the Maoris; it is common to the Malay family generally. Certain writers please to call the Maoris a "provisional race," but the phrase though learned means little. The Maori is becoming extinct, like many other races, from almost identical causes. All over the world we see some races progressive, some stationary, others decaying; others recently extinct, a few fossil. The Anglo-Saxon race is rapidly progressing; the French seem nearly stationary; the North American Indians are fast vanishing; so are the Bosjesmen. Soon will vanish the Ainos, the Eskimos, the Australian aborigines, the Kamskatdales, the Makalolos and the Morioris. Lately extinct are the Tasmanians, the Charruas, the blacks of California. Long extinct are the race found as mummies in the caves of Madeira, the Cro-Magnon race; the people whose remains are found in the caves of the Pyrenees and the Perigord: still more anciently extinct is the race to whom belonged the fossil man of Neanderthal.

All over the world we see evidences abundant, clear, and indisputable, that races of mankind like individuals have their birth, their period of growth; some are fertile and give birth to other races; some races are sterile, merely propagating themselves for a time, but in either case invariably like individuals beginning to die and then becoming extinct. Such a race is the Maori, a small race inhabiting a strange land, multiplying rapidly, giving birth to one weakly offspring, the Morioris, and now steadily dying, just as do individuals. The race is "run out," it is *effete;* seems thoroughly worn out, and its approaching death has been hastened by the struggles with a newer and a fresher race. The races of mankind are like individuals in this respect, each has its birth, its maturity, begets fresh races or individuals, and then slowly or rapidly decays. They die out just as certainly as do individuals. We as individuals have a certain time, bar accidents, to grow, increase, multiply, and decrease. I believe that races have the same, and that in time all the existing races, no matter how flourishing, will die out: in some instances leaving a progeny, in others none. The public settle the question of the dying out of the Maori race in an off-hand manner, by saying "the black man always speedily disappears before the white;" but that the advent of the white man alone is the sole cause is disproved by the dying out of the Dyaks in parts where the whites have barely reached; so, too, in other islands of the Pacific where the white race can have had at the utmost a trivial effect. Undoubtedly we do speedily kill the black races in all countries sufficiently cool for us to live and thrive in.

The rapid decrease of the Maoris is a startling fact when we recollect that for the last fifteen years they have had no devastating wars: that of late they have been living in peace among themselves, and in the South Island have not fought the Europeans or among themselves for thirty years. Formerly the tribes were always at war with adjacent tribes, and when not actually fighting were continually destroying each others crops. Formerly their food was hard to get, and poor when got: now the supplies are regular and far more nutritious. They all possess ample means. They never die of starvation. They can all obtain ample clothing. The struggle for existence is among them far less severe than it is amongst ourselves, yet our race, by natural means, apart from immigration, is increasing as rapidly as the other is decreasing. Moreover, there seems now to be less chance than ever of any union of the races. Half-castes appear to be far fewer proportionately than in the early days of the colony; and those few who do not revert to the semi-savage state, but become civilized, are an unproductive race. In the course of a few generations the Maoris will die out and leave no trace of their union with the whites.

To gain a clear view of the effects of the different causes leading to the extinction of the race it will be well to study very briefly the Maoris in their former wild and their present civilized conditions. Before we came to these islands the natives were dotted in clusters all over the islands, but more thickly in the northern one. These clusters were generally on small or lofty hills, with a wood near and a river at the base. As they were divided into many tribes, which were always ready to fight for their own protection, each small tribe, or parts of bigger tribes, entrenched themselves on the spurs of a mountain or the brow of a hill. One side of the hill was usually a steep ascent, and the other sides frequently defended by a ditch and rampart. In these highly-placed forts they slept, descending by daylight to the damper lowlands or the swamps and rivers for fishing. Any food they got was irregular in supply, and nearly always hardly earned, almost always was bulky, but very innutrient. Their clothing was very scanty, and put on or off without any regard to so-called decency. They intermarried largely. Their lives were always harassed by actual warfare or a dread of assaults. They had few diseases, and as communication with different parts of the islands was rare, epidemics did not do much damage. The Maoris enjoyed an immunity from very many diseases which have long affected us, *e.g.*, smallpox, syphilis, measles, scarlet fever, whooping-cough, typhus, and probably typhoid. But though they had few diseases, those few were deadly. Consumption in its various forms killed old and middle-aged and young. They suffered from a malarious fever, from diarrhœa, from bronchitis and pneumonia, and many from rheumatism. Rheumatism was a frequent scourge. Scrofula thinned the children's ranks. Epilepsy and dropsy were not infrequent. A species of leprosy (*ngerengere*) was prevalent. In addition to these and other diseases, cannibalism was the cause of death to many. Infanticide, especially female infanticide, was very common. Old people, both men and women, chiefly the latter, were allowed to die of neglect or starvation. They sometimes died from eating unhealthy eels or from a surfeit of lampreys. Suicide was exceedingly common, but is now rare. Murders were numerous. In the olden times, if a husband died the woman nearly always killed herself. Under the painful operation of tattooing some died; and lives were lost by the old warriors' dislike of dying in bed, for when they felt death approaching they used to arm themselves to the teeth, and then at night, gathering their remaining energies for one last struggle, would rush headlong into one of the enemies' camps, generally killing men, women, and children, before they themselves sank covered with wounds.

Numbers died because they were *makuhied:* were bewitched, died through sheer fright, after infringement of the *tapu.* Slaves were known to die of nostalgia. Their knowledge of surgery being limited, they died frequently from slight wounds. Sometimes great Maori chiefs dropped dead from excessive excitement. In times of war, or of scanty food supply, the old women were killed. A few died from the bite of the *katipo*, or poisonous spider, and a few from eating poisonous berries, and some are said to have died from sunstroke.

Now, the Maoris have quitted all their old hill-forts, and live at the edge of a bush or a swamp, almost always on low-lying, damp, ill-drained spots. It was the author of "Old New Zealand" who first drew our attention to this most important fact. Their old hill-forts were sunny and airy; the winds blew away the odours, and they were often above the mists and dews that hang round their present habitations. Usually perched on the edge of a cliff, with a scanty humus beneath their whares, and below that again rocks which let the water escape, these places were always dry and tolerably clean. Now, however, they live in sheltered spots, with only a moderate amount of sunlight and but little wind, with abundance of morning and evening moistness; below, a thick black humus, with probably a clay basis which retains the water. This land lying low there is usually no subsoil and still less surface drainage. The soil all round their whares is often spongy with retained water and decaying organic matter; even the floor of their huts is frequently damp. In very many cases it would have been quite impossible for them to have chosen worse or more unhealthy sites for their dwellings. I am quite convinced that this question of change of site is infinitely more powerful in its effects than has hitherto been supposed. The chief disease that kills the Maoris is consumption. I believe it kills more than all the other diseases put together. In any assembly of Maoris there is sure to be heard a large proportion of coughs, with a death-knell ringing in their tones. We are apt to think consumption dreadfully disastrous to our own kith and kin, but among the Maoris its effects are still more terrible. Consumptive people among ourselves do frequently refrain from marriage for fear of its affecting their offspring, but among the Maoris no such sentiment prevails. No matter how consumptive they will marry, and the results are seen in the sickly offspring, dying early of kindred inherited diseases. Usually among ourselves, even if persons with a consumptive diathesis marry, they mate with healthy people who are not their kinsfolk. With the Maoris it is altogether different. I am quite convinced that this change of locality is one of the most important factors leading to extinction of the race. The whole evidence of modern medicine shows, beyond a shadow of a doubt, that the two chief causes of phthisis amongst all nations is the intermarriage of phthisical people, and dwelling on low, damp, ill-drained soils: yet these are the very things which the Maoris seem to prefer doing. Amongst ourselves the awful ravages of phthisis may be either entirely checked or greatly abated, by care, by medicine, by nursing, and by change of climate ; of all these the Maori knows nothing. He undergoes no medical treatment at all, or only in the last stages, when medicine is powerless ; he never takes care of himself, he goes out in all weathers, gets soaked and does not change his clothes, and his food is not the well-cooked, wholesome, easily digestible food fit for an invalid ; he never wears suitable warm clothing. This frightful scourge (phthisis) is still further aggravated by the close fetid air of their tiny *whares*, or the draughty condition of their badly made wooden houses. Again, as so many persons, healthy as well as unhealthy in all stages, sleep all huddled close together in their unventilated *whares*, they breathe and rebreathe each others unhealthy breaths. The consequence is that the naturally healthy catch the disease in large numbers. Amongst ourselves who have private sleeping rooms, we see the ill effects, but among the Maoris the results are awful to contemplate.

This evil habit of pitching their dwellings on low-lying swampy ground causes many deaths from rheumatism, from bronchitis, pneumonia, and low fever.

I wrote to a number of medical men to obtain their experience, and to them I am exceedingly grateful for much most useful information. Unfortunately the Maoris need not have their deaths certified to, and in a large class of diseases, especially those of women, they never consult a doctor. Owing to these causes I am unable to present to this society any statistics of disease ; but still it is not difficult to detect the chief. The principal diseases of infants are scrofulous ; large numbers die from scrofula in some shape or another. From the time they are weaned they eat anything the mother eats, and the consequence is that most Maori children look badly fed, big-bellied, with wasted limbs, and with eruptions about their orifices. They die largely from the effects of bad feeding, getting tabes mesenterica, chronic diarrhœa, atrophy. They suffer from swollen glands and eczematous eruptions. Some have hydrocephalus, acute and chronic. Dr. Spencer, who has for many years attended a Maori orphanage, says they improve wonderfully on admission ; their bellies shrink ; their limbs grow bigger, and their eruptions vanish ; but about puberty they often get weak again and break out afresh with eruption. They are very subject to chronic peratitis.

Dr. Earle of Wanganui dilates on the many hundreds of children that die annually from dysentery and tabes mesenterica, brought on by improper food and the want of a milk diet. With regard to a milk diet, Mr. Locke writes that in those instances where the children are fed on milk they improve wonderfully in appearance. Archdeacon Williams attributes the decrease of the race chiefly to the dreadful mortality existing among the children. Most observers have had their attention drawn to this fact. No more striking difference between a Maori *pa* and a white village can be noticed than the fewness of the children in the one with the multitude in the other, and the difference in the physique of the feeble black and the healthy white child is equally remarkable. Though, as I shall show hereafter, the one race is noticeable for its sterility and the other for its fecundity, undoubtedly the marked difference in the number of children seen in a village is due to the fact that Maori babies die out in such awful proportion. Any observer visiting a number of native *pas* could not help seeing that any race with so few children must inevitably soon become extinct.

*Imported Diseases.*

The imported diseases have, of course, been very powerful agents in bringing about the decrease in the race. In the early part of this century a disease swept through the country like an epidemic: it is believed to have been a kind of influenza, but nothing is known accurately. Since our arrival in the colony there have been many attacks of measles which have always been very fatal, especially the earlier epidemics. This disease, so mild among ourselves, is wondrously fatal whenever it gets among the island populations of the Pacific. Even smallpox has never been known in these islands and happily the natives will not suffer much from this disease because so many are being vaccinated. Scarlet fever has at times been disastrous. Diphtheria has had its victims, but, strange to say, this disease and several others do not appear to have greatly affected the natives. I believe one of the greatest curses to the Maoris is the popularly-called low fever, which is nothing else than typhoid. The spread of this fever is largely encouraged by the absence of all drainage in their encampment. As yet, we have not brought to them smallpox, or cholera, or plague, or yellow fever, or typhus, or relapsing fever, or ague, and it is highly probable that they will not appear. Whooping cough has done a good deal of damage, as it is so frequently associated with pneumonia.

Many observers not trained in medicine talk about the frightful effects of that "awful scourge" syphilis, and say that the Maori population is saturated with it, and that its fearful effects are seen in the sterility of the race and the astonishing mortality existing among the children. To this disease I have paid special attention and made special enquiries from doctors—the only class of men whose opinion is worth taking—and they confirm me in the belief that, though the Maoris are affected by it, yet its results are rarely severe. My own feeling (remembering the frightful scourge it proved on its introduction to various parts of Europe) is one of astonishment at the smallness of the evil. Several doctors who practise largely among the Maoris assure me that they never saw true syphilis in a Maori. My own experience is that amongst the large number of Maoris I have seen I have not been able to detect any evils from this cause, yet I am quite sure that in any like number of low-living whites the evidences would be abundant. I have never seen Maori children with any marks of syphilis. Though I have searched everywhere and have tried to seek confirmatory evidence of the reports of the frightful ravages of syphilis, I am forced to the conclusion that they are unfounded, and that syphilis has been a very unimportant one among the many factors leading to the decrease of the Maoris.

On the other hand, I readily admit the influence of a milder form of lues venerea. The prevalence of this disease is so great as really to merit the term universal. It is probable that it existed mildly before we whites came here, and that we imported a severe variety of it. The prevalence of this disease in both sexes leads to sterility, by causing the inflammation of the secretory passages of both races, and especially probably in women, as is seen in a particular class of women in London, where the extension of this inflammation to the Fallopian ducts leads to their occlusion and a consequent sterility. It is my belief that this variety of disease will account for some of the barrenness existing among the women.

Leprosy, formerly common among the Maoris, has now almost disappeared, under the constant supply of nutritious food.

Looking then at the question as a whole, I am inclined to think that imported diseases have not been the chief causes leading to the disappearance of the Maori, but that they have only played a part with others. I think that other causes are more effective; in fact, with a few exceptions of two or three rather severe epidemics, and one frightfully severe, as mentioned by Colenso, that occurred many years ago, there is no evidence to show that, provided other causes did not exist, there would be sufficient power in these diseases to kill the race. Did such new diseases (we will suppose imbibed by us from the aborigines) attack us, our natural increase of population would soon repair their ravages in our ranks. As a matter of fact, the Maoris die chiefly from such diseases as phthisis, in all its protean forms, from bronchitis and pneumonia, and from renal affections, which are not imported diseases, whilst the children die because they are born weakly; and their chief foes are bad food, irregular clothing, and inherited diseases, and their low, damp habitations; whilst the imported diseases are not nearly so powerful in their effects as are these.

I think that, viewed by the light of modern research, which shows that all epidemic diseases are due to the propagation of minute vegetable organisms in our bodies, it is somewhat strange that these organisms, which like vaccine tend to sterility when repeated too often, should not have flourished far more on such virgin soils as the bodies of the Maoris. It has occurred to me, but of this I have no proof, that the phthisis which is so invariably and so speedily fatal to the Maoris, may owe some of its severity to the importation of phthisis germs of a stronger and more virulent nature, such germs finding a most nutrient soil in the bodies of the weakly constitutioned Maoris.

*Other Factors.*

Alcohol has undoubtedly assisted in killing the natives. The liquors drunk by the natives are usually the poorest, the worst, and the most adulterated. Alcohol seems to affect them just as it does ourselves. It kills them indirectly, by leading to various diseases, and directly by leading to severe accidents. Maoris when drunk will lie about anywhere in the rain, or on a damp soil, or with wet clothes on, and this of course leads to more deaths through coughs and colds and rheumatism. The large revenues arising from the sale and lease of their lands are chiefly spent on alcohol. The sexes drink alike, and drink till all the money is gone and the landlords refuse to give them any more credit.

Tobacco is another evil agent: for the incessant smoking of the worst and most fiery brands, by men, women and children, is certainly productive of a lowered vitality, which shows itself in an enfeebled progeny, and renders all classes more accessible to evil influences.

Among all Maori experts there is a consensus of opinion that our mode of clothing ourselves, imperfectly adopted by the Maoris, has been to them a source of disease. Formerly, on entering their *whares* with wet mats, they simply flung them aside, whereas, now, their modern European clothing they keep on, and do not change until they are dry. Moreover they do not regulate this clothing to suit changes of weather, but will wear warm clothes in the sultriest weather, and in bitter cold will put on any scanty garments they may have. This undoubedly does lead to many evils, and especially in the case of children, and tends to many disorders which eventually end fatally.

I agree with certain writers in thinking that *indolence* is also a cause of their decrease. Formerly they were forced to work continually for a living, now they lead the laziest of lives; this laziness generates a host of evils. In the United States it has been observed that negro slaves kept at work increased in numbers, whilst freed negroes steadily decreased.

*Wars* during the past thirty or forty years have destroyed a number of Maoris, but though they lost, in their wars with us, many on the battle-field, and very many more by semi-starvation leading to lowered vitality, and others from diseases arising out of the hardships they endured, yet these wars were neither so long nor so frequent, nor so sanguinary as their former incessant intertribal strifes. Moreover, when we took any Maori prisoners, we lodged and fed them well—only we did not slay and eat them afterwards as was the former custom of the country.

Many writers assert that *horses* have been a not unimportant factor, in two ways (1) directly by falls, which either killed outright or after a time; (2) by making locomotion so easy as to induce the natives to be always travelling long distances, thus carrying diseases far and wide: this easy travelling also induced them (by opening wider their range of pleasure) to neglect necessary work in their fields; it also led to all the evils that spring from clothes wetted on their long journeys and worn till dry.

Natives whose limbs are severely crushed by machinery, in battle, or by other accidents, not infrequently die because they refuse to submit to amputation.

Mental depression is held by many authorities to have a large effect upon the Maoris, and certainly the loss of their former cropping grounds, of their sacred burial grounds, of the rivers and lakes wherein they formerly fished; and the evident decrease of their race does probably affect a few, but most assuredly only a very few. A want of courage, however, in another direction does influence the death-rate: namely, the readiness with which they "throw up the sponge" when attacked by disease. Unquestionably many Maoris die of slight ailments because when attacked they do not fight against the disease and strive to resist its ravages, but quietly coil their blankets round them, and lie down passively to die. They seem to have no pluck, and their friends look on in a listless do-nothing way, accepting their fate needlessly.

*Sterility.*

Though the adult Maori death-rate is greatly in excess of that of the whites, yet the excess is not so much in excess as to lead to the rapid decrease of the race were it not that the race is so infertile and its children die with such frightful frequency. The Maori race is singularly infertile. This infertility is common to the people in almost all Polynesia. Wallace asserts that the Dyaks are fast dying out, even in places where Europeans have but little intruded, and that the infertility of the women there is very marked, the number of births to each woman being extremely few. De Quatrefages quotes similar statements. In the Marquesas, at Taio Hae, M. Jouan saw the population fall, in three years, from 400 to 250, during which time only three or four births were registered. In the Sandwich Islands, from among eighty married women, M. Delapelin found that only thirty-nine had children. There were only nineteen children in the twenty principal families of chiefs, and in the same islands, in 1849, the official statistics of M. Renny gave 4,520 deaths to only 1,422 births. The Kanakas, though separated by so many thousands of miles of water, are singularly like the Maoris in appearance, language, and mythology: therefore it is not a little strange to find among them sterility like that which exists among the Maoris. Nearly all the persons knowing the Maoris well whom I have happened to consult, are agreed on this point, viz., that many women are absolutely sterile, and that the others are only moderately fertile, having only one, two, or three children. The Maoris themselves recognize the fact but can assign no cause. Colenso says that children are becoming fewer every year, and that of the seven principal chiefs in Ahuriri, all but one was childless, and of the one who had four sons three were fruitless. Judge Fenton gives some remarkable statistics in his "Observations on the State of the Aboriginal Inhabitants of New Zealand, 1859." In certain well-known tribes in the Waikato, between the years 1844 to 1858, there were: Deaths, 650; births, 320. He gives the following striking table of results:—

| — | Ngatitapa. | Ngatikarawa. | Ngatikahu. | Ngatitahinga. | Te Ngaunga. | Ngatikoura, &c. | Ngatihinetu, &c. | Ngatiwhauroa. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| Number of wives whose issue are now living. | 46 | 8 | 22 | 14 | 32 | 31 | 107 | 15 | 221 |
| Number of wives whose issue are dead .. | 19 | 2 | 3 | 4 | 10 | 11 | 38 | 2 | 68 |
| Number of barren wives .. .. .. | 24 | 5 | 11 | 9 | 15 | 8 | 75 | 7 | 154 |

Farther on in this book he estimates that the ratio of barren to productive Maori women is as 1 to 2·86. To account for this startling infertility many theories have been invented, but it is more than certain that the great bulk of them are imaginary and baseless. Doubtless this infertility arises from many causes, and not a single cause. I believe that the chief source of this evil is interbreeding; that the Maoris have almost always married in *their own or in some nearly adjacent tribe.* Nearly all the pure races of men and animals are infertile, as compared with the mongrels. Any reference to Darwin's "Plants and Animals under Domestication," or his later work detailing his researches into the crossing and fertility of plants, will save the need of cumbering these pages with overwhelming proof of the need of crossing to maintain the fertility of the race. Galton has demonstrated the infertility of aristocracies whose members married only with each other. These, and a host of other authorities, show that any race of man which breeds in and in, becomes more and more infertile, and the scanty progeny more and more sickly and likely to perish.

When the Maoris came here several centuries ago, they were probably not quite a pure race, but were Malays with an infusion of Papuan blood. This infusion of Papuan blood can, I think, be traced to this day, appearing every now and then amongst their lower classes. Arriving in a fresh and more invigorating climate than that to which they had been used, and finding the supplies of food abundant and easily got, their fertility increased by this slight cross with the Papuans; it was no wonder they multiplied rapidly, but the Papuan blood being only in small quantity, and always shunned and despised, was soon an insignificant quantity, and the Malay blood became purer and purer. As the Maoris spread over these islands and divided themselves into tribes, living far apart, usually at war with each other, breeding in and in was almost a necessity, and hence, as I believe, the chief cause of the barrenness of the race.

Though I am free to admit the existence of other, yet I feel sure that this is the chief cause. It has been alleged that early promiscuity on the part of very young Maori women is the chief cause, but though certainly an important item, it is not the chief, and is not more common now than formerly. Alcohol and tobacco are also credited as evil agents, but for these no proof exists. Syphilis has been blamed by many, but seeing how very slightly it has affected the race there is no evidence to show that it has at all decreased the fertility of the race. On the other hand, I believe that the frequency of the milder form of lues venerea has by its frequency and severity been a frequent cause of sterility in both sexes by inflammation of and subsequent stricture and closure of the various ducts, and especially obliteration of the passage through the Fallopian tubes. In exceptional cases I think that the introduction of horses has caused abortion. Some allege that hard work produces this infertility, but though it may aid, it cannot be an important factor, for Maori women have always had to work and carry heavy burdens, even in past times when the race was fertile. The Maoris thought that all sterility was due to the females, and disregarded the abundant proof that many men were always childless, no matter how many wives they took. Formerly if a woman were childless she took another mate for that reason and no other: now, however, she sometimes remains sterile and faithful. It is probable that the great number of males and the fewness of the women leads to sexual indulgences in great excess, thereby causing a diminished fertility.

I am of opinion too that the abundance of easily-got food which they now have in regular supply—food too which is *infinitely more nutritious* than anything they had in the olden times before we came to the country—has led to a state of fatness and general plethora which, as in all the lower animals, leads to a lessened fertility, and in others to absolute sterility. On visiting Maori pas we see nearly all the young women very fat, though the old ones are generally very thin. All breeders of domestic animals recognize the fact that over-feeding leads to lessened fertility, and that the remedy is a restricted diet. Maori women now drink fattening beer and milk, and tea and sugar, in lieu of water; and eat meat, and wheat, and oats, and potatoes, each and all of which they get in full supply, and every one of which contains far more nutriment than that in treble or quadruple the quantity of shell-fish, or the roots of the fern and the convolvulus. Though many Maori women still work hard, yet they do not work sufficiently hard to carry off the extra food-supply, and very many of the wives and daughters of the wealthier natives do very little work indeed. Extra food-supply in conjunction with diminished muscular activity is I am sure an important factor among the many leading to the extinction of the race. The very early age at which the girls breed undoubtedly diminishes the fertility of the race.

*Disproportion of the Sexes.*

My friend Mr. Govett quoted to me from some author a statement to the effect that in all flourishing races of mankind the females were in excess, but that in decaying races the females were in a minority. I have not been able to find his authority, but when applied to the Maoris it is strikingly correct. In Fenton's statistics in 1859 the proportion is, males 31,667 to females 24,303. Colenso's statistics (see above) give a like result. The still more accurate Government census of 1881 shows males 24,370 to females 19,720. Amongst the Kanakas in the Sandwich Islands I find a like disparity between the sexes, there being males 31,650, females 25,247.

It is easy to understand why this disproportion existed in New Zealand before 1840, because then, as Colenso points out, in their devastating intertribal wars the female children (slaves) were sure to be killed first for food; and because in times of hardship women naturally succumb first. No such causes now exist, yet is there still this great preponderance of males; and among another branch of their own race, the Kanakas, the same inequality of the sexes exists. For the existence of this strange phenomenon I feel unable to give any satisfactory reasons, though I believe there are many combining to produce this result—(1.) Male children predominate in mountainous countries, and it is only for about a generation and a half that the Maoris have dwelt on the plains.

(2.) Abundance of food-supply to mothers is found to result in an excess of male offspring. (3.) It is found elsewhere that if the male are considerably older than the female parents, males will be in excess, and *vice versâ.* Among the Maoris the male are usually considerably older than the female parents, and male births do preponderate. The statistics of civilized countries show an excess of male births, this excess being in after-life greatly reduced by the greater death rate existing among male children. Later in life Maori women die from the evils of early breeding, and from their greater liability, whilst pregnant, to take any epidemic diseases.

*Half-castes.*

Reasoning from analogy, it would have seemed probable that if much of the infertility of the Maoris were due to purity of race and interbreeding, a large fertility would have attended a cross with the more vigorous fertile white race: such, however, is not the case. It is true that the marriage of a white man and a Maori woman is often attended with a large family, but considering how very frequent have been and still are the promiscuous unions between the two races, the result is surprisingly small. No accurate census exists of the half-castes, but their number of all ages and sexes is probably considerably under 1,000. The half-castes are often handsome and well made, but they all die young, indeed there is a wide-spread belief that scarcely any attain the age of forty. Young half-caste women especially die very young unless they are well cared for. Both sexes die of consumption; the ravages of the chief destroyer of both parent races seems to attack them with intensified vigour. Topinard, writing on the respiration of various races of men, tells us that the mulattos have a chest capacity inferior to that of either parent race. Even in sultry Hindostan, the Topas, a cross between Hindoo women and French or Portugese men, are far more liable to phthisis than either parent race. Huth ("Marriage of Near Kin") says the European North American half-breeds near Quebec are peculiarly liable to phthisis, and the greater number die early. I believe that this lessened chest capacity is to be found in nearly all New Zealand half-castes. It is true that many have handsome figures and broad shoulders, but their chests are usually of the shallow type seen in the consumptives of our own race. If, as seems probable, phthisis is largely increased by the presence of bacilli or other organisms, it is highly probable that such European microscopic organism, like introduced European grasses and other plants, finds a suitable nidus in the half-caste, and flourishes with renewed vigour. Be that as it may, the half-castes are a delicate race and succumb early in life to phthisis. The offspring of half-castes by either race are a very feeble race and rapidly tend to extinction. Though the climate is excellent for both races, the crossing does not seem to result in improved fertility. The cross between a white woman and a Maori man has been so rare as not to afford any data for observation. As white women become more plentiful everywhere, the proportion of half-castes to the two races is steadily diminishing. Early colonists and many theorists believed that the two races might amalgamate; as a matter of fact the two races will never mingle, and any infinitesimal influence that the white race may receive until that not far distant time when the Maori race dies out, will thereafter be at once imperceptible. No New Zealander will boast like some Americans that the blood of Pocahontas still flows in their veins, or that they are connected with that magnificent race "the children of the sun," the Incas. In another century only the prying ethnologist will be able to ascertain in isolated spots any partial effect of the Maori blood. This utter effacement of the Maori race, its complete inability to engraft itself on the European race, is singular, because the Maoris are a sturdy, powerful people with very distinct race characteristics, which they might have been expected to transmit at least in some degree.

*Longevity.*

In discussing the rapid decrease of the race, we must not overlook the question of the longevity, the life average, of the Maoris. Spite of all the out-cries that medical science helps to depreciate any race, by causing the weak and sickly to survive and breed, the average life of a civilized is far greater than that of a wild people. The Maori race is one whose average duration of life is small: they mature early and wither quickly. Lancaster ("Comparative Longevity") suggests that, as savages lead very hard lives and die often under the results of accumulated hardships, there may grow up among them, as an inherited quality, a tendency to die at early periods; or, as he puts it, there may be a "disease Eskimo" or a "disease Maori." This tendency to premature old age and death is marked among the Maoris; their boys and girls early attain puberty, early breed, and quickly attain maturity. Maori women look old and "going down hill" when about thirty, and Maori men of fifty or sixty are not to be compared for vigour with Europeans of a like age. This lessened race longevity by limiting the nnmber of years during which they can breed, and by hurrying them to their graves, assists in hastening the rapid disappearance of the race.

*Summary.*

In conclusion, I hope I have made it clear that the Maoris were a disappearing race before we came here; that such disappearance arises from an excessive mortality, such mortality being largely due to the change from living in lofty, dry, well-aired villages, to miserable, damp, low-lying unhealthy *whares*; that this change has caused an immense increase in the number of deaths from phthisis and other diseases of the chest, and rheumatism; that this change has acted very severely upon the children; the other great cause being the large amount of absolute sterility and the small reproductive powers of the race. I believe that to these two things is due the rapid decrease of the race; a lessening in numbers hastened somewhat, though only in a small degree, by imported European diseases; and that only one imported vice, viz., alcoholism, has in the least helped to hasten the disappearance of the race.

Taking all things into consideration, the disappearance of the race is scarcely subject for much regret. They are dying out in a quick, easy way, and are being supplanted by a superior race.

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## ART. LXXVI.—*On the fine Perception of Colours possessed by the ancient Maoris.* By W. COLENSO, F.L.S. (ADDENDUM TO ART. III.)

[*Read before the Hawke's Bay Philosophical Institute, 10th October, 1881.*]

I PURPOSE here noticing more particularly some of the errors in Mr. Stack's paper; those especially which I have not referred to in my paper.*

At page 154† Mr. Stack says:—"What stage had the colour-sense of the Maori reached before intercourse with Europeans began? This can readily be ascertained by reference to the terms existing in the language at that date, for giving expression to the sense of colour."

I deny that this can "*readily* be ascertained" even by any expert Maori scholar; still it was, and is known; but not in the bald way that Mr. Stack supposes.

He then goes on to say, that "there are only three colours for which terms exist" (!) which he also follows up with certainly erroneous attempts at derivation of his three Maori terms, relying as he tells us upon "a few standard works, which will always serve for reference, whenever a question may arise as to the meaning of any word in the language. One of the most reliable of these is the translation of the Bible, the work of Archdeacon Maunsell," etc.

Here I note, (1)—"for reference as to the meaning of *any word* in the language." Now this remark alone would, *à priori*, confirm me in my supposition of Mr. Stack's insufficient knowledge of Maori. There are hundreds,

* See above, p. 49.

† See "Trans. N.Z. Inst.," vol. xii.,—and so throughout, whenever Mr. Stack's paper is referred to.

aye, thousands of Maori words that are not to be found in the works he mentions; and it was my certain knowledge of this fact which led me to undertake the heavy work of the Polynesian (or New Zealand) Lexicon,* which knowledge was also both increased and confirmed in me as the years of labour therein rolled on.

(2.) That the translation of the Bible into Maori was *not* the work of Archdeacon Maunsell. The New Testament was translated and in use before Archdeacon Maunsell arrived in New Zealand; so were the Book of Psalms, and other Books and parts of Books of the Old Testament; the original translation of the New Testament being mainly the work of the late Dr. Williams, the first Bishop of Waiapu. That Dr. Maunsell largely aided (under Bishop Selwyn) the zealous hard-working band of coadjutors concerned in the present edition is correct.

(3.) Then, most astonishing of all, Mr. Stack goes on to quote even *Greek words* from the *Septuagint*, to meet certain Maori words used in the present translation of the Old Testament!

In the conclusion of his paper, Mr. Stack winds up with saying,—"In common with the colour-blind the Maori *confounded* the lighter tints of several different colours,—and were *blind* to *blue*."

In my paper (*supra*) I have shown the contrary of these assertions; and I bring this sentence forward here (*re* the *blue*) just to meet one of Mr. Stack's chief and earliest Septuagint quotations. He gives us, ὑακινθον—blue (Exodus xxv., 4).

(1.) Is he aware that this Greek word means other dark colours equally with blue?

"By Homer, Odysseus' hair is likened to the hyacinth (ὑακινθος), and the ancient Greek commentators, to whom the conception was not yet so foreign as to us, quite correctly refer the simile to the black colour (μέλας). Pindar speaks in the same sense of violet locks. With Homer, also, the word κύανος (our *cyan*) is the deepest black. The mourning garment of Thetis he calls κυάνεον, and at the same time 'black as no other garment.' The same colour-term is applied to the storm-cloud, and the *black* cloud of death, and several times by adding μέλας it is distinctly explained as black." —*Gieger*, *Frankfort Lectures*, 1867).

(2.) Would Mr. Stack be surprised to hear that perhaps the Hebrew word in that place (*tepaylĕt*) does not, or may not, mean blue? This is what some of the *old* and learned doctors have said about it in their trans-

* I have often—aye, almost constantly—lamented, that the Government did not carry on this work: had such been done, neither Mr. Stack nor myself had written our papers.

lations and comments:—"Kimchi explains *tepaylĕt* by *bleu*; Abarbanel translates, *silk*; Ebn Exra, Rashi, and others, *yellow*; and Luther, *yellow silk*; others, *indigo*—(but ὑακινθος is not exclusively blue)," etc., etc. (Dr. *Kalisch, in loc.*)

Mr. Stack further says (p. 154),—"The Maoris appear to have reached the third stage of colour-sense development, when, *all at once*, the arrival of Europeans *revealed* to them the *entire scale* of colours possessed by *the highest races* of mankind."

Mr. Stack will find that in the earliest mental productions that are preserved to us of the various peoples of the earth the colour *blue* is not mentioned at all.

"Let me first mention the wonderful, youthfully fresh hymns of the Rigveda, consisting of more than 10,000 lines; these are nearly all filled with descriptions of the sky. Scarcely any other subject is more frequently mentioned; the variety of hues which the sun and dawn daily display in it,—day and night, clouds and lightnings, the atmosphere and the ether,—all these are with inexhaustible abundance exhibited to us again and again in all their magnificence; only the fact that the sky is *blue* could never have been gathered from these poems. * * * The Veda hymns represent the earliest stage of the human mind that has been preserved in any literature; but as regards the blue colour, the same observation may be made of the Zendavesta, the books of the Parsees, to whom, as is well known, light and fire, both the terrestrial and heavenly, are most sacred, and of whom one may expect an attention to the thousand-fold hues of the sky similar to that in the Vedas. The *Bible*, in which, as is equally well known, the sky or heaven plays no less a part, seeing that it occurs in the very first verse, and in upwards of 430 other passages besides, quite apart from synonymous expressions, such as ether, etc., yet finds no opportunity either of mentioning the blue colour. * * * The *Koran* does not know the blue colour either, however much it speaks of the heavens. Nor is the blue sky mentioned in the *Edda* hymns. * * * Nay, even in the *Homeric Poems* the blue sky is not mentioned, although in the regions where they originated it exercises such a special charm on every visitor. * * * The ten books of Rigveda hymns, though they frequently mention the earth, no more bestow on it the epithet green than on the heavens that of blue. They speak of trees, herbs, and fodder-grass, of ripe branches, lovely fruit, food-yielding mountains, of sowing and ploughing, but never of green fields. Still more surprising is the same phenomenon in the Zendavesta.

"Aristotle, in his 'Meteorology,' calls the rainbow tri-coloured—viz., red, yellow, and green. Two centuries before, Xenophanes had said, 'What they call Iris is likewise a cloud, purple, reddish, and yellow in appearance;' where he leaves out the green, or, at all events, does not clearly define it. In the Edda, too, the rainbow is explained to be a tri-coloured bridge.

"Democritus and the Pythagoreans assumed four fundamental colours, *black*, *white*, *red*, and *yellow*, a conception which for a long time obtained in antiquity. Nay, ancient writers (Cicero, Pliny, and Quintilian) state it as a positive fact that the Greek painters, down to the time of Alexander, employed only those four colours. * * * The Chinese have since olden times assumed five colours, viz., green in addition to the foregoing."—*(Gieger, loc. cit.)*

And so Max Müller.—"There is hardly a book now in which we do not read of the blue sky. But in the ancient hymns of the Veda, so full of the dawn, the sun, and the sky, the blue sky is never mentioned; in the Zenda-vesta the blue sky is never mentioned; in Homer the blue sky is never mentioned; in the Old and even in the New Testament the blue sky is never mentioned. It has been asked whether we should recognize in this a physiological development of our senses, or a gradual increase of words capable of expressing finer distinctions of light. No one is likely to contend that the irritations of our organs of sense, which produce sensation, as distinguished from perception, were different thousands of years ago from what they are now. They are the same for all men, the same even for certain animals, for we know that there are insects which react very strongly against differences of colour. * * * Democritus knew of four colours, viz., black and white, which he treated as colours, red and yellow. *Are we to say that he did not see the blue of the sky because he never called it blue, but either dark or bright?* * * * In common Arabic, as Palgrave tells us, the names of green, black, and brown, are constantly confounded to the present day. It is well known that among savage nations we seldom find distinct words for blue and black; but we shall find the same indefiniteness of expression when we inquire into the antecedents of our own language. Though *blue* now does no longer mean black, we see in such expressions as 'to beat black and blue' the closeness of the two colours. * * * As languages advance, more and more distinctions are introduced, but the variety of colours always stands before us as a real infinite. * * As no conception is possible without a name, I shall probably be asked to produce from the dictionaries of Veddas and Papuas any word to express the infinite; and the absence of such a word, even among more highly civilized races, will be considered a sufficient answer to my theory. Let me, therefore, say once more that I entirely reject such an opinion. * * * The infinite was present from the very beginning in all finite perceptions, just as the blue colour was, though we find no name for it in the dictionaries of Veddas and

Papuas. The sky was blue in the days of the Vedic poets, of the Zoroastrian worshippers, of the Hebrew prophet, of the Homeric singers, but though they saw it they knew it not by name; they had no name for that which is the sky's own peculiar tint, the sky-blue."—*(Lectures at the Charter House*, 1878: LECTURE I).

"It is noteworthy down to what a late period both the Greeks and the Romans still confounded blue and violet, especially with grey and brown. Even long after scientific observation had separated these colours they seem to have been mixed up together in popular conception. And thus it happened that Theocritus, and, in imitation of him, Virgil, by way of excuse for the bronzed hue of a beautiful face, could still say, "Are not the violets, too, and the hyacinths black?" With a similar intention Virgil says: "The white privets fall; it is the black hyacinths which are sought after and loved." Nay, even Cassiodorus, at the beginning of the sixth century after Christ, gives an account of the four colours employed in the Circensian Games, which, as is well known, sometimes acquired a fatal significance: green had been dedicated to spring, red to summer, white, on account of the hoar-frost, to autumn, blue to the cloudy winter—*venetus nubilæ hiemi.* Classical antiquity, in fact, possessed no word for pure blue. * * * The Romanic languages found indeed no fit word for blue in the original Roman tongue, and were obliged partly to borrow it from the German. Thus, among others, the French *bleu* and the older Italian *biavo*, are, as is well known, borrowed from the German *blau*, which, in its turn, in the earliest time signified black."—*(Gieger, loc. cit.)*

I have been at the trouble of bringing forward all this first-class authority evidence, to show—(1) that "the highest races" did *not* possess "the entire scale of colours;"—(2) that had the Maoris not been already in possession of the knowledge of colours, and of their shades and hues, "the arrival of Europeans" among them would not suddenly have "revealed" such to them;—and (3) that such a wholesale mental revolution, as Mr. Stack here states, has never, and could never take place "all at once."

I feel, however, that I must specially notice two or three more of Mr. Stack's statements.

He says (p. 155)—"*Kura* (red) is used very often instead of *whero* to describe redness in any *inanimate* object."

Mr. Stack evidently never heard of any of their (many) old supernatural beings, still believed to be existing, called *Kura*; and was not *Kura* a common term for the chief men in the olden time? *e.g.*—"I te oranga o tenei motu, he *Kura* te tangata."

Again (p. 156)—"While they regarded the rainbow as a divinity, * * to their organ of sight it presented *one* characteristic tint, and that was *ma* (white), or allied to light."

This assertion I have already fully met in my paper *(supra)*; but I would further ask—Why, then, was it so commonly called *Kahukura*—"scarlet," or red, garment?

Mr. Stack also quotes the well-known passage in Isaiah i, 18, for "scarlet and crimson." But the "scarlet" of King James' days (the time of the translators of the English Bible) was not the same identical colour as the scarlet of to-day. Our modern scarlet was not then known.

Again (p. 155), Mr. Stack says, "*Pounamu*, or greenstone, * * * is sometimes used now as a colour-term. *Karupounamu*=green-eyed, is the term applied to persons with light-coloured hazel eyes, but I never heard *pounamu* used to describe the colour of the sea."

I refer Mr. Stack to one of "the few standard works" which he quotes—Sir G. Grey's "Mythology," pp. 158, 159 (or to his "Poetry of the New Zealanders," pp. xciii., xciv.), where he will find two sentences in excellent Maori, *re* the colour of the eyeball, and of the water, in both of which the *pounamu* is used as a simile.* Evidently, he has also overlooked the little bird called *Titipounamu (Acanthisitta chloris)*;† the shark called *Tahapounamu*; the lizard called *Pounamu-kakanorua*; the early winter potato of the Ngapuhi tribe called *Pounamu*; our northern lakes called *Rotopounamu*; and the *Aupounamu*, the *Waipounamu*, etc., etc. Again, in my two editions of the Maori Bible (one in 12mo. and one in 8vo.), the passage in Esther i. 6, contains the word *pounamu* for green colour, and not that "Maoricized" abomination—*karini*—which Mr. Stack quotes.

Mr. Stack also says (p. 156), "*At the suggestion of Europeans* the indigo-blue plumage of the *pakura (Porphyrio melanotus)* is sometimes employed to indicate the colour, which before intercourse with Europeans was *unrecognized*." These two statements (which I have italicized) I deny; and I should not care to do so here, only to show that I had written to the direct contrary in 1865 ("Essay on the Maori Races," § 33).‡

Further, Mr. Stack says (same page), "No words are found in the Maori language to express violet, brown, orange, and pink colours; but there are no less than three words to express pied or speckled objects." This is

* See "Trans. N.Z. Inst.," vol. xi., pp. 97 and 98, for my translation.

† Observe here how Dr. Sparrmann (who accompanied Captain Cook to New Zealand) naturally hit on the same term in colour for this bird *(chloris)* as the Maoris had formerly done.

‡ "Trans. N.Z. Inst.," vol. i., p. 37 of "Essay."

incorrect, as my paper (in part) will show, where brown, orange, and pink are brought forward. And as to there being "no less than three words for speckled objects," I know more than a dozen!

Again, Mr. Stack says (p. 156),—"Further proof of their imperfect perception of colour is furnished by the fact that the Maoris have never shown any real appreciation of floral charms. * * * Flowers generally were despised, and the greatest astonishment was expressed by Maoris in the early days, when they observed the pains taken by colonists to cultivate any but flowers of the gaudiest hues."

Here I observe,—(1) Flowers were *not* despised; very far from it. It was owing to their fading so quickly, especially when in close contact with the human body; I have known, however, young chiefs often to fix a flowering sprig in their ears. It was not the national custom of the Maori women to decorate their hair, for they generally wore it cropped (*vide* Cook and others); but I knew them at an early date to bind their hair with a graceful wreath of *Clematis (C. colensoi*, and *C. hexasepala)*, and of *Lycopodium volubile*, and not unfrequently with a neat green fillet of fresh flax. (See plate xix., in Parkinson's "Journal;" Parkinson was Sir Joseph Banks' draughtsman, and here in New Zealand with him.) (2) The Maoris never wantonly destroyed "right and left" the shrubs and small trees around them,—like the "superior" or (to use Mr. Stack's own words) "the *higher* races" invariably did; it was a pleasing sight to see their hastily put-up booths or "tabernacles" in travelling, or abutting on their country plantations and river and seaside fishing grounds, their *karaka* fruit and bird preserves,—always made in a snug bowery place; even the common privies of their *pas* (towns) were often so situated, and I have known such public spots with planted and trained shrubs and creepers *(Solanum aviculare*, and *Muhlenbeckia adpressa)* growing over them; and they never cut down the trees growing near for firing, fencing, or any purpose; rather than do such wanton acts, they would travel miles to procure poles, sticks, etc.* (3) That "astonishment" experienced "in the early days" was not *re* flowering plants of non-gaudy hues, but plants *not* producing *fruit* (tubers, etc.). From long before Mr. Stack's earliest recollection the Maoris planted with "pains" the potato, the onion, the melon, and the cabbage; the flowers of these did not possess "gaudy hues;" but being a practical people, a true race of hard-working agriculturists, they were astonished at such waste of labour, good ground and fences, in non-productive plants.

Mr. Stack also says (p. 158),—"They (the Maoris) seem to have *lost* all sense of harmony in colouring." *Qu.* Could they lose what (he had repeatedly said) they never possessed?

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* See "Trans. N.Z. Inst.," vol. xiii., p. 373.

Further, and lastly, Mr. Stack says (same page),—"Most persons have had an opportunity of observing the incongruous colours in which a Maori belle arrays herself when seeking to attract admiration in our streets. Her mode of adornment proves that her sense of colour is still very defective. She knows each colour by name* but she has an imperfect mental conception of it, and therefore cannot realize what a fright she makes herself by wearing colours that will not harmonize." Mr. Stack might more justly have applied these words to a fashionably dressed *European* female, such as I not unfrequently meet with here in Napier. Take out the word *Maori* and insert *European* or *Colonial*—and the sentence is complete. Such, almost word for word, I have last year frequently seen in our more respectable papers, English and Colonial, when writing on the horried deformities of the fashionable and bizarre female dress of the day. In my estimation, the Maori woman of to-day has been so far vitiated and debased in taste as to run after and adopt those ultra European fashions.

I have thought it necessary thus freely to criticize Mr. Stack's paper in the interests of our English and European philological and physiological writers (as Max Müller, Herbert Spencer, Darwin, Tylor, Lubbock, etc.), who, in the prosecution of their studies and researches, naturally look to such a volume as our New Zealand Institute "Transactions" for correct information *re* the Maoris: and to allow such erroneous notions and statements, however innocently made, to remain unchecked, would never do.

I wish to add, that I do not believe that Mr. Stack has erred *wilfully*; and, further, that if, even now, he were to travel leisurely among the Maoris in the interior of the North Island, he would himself soon discover many of his errors, and abandon them.

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* I suppose that some of those colours of dress, she is said now to know by name, are such as the following, *e.g.*:—

| | |
|---|---|
| plum-colour | rose-colour |
| lavender-colour | orange-colour |
| lemon-colour | claret-colour |
| sage-green-colour | pea-green-colour |
| fawn-colour | mouse-colour |
| dove-colour | salmon-colour |

etc., etc., etc.

Now where is the very great difference in expression, or rather, say, the superiority, of these of the Europeans over those of the Maoris, by whom similar natural objects having the exact shade of hue required were also used comparatively?

Art. LXXVII.—*On the Origin of the New Zealand Flora—being a Presidential Address to the Otago Institute.* By Geo. M. Thomson, F.L.S.

[*Read before the Otago Institute, 31st January,* 1881.]

Among the many questions of interest which offer themselves for solution to the botanist, none possess more fascination than those dealing with the geographical distribution of plants ; and if this is so in other parts of the world it is doubly so in New Zealand, where the existing conditions are almost unique. The present distribution of our flora leads up to a wider and far more interesting question, viz., its origin, and the investigation of this brings under review many collateral subjects, among which may be considered the former land connections existing between what is now New Zealand and other parts of the world.

The main question cannot be considered alone, but must be taken in conjunction with the origin and distribution of our fauna, and with the great geological changes which have been effected in past times, and which have brought about in our time a distribution of land and water very different from that which existed at the end of the Secondary or commencement of the Tertiary period.

But it would be almost impossible in the limits of a single address to discuss the subject in all its aspects, and I shall therefore confine myself to a small portion only of it, stating in the first place what has been written on this topic, and then pointing out some of the interesting facts which an examination of it reveals.

Every naturalist who has visited New Zealand has had his attention drawn to the many remarkable features of its fauna and flora, but Sir Joseph Hooker, Professor F. W. Hutton, and Mr. Wallace, are the only writers whose works I am acquainted with, who have attempted to solve the problems presented to them.

The first-named botanist in the introduction to the "Flora Novæ-Zealandiæ" has summarized the information at his disposal in a masterly essay, which forms the basis of our knowledge as to the distribution of the Flora. But he has not sought to trace the origin of our species more directly, confining himself to their affinities and to their occurrence in other countries, but not seeking to solve the question as to how they have found their way here. Between the publication of the "Flora Novæ-Zealandiæ" (in 1853) and the issue of the "Handbook" (in 1867), about 200 species of flowering plants were added to the Flora, while up to date about 150 more species have been added, bringing the total up to 1,085 species. More close and accurate investigations of many of our local botanists are the means of continually adding to this list. Still the general conclusions arrived at in the "Flora Novæ-Zealandiæ" have not been materially altered by recent discoveries.

Sir Joseph Hooker was struck by the preponderance of Australian types among those plants which he found to be common both to New Zealand and other countries of the world. Nearly one-fourth of these plants were Australian, nearly one-eighth South American, and one-tenth common to both Australia and South America. Of the remainder about one-twelfth were shown to be European and one-sixteenth antarctic. When we find similar plants in two widely-separated parts of the globe, we are naturally led to consider how they have reached these distant localities, and if no satisfactory solution of the question is afforded by an examination of their structural means of dispersion, we are further tempted to speculate on the former land connections which have existed. The preponderance of Australian plants in New Zealand is not to be accounted for by proximity alone, as the wide extent of sea which separates the countries forms the most effectual of all barriers to the migration of the majority of plants. Sir J. Hooker points out that no theory of transport of the forms common to the two regions will account for the absence of "the *Eucalypti* and other *Myrtaceæ*, of the whole immense genus of *Acacia*, and of its numerous Australian congeners," or the absence of *Casuarina*, *Callitris*, *Dilleniaceæ*, etc., and the variety of such large Australian orders as *Proteaceæ*, *Rutaceæ*, and *Stylidieæ*. Nor will any theory of variation account for these facts. And he continues: "Considering that *Eucalypti (Myrtaceæ)* form the most prevalent forest feature over the greater part of South and East Australia, rivalled by the *Leguminosæ* alone, and that both these Orders (the latter especially) are admirably adapted constitutionally for transport, and that the species are not particularly local or scarce, and grow well wherever sown, the fact of their absence from New Zealand cannot be too strongly pressed on the attention of the botanical geographer, for it is the main cause of the difference between the floras of these two great masses of land being much greater than that between any two equally large contiguous ones on the face of the globe." Read in the light of our accumulated knowledge, the following remark is of interest: "New Zealand, however, does not appear wholly as a satellite of Australia in all the genera common to both, for of several there are but few species in Australia, which hence shares the peculiarities of New Zealand rather than New Zealand those of Australia." That is to say, that he saw that those plants which occur both in Australia and New Zealand had not necessarily all passed from the former to the latter country, but that in many cases the opposite had occurred. After describing the affinities existing between the plants of New

Zealand and those of South America, Europe, and the antarctic regions respectively, and further pointing out some remarkable Pacific Island peculiarities in our flora, Hooker concludes by stating that the existing botanical relationships "cannot be accounted for by any theory of transport or variation," but that they are "agreeable to the hypothesis of all being members of a once more extensive flora which has been broken up by geological and climatic causes."

Leaving out of account minor speculations on this subject, we may next consider the second writer named, who deals—although indirectly—with the question.

Prof. Hutton's theory*, deduced from the distribution of the struthious birds in the southern hemisphere, is that there formerly existed a great "antarctic continent stretching from Australia through New Zealand to South America, and perhaps on to South Africa. This continent must have sunk, and Australia, New Zealand, South America, and South Africa, must have remained isolated from one another long enough to allow of the great differences observable between the birds of each country being brought about. Subsequently New Zealand must have formed part of a smaller continent, not connected either with Australia or South America, over which the moa roamed. This must have been followed by a long insular period, ending in another continent still disconnected from Australia and South America, which continent again sank, and New Zealand assumed somewhat of its present form."

It is of course assumed that this former extensive antarctic continent existed at a date anterior to the first occurrence of mammals either in Australia or South America, and consequently that all subsequent immigrants from Australia, or from the islands lying to the north, must have found their way across the intervening expanses of ocean. Professor Hutton recognizes many of the difficulties in the way of this theory, as, for example, the occurrence of grass-birds (*Sphenœacus*) in both Australia and New Zealand, and the existence of the genus *Ocydromus* (woodhens, etc.) in New Zealand, Lord Howe's Island, and New Caledonia; as the birds of both these genera are almost or quite unable to fly.

The examination of our fresh-water fish leads him to the conclusions "either that our connection with Australia was later than with South America, or that in the old continent New Zealand and Australia were inhabited by one, and South America by another species" of the grayling family. "The fresh-water fish also prove that our connection with the

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* On the Geographical Relations of the N.Z. Fauna, by Captain F. W. Hutton. "Trans. N.Z. Inst.," vol. v., p. 227.

Chatham and Auckland Islands was much later than with Australia." And then he goes on to say:—"The distribution of *Anguilla latirostris*, which is not found nearer than China (and of *A. obscura*, a closely allied species, which occurs in the Fiji Islands), adds its testimony to that of *Lotella* and *Ditrema* (other species named by him), of a former connection with that part of the world, not by way of Australia; and we shall find that this remarkable connection with China and the Indian Archipelago, thus dimly shadowed out by the fishes, gets stronger and stronger as we review the invertebrate animals."

The examination of these lower forms leads to the same general conclusions—a strong relationship on one hand with Australia, and a similar, but distinct, relationship with islands and countries to the north.

In summarizing the facts of the geographical distribution of the fauna, the following results are arrived at by him:—1. "A continental period during which South America, New Zealand, Australia, and South Africa were all connected, although it is not necessary that all should have been connected at the same time, but New Zealand must have been isolated from all before the spread of mammals, and from that time to the present it has never been completely submerged. This continent was inhabited by struthious birds," etc., etc.

2. After a period of subsidence, a second continent came into existence, "stretching from New Zealand to Lord Howe's Island and New Caledonia, and extending for an unknown distance into Polynesia, but certainly not so far as the Sandwich Islands." And while this continent was connected with China either directly or by a chain of islands, it must have been cut off from the New Hebrides by a strait.

3. "Subsidence again followed, and New Zealand was reduced for a long time to a number of islands, upon many of which the moa lived." This supposition is necessary to account for the number of species of *Dinornis* which formerly existed, as the birds must have been "isolated from one another for a sufficiently long period to allow of specific changes being brought about."

4. Elevation ensued, the isolated islands became connected together into one large island, which was not however connected with Polynesia, and over which the various species of moa roamed. And lastly,

5. By a process of subsidence the islands assumed something of their present form.

This theory is a most ingenious one, and is well worked out, and had available information been at hand as to the depth of the circumjacent seas, no doubt many of the conclusions arrived at would have been modified. The geological evidences are adduced in support of it, and though the distribution of the flora is not critically gone into, certain remarkable facts of the distribution of genera such as *Eucalyptus*, *Stilbocarpa*, *Metrosideros* and others, are brought forward by way of corroboration.

Some four years after the publication of Professor Hutton's paper, Mr. A. R. Wallace's great work on the "Geographical Distribution of Animals" came out, in which due consideration is given to the question of the origin of the New Zealand fauna, and to the discussion of Professor Hutton's views. Mr. Wallace in this work does not agree with the idea that there was a former great antarctic land connection, but believes that there was a great southward extension of land, perhaps considerably beyond the Macquaries, and that this being within the range of floating ice during the colder epochs, and within easy reach of the antarctic continent during the warm periods, there arose "that interchange of genera and species with South America, which forms one of the characteristic features of the natural history of New Zealand." Professor Hutton's theory is primarily based on the distribution of the struthious birds, but Mr. Wallace is of opinion that the ancestral struthious type probably once spread over the larger portion of the globe, and that as higher forms, particularly of the Carnivora, became developed, it was exterminated everywhere except in those regions where it was free from their attacks, and that in these regions it developed into special forms adapted to surrounding conditions. This conclusion is supported and rendered almost certain by the discovery of remains of this order in Europe in eocene deposits, and by the occurrence of an ostrich among the fossils of the Siwalik Hills.

While considering that no other form of animal inhabiting New Zealand requires a land connection with distant countries to account for its presence, Mr. Wallace concludes, in accordance with principles well established in an earlier part of his work, that the existence is demonstrated of an extensive tract of land in the vicinity of Australia, Polynesia, and the Antarctic Continent, without having been actually connected with any of these countries, since the period when mammalia had peopled all the great continents.

Last year the issue of Mr. Wallace's most interesting work on "Island Life," added another contribution to our knowledge of the question under discussion, and the three chapters devoted to New Zealand put the problems very clearly before us. A very important factor, and one which had not hitherto been considered, is now introduced—viz., the relative depths of the seas surrounding Australia and New Zealand. It is shown, by the aid of a map, that if the whole of the circumjacent ocean, which is at present less than 1,000 fathoms in depth, was to be elevated above sea-level, a very remarkable change in the conformation of the existing land would take place. New Zealand would be extended very greatly to the west and north-west, and two long narrow arms would stretch, one to Lord Howe's Island, and the other by Norfolk Island to the Great Barrier Reef, and thus a connection with North-eastern Australia would be made. The same elevation would extend the area of Australia round its western, southern, and eastern coasts, while a long tongue of land would unite it with Tasmania, and would reach to the 50th parallel S. latitude. But even with this great elevation of 6,000 feet, a wide sea would remain between New Zealand and temperate Australia. The northern extension of Australia would connect it on the one hand with Malaysia, Borneo, and Celebes, while from New Guinea a broad eastern extension would include the New Hebrides. Starting from these indications Mr. Wallace shows that we ought to expect to find that New Zealand was most probably connected at a remote period "with tropical Australia and New Guinea, and, perhaps, at a still more remote epoch, with the great southern continent by means of intervening lands and islands," as "a submarine plateau at a depth somewhere between one and two thousand fathoms stretches southward to the antarctic continent."

It is not my intention here to follow Mr. Wallace in all the arguments he adduces to show the origin of our fauna, but a few of his facts are suggestive and confirmatory of his theory, as opposed to that of Professor Hutton, which he again discusses at some length. Thus our struthious birds are shown to be allied, not to the rheas of South America, but to the cassowaries and emus of North Australia and New Guinea. Again, "the starling family, to which four of the most remarkable New Zealand birds belong (the genera *Creadion*, *Heteralocha*, and *Calleas*), is totally wanting in temperate Australia, and is comparatively scarce in the entire Australian region, but is abundant in the Oriental region, with which New Guinea and the Moluccas are in easy communication. It is certainly a most suggestive fact that there are more than sixty genera of birds peculiar to the Australian continent (with Tasmania), many of them almost or quite confined to its temperate portions, and that no single one of these should be represented in temperate New Zealand."

But this connection with tropical Australia must necessarily have been at a remote period, before the latter received its mammalian fauna, or else that portion of Australia which was in connection with New Zealand "was itself isolated from the mainland, and was thus without a mammalian population." And this is the essentially novel and interesting part of the theory which Mr. Wallace seeks to prove by an examination of our flora, and by the existing geological conditions of Australia.

Stated concisely, his conclusions are that for a long period of time Australia was divided into two islands, a western and an eastern. In the former of these, the peculiarly characteristic Australian genera, both of plants and animals, originated. The eastern island stretched in a long narrow line from the tropics to the south of Tasmania, and in connection with its tropical portion there was probably a prolongation of New Zealand to the north-west. By this bridge, with its southerly and south-easterly ramifications, a stream of immigrants set in from the tropical regions further north, so that numerous genera and even species of plants, as well as some animals, were spread along both shores of the sea separating New Zealand from Australia. The subsequent depression of the northern area caused a separation of New Zealand from tropical Australia, while the elevation of the comparatively shallow sea separating the western from the eastern island, united these two into the great continental island of Australia, over the whole of which the peculiar western forms spread rapidly, and apparently at a much greater rate than the tropical and eastern species did. While the presence of the Australian, Asiatic, and Polynesian elements in the New Zealand flora are traceable to this former land connection, the antarctic and South American forms are believed to be due to immigration from outlying islands and extensions of land to the south, and the European, or more correctly the arctic element, is explained by the extraordinarily aggressive character of the so-called Scandinavian flora, which has enabled it to push its colonists over the three great southern areas, viz., South Africa, South America and Australasia.

Mr. Wallace's explanations of the origin of our flora must commend themselves as extremely satisfactory to every one capable of judging of the questions under consideration. Our subsequent knowledge may modify some of his conclusions to a slight extent, but it is by the publication of such hypotheses and theories, and the application of them for the solution of difficult problems, that correct ideas are most rapidly attained. Not only is our interest heightened by such speculations, but definite issues are placed before our minds, and we are enabled to judge more and more accurately of these, and to recognize how vast the field to be traversed is. It is well to bear in mind that as our stock of facts increases, so also does our knowledge of our ignorance, and that the latter often increases in a much more rapid ratio than the former. We begin by discussing a limited question, satisfied perhaps that we have sufficient information accumulated to enable us to give a definite answer, but at every turn collateral points are raised, until at last we feel ourselves face to face with an overpowering mass of questions all demanding solution, and are at the same time conscious of our inability to grapple with them. But it is only given to the few—to a very limited few indeed—to be able to generalize and build up into a homogeneous whole the heterogeneous materials collected by the multitude. We can all help to accumulate these materials together, leaving it to the master-minds of science to use the fruits of our labour.

I have very briefly attempted to show what are the principal theories enunciated to account for our flora. I now propose to examine some of the modes by which plants become distributed, particularly noticing their application to New Zealand plants, and further, to show a little more in detail than Mr. Wallace could afford to do in a general work, the relations of our flora to that of Australia.

In examining such a problem as the distribution of plants, it is manifest that one of the most important considerations to be taken into account is their mode of dispersal, and chiefly, of course, the mode of dispersal of their seeds. Some plants, such as the strawberry, no doubt have the power of spreading themselves over wide areas by means of their long trailing shoots, as we see this plant doing at the present day wherever it has been introduced. But even the strawberry appears to be dispersed much more by its seeds than its suckers, and it is the seed therefore which must be considered chiefly. The most important agents concerned in the dispersal of seeds are (1) the wind; (2) birds or other animals; and (3) ocean currents. Besides these, icebergs may have been the means of bringing some plants to our shores; rivers have certainly distributed them from higher to lower levels; and lastly, human agency has been an efficient cause in late years. But for the first of these extra causes—viz., icebergs—we have no data beyond very general ones to go upon, and the other two have little bearing on the wide question of the origin of the flora.

(1.) The wind is certainly a most efficient agent in the dispersal of seeds, and many plants have their seeds specially adapted for the purpose of being so distributed. The order Compositæ shows the greatest specialization in this respect, the calyx-limb being modified in a large proportion of the species into a pappus, which acts as a parachute. The order is the largest in the New Zealand flora, numbering 24 genera and including 167 species, but from its wide-spread means of dispersion is of less value than less highly differentiated orders. The majority of our plants of this order are either Australian or are allied to Australian forms, a few being of very wide distribution. Another contrivance for wind-dispersion is found in the persistence of the stigma in the form of long feathery awns on the achenes. This is represented in the genus *Clematis*, a genus occurring in all temperate climates, and of which the New Zealand species, as well as the Australian, are all endemic. Its origin here is therefore an open question. The genus *Atherosperma*, belonging to a specially South American order, is similarly characterized, but its occurrence here has no special significance, as Australia possesses an endemic species as well as New Zealand. The genera *Epilobium* and *Parsonsia* both have tufts of hair on their seeds to aid in their dispersal; the former is a very wide-spread genus in all temperate regions, and some of its species are common to both hemispheres; while the latter is an Asiatic and Australian genus. The only other contrivances which aid in the wind-dispersal of our New Zealand plants are wings on the fruits or seeds. These occur, but feebly developed, on the nuts of *Fagus*, and on the seeds of *Knightia*, *Dammara*, and *Libocedrus*. The first of these occurs in both the north and south temperate regions; but our and the Australian species are all probably of antarctic origin. The second genus has one New Caledonian representative, and the third is Australian, Malaysian, and Polynesian in its distribution, while *Libocedrus* is found only in New Zealand and South America.

While special adaptations for wind-distribution are apparently few in New Zealand plants (if we except the Compositæ), there are no doubt many seeds which are readily blown about by reason of their small size and lightness. I have no data to guide me here, but will instance the order Orchideæ, all the species of which have minute, light seeds, and all the genera of which are either Australian or from further north, or have an Australian facies.

(2.) The second mode of dispersal mentioned is by means of birds, and this is accomplished in three ways—"either by swallowing fruits and rejecting the seeds in a state fit for germination, or by the seeds becoming attached to the plumage of ground-nesting birds, or to the feet of aquatic birds embedded in small quantities of mud or earth." With regard to the first of these modes, it is probable that the bright colours of most succulent fruits serve to render them conspicuous and attractive to birds, which are thus led to swallow them. But most seeds, enclosed in fleshy pulp, are furnished with a hard shell or test, and most fruit-eating birds have a very soft gizzard, incapable of grinding-up the food which they eat, and so it happens that these birds become the unconscious means of distributing plants producing such succulent fruits. I find that altogether some 59 genera of plants in New Zealand produce succulent fruits, mostly drupaceous, that is, having the inner layer of the pericarp hard or stony, so as to protect the seeds. And of these no less than 41 genera are common to these islands and Australia or the tropics of the Old World. Only 18 of these genera occur also in America, and their range is either very wide, as in the case of *Myrtus*, *Eugenia*, *Solanum*, *Cassytha*, and *Astelia*, or they are of antarctic distribution, and have in most cases invaded

Australia and countries to the north as well as New Zealand. *Coriaria*, *Fuchsia*, and *Callixene* are the only New Zealand genera with succulent fruits which occur in South America, but not in Australia, or any other land to the north of New Zealand. When it is remembered that most of our land birds are either characteristic of the Australian region or are allied to Australian forms, a certain amount of light is thrown upon this subject. It must not, however, be supposed that the possession or the want of succulent fruit is a character of great importance or significance; it is probably a very minor character, as even in the same species (e.g., *Gaultheria antipoda*) we may find great differences in the extent to which succulent tissue is developed in the pericarp of the fruit. Still it constitutes one of those minor coincidences, the sum of which, when taken together, throws considerable light on this and kindred questions.

Besides swallowing the fruits of plants and rejecting the seeds, birds carry seeds attached to their plumage. A few grasses may be thus carried by means of their hispid awns, and the seeds of some *Pittosporums* may adhere by their glutinous surface, but with these exceptions I only know of two genera which owe their means of dispersal to any special contrivance which enables their seeds to adhere to passing objects; these are *Acæna* and *Uncinia*. In the former genus, the four angles of the persistent calyx are produced into spines, which in the majority of the species bear small barbs at their apex, and the fruit thus adheres very readily; the genus is confined to the southern hemisphere, except in America, where it has spread as far as Mexico and California, and in Polynesia as far as the Sandwich Islands. The occurrence of the barb is a very peculiar feature in the New Zealand species. The common *piripiri* (*A. sanguisorbæ*) is a native of Australia, Tasmania, and Tristan d'Acunha, as well as New Zealand, and the calyx-spines are always barbed. *A. adscendens*, another barbed species, occurs also in Fuegia and the Falkland Islands, while *A. novæ-zealandiæ*, a third barbed species, though endemic, is altogether too near *A. sanguisorbæ* to rank as an exception. The other four species are also endemic, and of these *A. depressa* bears barbs, while the other three, *A. microphylla*, *buchanani*, and *inermis*, are almost entirely without them. The barbs, while no doubt of use in adhering to the feathers of birds, are best fitted to stick to the hair and skin of passing animals, and I think that in these smooth-spined *Acænas* we have a case of loss of an organ through disuse.

The other specially furnished genus is *Uncinia*, sedges which occur chiefly in the southern hemisphere, but range as far north as the mountains of Abyssinia. The seed in every species is furnished with a long hooked bristle which springs from the base of the nut, and projects out of the utricle or sac enclosing the fruit. Our species are mostly endemic, but one is almost identical with a Fuegian species, and one or two with Tasmanian forms. It appears to me probable that the singular Chatham Island Lily (or Forget-me-not), *Myosotidium nobile*, is derived from an originally barbed plant, and that by long isolation it has lost the barbed bristles on the nuts characteristic of the Australian genus *Cynoglossum*, its nearest allies, just as it has lost the hispid character considered so distinctive of other Boragineæ.

The last mode specified in which birds carry seeds, is—attached to the mud or earth which clings to their feet. This subject has already been so carefully and conclusively worked out, particularly by Mr. Darwin in the "Origin of Species," that I need not do more than refer to it. Sir J. D. Hooker, in the recently-published (1879) account of the botany of Kerguelen Island (Challenger Expedition Reports), considers that the few species of flowering plants of that island, presenting, as they do, a decided Fugian facies, have been thus brought by land birds. These are very abundant on the Falkland Islands, where the vegetation is identical with that of colder South America, and favoured by the prevalent westerly gales and the numerous stepping-stones, probably in the form of islands formerly existing, these land birds have probably found their way to Kerguelen Island. And he goes on to say that "the absence of such birds from the present avi-fauna of the island offers no obstacle to such a speculation, as such immigrants would on arrival speedily be destroyed by the predatory gulls and petrels of the island." It is probable that some of the antarctic and South American forms occurring in New Zealand, and also in Tasmania and South-east Australia, have been thus introduced; and this probability is increased if we assume, with Mr. Wallace, that changes similar to those which have occurred in the arctic regions have also taken place in the antarctic, viz., that great alternations of climate have occurred in past ages, during some of which the now ice-clad antarctic continent bore an abundant flora of south-temperate forms, obtained probably from South America, the nearest continental area.

(3.) The third mode of plant-dispersion alluded to is by means of ocean currents. This subject has also been carefully examined by Mr. Darwin, and the results of his interesting experiments are detailed in the "Origin of Species," and have been largely employed by Wallace in accounting for the flora of oceanic islands, such as the Azores. I need not recapitulate these results here, but will merely point out that the length of time during which many seeds will float and retain their vitality, and also the probabilities of such seeds being carried to localities suitable for their germination, are probably much greater than the popular idea would assign to them. In former epochs, when there was a greater land extension, and, perhaps, a more temperate climate in the antarctic regions, this mode of distribution may have sufficed to introduce some species into New Zealand, but it appears somewhat improbable that it still continues to any considerable extent. A correct knowledge of the oceanic currents which impinge on our coasts, will alone enable us to form an estimate of this means of plant immigration, and this information I do not possess.

Having considered very briefly these modes of plant dispersal, and noticed the geographical distribution and relationships of those genera which have been affected chiefly by their modifications of form, I would take a brief glance at the endemic forms which occur so abundantly in our islands. As these have probably all originated in or near the localities where they now exist, they can only aid us in the solution of the present question by their affinities. Many of these affinities are very difficult to establish, but in the majority of cases where the relationship of our endemic species to the flora of other countries is evident, it is found that Australian forms greatly predominate. Long isolation, together with complete change in their environment, has probably served to modify many of the immigrants, so that their affinities have become obscured, and this has acted in many cases so effectually as to mask them altogether. Usually variation first appears in the habit of the plant, and we see this in the form of the foliage, etc., of *Ranunculus lyallii*, our coriaceous *Veronicas*, *Olearias*, *Ligusticums*, etc. The same change is seen in recently-introduced plants, as in the common watercress *(Nasturtium officinale)*, which in New Zealand rivers shows a tendency to assume a very different habit from its European parent. Protection against some forms of insect enemies, probably Orthopterous, appears also to have played an effectual part in modifying the epidermal structures of many of our species, and may partly account for the prevalence of coriaceous-leaved and woolly plants, among the alpine species in particular. But we have little data here to go upon ; and before passing on to the last part of this address I will just point out a few peculiarities of structure in our plants, which are of interest and full of suggestiveness.

One of these is the scarcity of spiny or prickly plants. As the function of spines and prickles is probably that of defence against mammalian enemies, we can readily understand the paucity of such contrivances in our plants. Even the apparent exceptions go to prove the rule in nearly every case. Where such defensive modifications do occur, we notice that the plants are usually to be found outside of New Zealand, and are most probably of foreign origin, their weapons of defence having been developed in countries where they were of service, and the New Zealand immigrants not having had sufficient time to lose them. Thus *Discaria toumatou* has its branches and branchlets reduced to spines; but the genus is wide-spread in the southern hemisphere, and our species is almost identical with an Australian one. So strong a case cannot be made out with regard to *Aciphylla*, or spear-grass, whose leaves and bracts are all spinous, and constitute a most powerful means of defence. The genus is certainly found in Australia, but the spines are not developed to any extent in the Australian species, while our bayonet-leaved species are endemic. *Hymenanthera*, with excessively rigid branches, and *Eryngium*, with spinous leaves and bracts, are both genera which range into Australia, in the latter case the species being identical. The same remark applies to many of our harsh cutting-grasses or sedges, belonging to the genera *Cladium*, *Gahnia*, *Lepidosperma*, *Carex*, etc., all being genera having wide distribution outside of New Zealand, and some having identical species in Australia. Again we have apparent anomalies in *Dracophyllum*, with its pungent-tipped leaves (a character common, however, to the Australian species), and in *Desmoschœnus*, the common, large, scabrid sedge of our sand-hills. Very few species have the fruit protected against grazing animals. The only cases I know of are *Sicyos angulatus*, of which the nut is covered with barbed spines, but which is a species common to Australia and parts of America; and *Entelea arborescens*, with a spinous capsule. This last plant is probably descended, after much modification, from a stray immigrant of a remote period, its nearest ally being *Sparmannia*, a Cape of Good Hope genus.

Even the following facts, slight and almost unappreciable as they are, tend to show that the absenee of grazing animals tends to modify species to a considerable extent. We have in New Zealand two species of manuka (*Leptospermum*); of these, *L. scoparium*, with pungent tips to its leaves, also occurs in Australia; *L. ericoides*, which wants the prickly tip, is endemic. Similarly there are two species of *Leucopogon*, of which *L. frazeri*, with a short spine or mucro at the apex of the leaf, occurs in Australia, and *L. fasciculatus*, with smooth leaves, is endemic. Lastly there are five heaths of the genus *Archeria*; of these, two occur in New Zealand and one in Tasmania, all having obtuse leaves; the other two occur in Australia, and have very acute almost spinous leaves.

The next matter bearing on this subject to which I now request your attention is the relation of our flora to that of Australia, as pointed out by Mr. Wallace in his latest theory, which is, that New Zealand was at one time connected with the Asiatic region by way of tropical Australia, while the whole of eastern Australia was an island separate from what is now Western Australia by a comparatively shallow sea. This, he affirms, is proven by the depth of the now intervening seas, by the geological formations of all the countries concerned, by the occurrence of so many New Zealand genera and species in Eastern Australia, and the absence from New Zealand of so many characteristic Australian orders and genera. It would be out of place here to go into these points minutely, because to do so would involve a mere recapitulation of Mr. Wallace's able and conclusive arguments, and I shall therefore confine myself only to a short examination of the relations of our flora to that of Eastern and Western Australia respectively. I have to apologize if I now descend into statistics, as the subject can hardly be treated in any other manner.

New Zealand possesses altogether 310 genera of flowering plants (303 A.R.W.), of which 248 (251 A.R.W.) are found in Australia, and of this number 146 range into Western Australia. But of these, no less than 114 genera are more or less widely distributed outside the Australasian region, leaving only 31 genera, peculiar to New Zealand and Australia, which range into Western Australia. I append the names of these genera below,* but my knowledge of the Australian flora is much too limited to enable me to say how many of them have their head-quarters in Eastern or how many in Western Australia. In this connection greater interest attaches to those *species* which occur in both New Zealand and Western Australia. There are altogether 215 New Zealand species (belonging to 134 genera) found in Australia, many of them being antarctic or South American forms which occur very sparingly on the mountains of Victoria and Tasmania. Of these 215 species, 106 (belonging to 79 genera) range into Western Australia, but subtracting 68 species (52 genera) which have a very wide distribution, we find that we have still 38 species of limited dispersion to consider. Of these 24† belong to genera whose head-quarters are outside of Australia, and their spread into Western Australia is probably more recent than into New Zea-

* New Zealand genera confined to New Zealand and Australia, which occur in Western Australia :—1, Pittosporum ; 2, Plagianthus ; 3, Phebalium; 4, Stackhousia ; 5, Pomaderris ; 6, Discaria ; 7, Swainsonia ; 8, Leptospermum ; 9, Actinotus ; 10, Olearia ; 11, Brachycome ; 12, Craspedia ; 13, Cassinia ; 14, Ozothamnus ; 15, Scævola ; 16, Dracophyllum ; 17, Logania ; 18, Persoonia ; 19, Pimelea ; 20, Poranthera ; 21, Prasophyllum ; 22, Pterostylis ; 23, Cyrtostylis ; 24, Caladenia ; 25, Arthropodium ; 26, Leptocarpus ; 27, Calorophus ; 28, Microlæna ; 29, Deyeuxia ; 30, Echinopogon ; 31, Schædonorus.

† 1, Ranunculus lappaceus ; 2, R. plebeius ; 3, R. rivularis ; 4, Claytonia australasica ; 5, Linum marginale ; 6, Pelargonium australe ; 7, Tillæa purpurata ; 8, Myriophyllum variæfolium ; 9, M. pedunculatum ; 10, Epilobium glabellum ; 11, Daucus brachiatus ; 12, Senecio lautus ; 13, Microseris forsteri ; 14, Sebœa ovata ; 15, Myosotis australis ; 16, Mimulus repens ; 17, Salicornia australis ; 18, Carex inversa ; 19, Deyeuxia forsteri ; 20, D. quadriseta ; 21, Danthonia semi-annularis ; 22. Schædonorus littoralis ; 23, Glyceria stricta ; 24, Bromus arenarius.

land; 7* belong to genera which are chiefly found in Eastern Australia, from whence the species in question have probably spread themselves east and west; and 7† more are of genera of which I do not know the centre of dispersion.

A close examination of the whole leads strongly to the conclusions that the basis of the floras of Eastern Australia and New Zealand are somewhat identical; that both have received immigrants independently after their separation, from north and south,—Australia by reason of its northern land connections with New Guinea receiving the greatest number of tropical species, and New Zealand from its southern extension the greatest number of antarctic and American species; that the West Australian flora proved more aggressive than the Eastern, and thus overran the whole continental area, giving it its peculiarly characteristic facies; and that of the Eastern species only those having considerable powers of dispersion have succeeded in spreading themselves westwards.

In considering the geographical distribution of a flora it is usual to bring under review only the phanerogamic or flowering plants, because the spores of Cryptogams furnish them with a most remarkable power of dispersion by wind. Yet even the distribution of our ferns and other vascular Cryptogams bears its testimony in support of the theory of the origin of the flora enunciated by Mr. Wallace. Excluding the endemic species there are about 30 per cent. of remaining forms which are spread extensively over a great part of the globe, about 4 strictly American, another 30 of tropical, Asiatic, or Polynesian occurrence, and about 36 per cent. almost exclusively Australian. Of the 85 species common to New Zealand and Australia, only 15 occur also in West Australia, and these are *all* species of very wide and general distribution.

In bringing to a conclusion these somewhat disconnected remarks, I shall endeavour to show how they may be pieced together so as to give some idea of the present standing of the whole question. In examining such a matter, some starting point or line of demarcation must be taken, for were we to go far enough back we should have to account for the very existence of flowering plants themselves. There are those who believe that all our species have been produced by development from a few forms originally created in this region of the world, while others ignore the idea of

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* 1, Vittadinia australis; 2, Erechtites prenanthoides; 3, Erechtites arguta; 4, Erechtites quadridentata; 5, Pterostylis squamata; 6, Microlæna stipoides; 7, Echinopogon ovatus.

† 1, Poranthera microphylla; 2, Thelymitra longifolia; 3, Schœnus axillaris; 4, Cladium glomeratum; 5, Cladium gunnii; 6, Dichelachne stipoides (Stipa teretifolia); 7, Dichelachne crinita.

development altogether. Wherever flowering plants did originate, it was most probably not in New Zealand; and all the information we possess on the subject leads to the conclusion that the parent forms of our flora were introduced from other lands during a long succession of ages, and that the process is still going on.

As has been already stated, there are about 1085 species of flowering plants known to occur in these islands, and of this number about 800 are endemic, that is, confined to this region. The relative numbers given in Hooker's "Flora Novæ-Zealandiæ" are 730 and 507, but the additions during the last thirty years have chiefly been of endemic forms. These species have been developed by the peculiar conditions to which the parent forms have been subjected during long periods of isolation. What these conditions have actually been we do not know, but in the majority of cases the changes brought about have only been of specific value. Even where they amount to generic importance the affinities can in nearly every case be traced, and we can form an approximately correct opinion as to the relationships indicated.

The greatest proportion of these endemic species is of distinctly Australian origin; there are also a number showing Polynesian affinities, and many of antarctic relationship. The remarks therefore which apply to the plants common to New Zealand and the regions specified, will apply to the originals from whence our endemic species have sprung. In accounting now for the species which are common to New Zealand and other parts of the world, we may notice first, that there is no absolute need on the part of the botanist, as there is on the part of the zoologist, to assume the existence in long past ages of former land connections with countries lying round about. But we have now reason to believe that there were former land extensions, which served to widen the area of New Zealand as it existed in olden times, and to bring it into closer proximity with other countries. From the antarctic circle a constant succession of south-westerly and southerly winds and currents may have served from time to time to convey seeds, and birds carrying seeds in their crops and attached to their feet, etc.; while icebergs may have aided in carrying masses of earth, spores, and seeds of certain antarctic species of plants. The antarctic continent, of which the now existing portions are probably only fragments, had in all likelihood alternations of climate such as we know to have existed at its antipodes, and during some of its warmer epochs it would be invaded by plants from South America. These would thus become spread round the south pole, from thence to be distributed radially to the countries lying north, as the climate again altered. Not only would antarctic forms thus find their way into New Zealand, but it is by this means that South American forms were likely introduced, and it is by this spreading north from a common centre that we must account for so many species which are found both here and in the Tasmanian and Australian alps. Why some species should become modified and others remain persistent, I do not know. Thus our *Fuchsias* and pepper trees are distinct from the species found in South America, though certainly derived from that region, while our tutu plants (*Coriaria angustifolia* and *thymifolia*) are identical with others found on the Andes. We cannot work out these problems with our present information, for the necessary factors are wanting.

The northern extension of New Zealand indicated by Mr. Wallace as existing formerly, would bring it into very close proximity to North-eastern Australia, which may then have been in form of a long, narrow island, running nearly north and south; and also close to extensive sub-continental areas, of which only the remains are now left in the Polynesian Islands. And not only did those forms which are common to New Zealand and Australia, and New Zealand and Polynesia, find their way thus southwards, but it was probably by this chain that the plants of European and Asiatic affinity now found in our islands were introduced. But it was only at a much later period that an upheaval took place of the comparatively shallow seas separating the eastern and western portions of Australia; and that those forms now so characteristic of Australia, and which had been long developing under the peculiar conditions of their isolation in the western portion, overran the whole continent and stamped their features so markedly on its flora. And it is to this explanation that we must look in accounting for the presence of so many plants in New Zealand and Eastern Australia which are not found at all in Western Australia. A few specially Australian plants may have at later periods found their way into this colony, as the prevalent winds here are from the west, and birds are still found which have apparently strayed across the intervening expanse of ocean, but their number must be almost inappreciable, and cannot affect the general result.

While many of the immigrants thus introduced may have transmitted their characters almost unaltered through many successive generations, so that we still rank their descendants as belonging to species yet to be found outside New Zealand, others gave rise to variations and sports, and in course of time the accumulation of these variations has amounted to specific importance, and in some cases even to generic.

I believe that some such explanation as that sought to be given here, will account for the present geographical distribution of our flora, but it will be long before we can trace the parent forms of many of our plants, and detect the alterations and variations they have undergone. A knowledge of the tertiary and secondary floras of New Zealand and Australia will help much towards elucidating this problem, but the palæo-botany of this part of the world is yet in its infancy, and very little is known on the subject.

It may be considered that too much stress is laid in this explanation on the elevation and subsidence of great masses of land, but a little consideratien will show that this is not the case. The deeply gouged-out character of our western lakes and sounds shows that they were cut out by ice, and to account for this we must either assume that the land stood very much higher than it does now, or the climate was very much more frigid. But even in the latter case we must assume a considerable elevation, as glacier action would cease at or very near sea-level, and our sounds are gouged down to great depths below present sea-level. Further, most of the low-lying eastern portions of this island have been formed at comparatively recent times by the denudation of our mountain chains, and most of this eastern coast is rapidly—one might almost say visibly—rising out of the sea. Again, the occurrence of fringing and barrier reefs in tropical seas is an almost certain mark of subsidence, as coral zoophytes cannot live at greater depths than about 120 feet, so that when we find these hugh masses of rock surrounding islands, and standing out of an ocean in some cases 1,000 fathoms or more in depth, we are bound down to the conclusion that the base on which the zoophytes commenced their labours was only a few fathoms from the surface, though now 6,000 feet deep.

In bringing these remarks to a close, I may just point out that a probably most important factor has been throughout left out of our calculations, viz., the physical changes which have affected the whole of our globe during comparatively recent geological epochs. Many theories have been advanced of late years to account for the glaciation of parts of the northern hemisphere, and the theorists have in some cases called in as auxiliaries all the powers of heaven and earth. But we may be sure that whatever causes could lead to results which are so apparent in one large portion of the world, must have at the same time caused great alteration in all other parts. But until we know with more certainty than we do at present what these great causes were, we cannot estimate what their effects on this portion of the world have been.

Art. LXXVIII.—*Origin and Early History of the Canterbury Museum: being the Annual Address.* By Professor Julius von Haast, Ph.D., F.R.S., President of the Philosophical Institute of Canterbury.

[*Read before the Philosophical Institute of Canterbury, 16th June,* 1881.]

Having by your goodwill been called to preside at your meetings, I was unfortunately prevented from delivering the customary address at the appointed time, being then in Melbourne on official business, and since my return I have been so much occupied in despatching the accumulated arrears that I am only to-day enabled to address you and to congratulate you on the advance our Society has made, and on its healthy condition and prospects. We have, it is true, passed through trying times since its foundation in 1862, and such times may come again; however, I am sure that the devotion of those members who have the advancement of science and the triumph of truth at heart, will steer our barque with steady hand over the troubled waters, and gain and retain for our institution such a position that those of us who stood at its cradle have all cause to be proud of its achievements. Instead of offering you a review of the results of research in the various branches of science, I have, in my few last addresses, taken the liberty to devote the time at my command to one or two subjects, then uppermost in my mind, and which I thought might be of interest to you.

In this year's address, with your permission, I wish to speak to you of another institution, at the cradle of which I stood also, like a number of our older members, whose hearty co-operation I enjoyed, and by whose powerful help that institution has grown from a small beginning to considerable dimensions. My subject this evening will therefore be "The Origin and Early Progress of the Canterbury Museum," in the course of which I wish to bring before you some facts concerning its infant days, and to preserve some recollections, which now, still fresh in our memory, will, in after years, when that institution has become still more fully a depository of all that is valuable and instructive in science, art, and industry, be of great interest to our successors. And as the Philosophical Institute, as soon as the Canterbury Museum wanted assistance, both intellectual and material, has never refused to afford it that aid which, especially at the commencement, was of the highest importance, when we had hard struggles for its very existence, it is a very grateful task for me to recognize this publicly, and to thank most warmly once more the members for their interest and help. Moreover, I believe that under these circumstances no better opportunity than to lay these notes before you to-night could be selected. It is scarcely necessary for me to point out to you of what great importance, principally in a newly-inhabited country, a public museum is; how many invisible influences it exercises in almost every direction; how thought, observation and research are incited by its existence; how, in a pleasant way, youth and age alike gain knowledge; and how, in one word, the intellectual and material welfare of the province have been promoted in many ways by its help. Similar thoughts were doubtless passing through the mind of Mr. William Sefton Moorhouse, Superintendent of the Province, when in December, 1860, at the request of that able statesman, I came to Christchurch to fill the post of Provincial Geologist, the first appointment of that kind made in the Colony of New Zealand. Having before my arrival in Christchurch been travelling over and examining several parts of the colony, I brought with me seven cases of specimens, mostly geological, rocks, minerals, ores and fossils, together with a herbarium. These formed the first nucleus of the Canterbury Museum, many of them being still exhibited in their proper places.

The office of the Geological Survey was then situated in the north-eastern side of the Government Buildings, on the first floor, consisting of the high tower room, my office, and inner low room, in which, on long tables, the collections as they gradually increased were placed.

The specimens brought by me from my former journeys to Canterbury consisted of:—

220 rocks, minerals, ores and fossils from the Province of Auckland.
15 rocks from the Province of Taranaki.
235 rocks, minerals, ores and fossils from the Province of Nelson.
—
470 specimens in all.

From my first journeys in Canterbury to the head-waters of the Rangitata, the Malvern Hills, and the head-waters of the Waitaki, such large collections were brought, that already in 1863, 742 specimens of rocks, ores, and minerals, and 520 fossils, had been added to the collections belonging to the Province.

Amongst other collections, 182 specimens of New Zealand shells had already been added. In 1862, at my suggestion, the Provincial Council voted £100 for the purchase of type collections in mineralogy, lithology, palæontology, and conchology, which were obtained from the Mineralien Comptoir, in Heidelberg, Germany, under very favourable conditions. It contained 2,613 well-selected specimens, many of them of permanent value. About the same time Professor Ferdinand von Hochstetter, who throughout the whole existence of the Museum from its very beginning has been its warm friend and supporter, sent a collection of German fossils, ores and minerals, of which some were of great rarity and beauty. On 12th August of the same year (1862) the cast of the skeleton of *Palapteryx ingens* arrived from Europe, which I also presented to the Museum. It was constructed and purchased from Dr. Jaeger, of Vienna, an eminent German palæontologist, from bones dug out in a cave in Nelson.

Although we possessed at that time already a small number of moa bones, mostly collected in Nelson, we were then greatly rejoiced at obtaining this cast, and we little dreamt that a few years later the Canterbury Museum would be able to boast of possessing a collection of moa skeletons unrivalled by any other museum. I also remember, when I visited about that time Mr. E. F. Gray, at Avon-head, and after much persuasion, in which I was assisted by the Rev. Canon Wilson, he gave me some leg bones of *Dinornis maximus*, that I felt very proud of their possession, and thought that we had obtained a real treasure.

Besides the geological specimens obtained during my journeys, a large herbarium and a number of bird-skins and invertebrates were collected, so that a fair beginning was made.

I find in looking over my notes that the first presentation to the Museum was made by Mr. C. J. Tripp, of a *Nestor notabilis*, in August, 1861. The next two of which I can find a record are a bird-skin (a shining cuckoo) by Mr. C. Dunnage, and a polished stone implement found under the root of a large tree in Wellington, presented by our member Mr. George Hart, then living in Wellington.

The first exchange was made with Mr. W. L. Buller, on 28th July, 1862, of a kea (*Nestor notabilis*), of which I had obtained a series during my journey to the Mount Cook region, for the skin of a Mantell's kiwi (*Apteryx mantelli*). In the session of the Provincial Council in 1863, the attempt was made to obtain a vote for the building of a museum, but without success. I then made an arrangement with the Provincial Government to give up the two rooms hitherto occupied, if the funds necessary for the fittings of a museum could be obtained. The Provincial Council voting £300 for the purpose, I vacated my offices for those formerly occupied by the Commissioner of Police.

Mr. R. L. Holmes, the Meteorological Registrar of the Province, was at that time appointed clerk to the Museum, and all my spare time was devoted to the arrangement and classification of the collections. Catalogues were prepared, and all seemed to promise a speedy opening of the Museum for daily public inspection, when the Provincial Government, being in immediate want of accommodation, requested me to give up my new offices and return to the former, and thus the opening of the Museum was unavoidably postponed. The show-cases obtained for the £300 consisted of a number of high wall-cases for the rocks, which now stand in the gallery of the moa room on the eastern side, and four desk-cases for the minerals, in which now the coins in the statuary gallery are exhibited.

In August, 1864, I reported to the Provincial Government as to the state of the collections, which had considerably augmented. Of the additions the following were the principal:—A collection of 60 specimens of rocks and fossils from the Chatham Islands, obtained by Mr. H. Travers, and presented by his father (Mr. W. T. L. Travers). Forty-five specimens of rocks, ores, and minerals from the Dun Mountain, all well selected; presented by Mr. T. Hacket, of Nelson. Fifty specimens of rocks and minerals received from Mr. J. C. Crawford, at the time occupied with a geological survey of Wellington, for examination and classification. Forty specimens of rocks and minerals collected by myself in the province of Otago; and 225 specimens of rocks and minerals from this province, collected during my journeys of 1863-64. This series contained 33 specimens of building stones, either from quarries already opened, or to which I wished to draw the attention of the public, as well as 180 Canterbury fossils, so that the whole geological series of New Zealand rocks consisted already of nearly 1700 specimens. Some 40 specimens of New Zealand shells had also been added to the collection.

The donations to the Museum began now to come in more freely, and I may be allowed to give here a list of those ladies and gentlemen to whom the Museum at its commencement became much indebted. Mr. F. T. Adams presented a collection of foreign shells. The late J. Cookson and Dr. Earl gave moa bones. Bird-skins were presented by the late Dr. Barker, who from the very beginning of the Museum showed himself a warm co-operator, and when afterwards officially connected with the institution, continued to the end of his life to take an active interest in its progress. Messrs. W. S. Raine, W. T. Travers, J. D. Enys, Hammett, and Master Barker, presented also bird-skins and eggs. We also received donations from Mrs. A. Louis, a collection of Australian *Coleoptera* from Mrs. T. Cass, and Mr. D. T. Triphook tertiary fossils, and from Mr. T. Kent native timber in polished pieces, whilst Mr. R. Fereday deposited his magnificent collection of British *Lepidoptera*, which lately he has generously presented to the Museum. In the year 1864 we received in exchange for a New Zealand herbarium 1086 specimens of European and North American plants from the Rev. J. Butler, of Langar, near Nottingham, and 460 specimens of Australian plants from Dr. Ferd. Müller, in Melbourne.

At the end of 1863 I wrote to the late Professor Louis Agassiz, whom I had known in Europe before he finally settled in the United States of North America, offering him to make exchanges with his museum at Cambridge, Massachusetts, and in May, 1864, he announced to me that a large collection of *Echinodermata*, both recent and fossil, had been forwarded, and it arrived in the latter part of that year. We also received a little later, for a small collection of New Zealand bird-skins, a fine series of European skins from the late George von Frauenfeld, the Director of the Imperial Zoological Museum, Vienna.

Thus, whilst accumulating material from New Zealand and abroad, I continued with the work of the geological survey in my old office, where the walls were lined with cases, receiving here many visitors, who took an interest in the collection hitherto brought together, or who wanted information of various kinds. In August, 1864, when the first account of the contents of the Museum was rendered to the Provincial Government, 5,860 specimens had already been catalogued.

In the Intercolonial Exhibition of Otago, in the beginning of 1865, the Canterbury Museum exhibited a large number of specimens both geological and botanical, together with the geological section of the railway tunnel between Lyttelton and Christchurch, as far as the work of construction had advanced at that time. This section was illustrated by a number of rock specimens; this being the first instance that a tunnel was made through the wall of an ancient crater, great interest was manifested by the scientific visitors of that first New Zealand Exhibition. During my stay in Dunedin, I made some excursions to the Otago goldfields, and brought a series of specimens back with me, which still illustrate the rich localities where the first rushes took place. During a journey, lasting about six months, in the newly discovered goldfields in Westland, which was then a part of Canterbury, I also collected in every direction, and besides a large series of geological specimens, brought back with me a number of bird-skins and plants. At my suggestion, the Provincial Government at the same time gave instructions to Mr. George Sale, their Commissioner at Hokitika, to purchase samples of gold from the several principal claims, and to obtain with them the wash-dirts from which the gold was derived, so as to have a record of the rich ground then worked by a large number of miners, who had flocked there from all parts of New Zealand and Australia. Having now obtained a considerable quantity of New Zealand bird-skins, I looked out for a taxidermist, whom I might entrust with setting them up. The late Mr. F. Fuller having offered his services, I procured, not without some trouble, a grant of £25 from the Provincial Government on 3rd August, 1865, to make a beginning. Fuller went to work with true enthusiasm, so that by December 25th he had already set up 130 specimens, and as a further sum was granted to me, and the Philosophical Institute gave some help, I could also send him out collecting, so that, at the same date, already 80 duplicates were available for exchange.

In the beginning of January, 1866, I went to the north-eastern portion of the province, when Fuller came with me, and from which we brought a further number of skins and skeletons of New Zealand birds with us on our return, and those new to our collection were now mounted. From the rest 78 specimens were selected and sent about the middle of April to Professor L. Agassiz, in Cambridge, Mass., as a return. I note this as being the first large collection sent out by the Canterbury Museum.

About this time a further sum of £100 was granted for show-cases, which enabled me to have all three sides of the large room lined with them, so that the mounted birds could be placed to advantage, and, moreover, be protected from dust and insects. I find in the notes of the presentations in 1865 the following ladies and gentlemen:—Mr. George Sale, then Government Commissioner in Hokitika; Mr. and Mrs. Alfred Cox, Orari; Mr. John Rochfort, Major Scott, Messrs Luxmore, C. J. Tripp, and J. D. Enys, as having presented New Zealand bird-skins and eggs. In 1866 the number of donors reached already 30, so that the space of time at my command precludes me from giving a complete list.

Leaving Mr. R. L. Holmes, the meteorological officer, in charge of the collections, I started in the beginning of March for the sources of the Rakaia in company with the taxidermist, Fuller, who now received a salary from the Provincial Government. After an absence of nearly seven weeks we returned to Christchurch, bringing with us, besides large collections of rocks, minerals, and fossils, an extensive herbarium and about 160 bird-skins, many of which were new to our Museum collection.

After my return, and with the assistance of several friends, of whom many still at the present time take great interest in the progress of that public institution, new efforts were made that a Museum should be built. The result of our endeavours consisted in the promise of some members of the Provincial Executive, that a sum of money would be placed upon the estimates of the coming session; however, before the same took place it was evident that such a step would not lead to any success, and the matter was again postponed for another year.

In the winter of 1866, two collections of bird-skins and some other specimens of natural history were sent to the Australian Museum in Sydney, of which the late Gerhard Krefft was at that time curator, and another was forwarded to the Zoological Museum at Vienna. A return collection of the former arrived at the end of September of the same year, and gave additional work to the taxidermist, who, with great zeal and energy, devoted his whole time to the work, accumulating day by day. Of other large presentations worth mentioning here, the Museum received about the same time a fine and extensive collection of rocks of the central part of Otago from Mr. T. Hacket, a series of bird-skins from the Northern Island from Mr. W. L. Buller, and a collection of fossils from Mr. J. D. Enys. About the same time a large collection of botanical specimens, consisting of fibres, barks, fruits, cones, seeds and timber arrived. They were sent by Dr. (now Sir) Jos. D. Hooker, the Director of the Royal Gardens at Kew. Dr. J. Hector, the Director of the Colonial Museum in Wellington, presented also a number of valuable specimens, amongst them the first pair of huias (*Heteralocha gouldi*).

Hitherto, the principal material for exchanges upon which we could rely were New Zealand bird-skins; however, in the beginning of December (1866) a new era for the Museum began, and to which, after that time, its rapid growth has principally to be attributed. At the invitation of Mr. G. H. Moore, then the New Zealand partner of Messrs. Kermode and Co., I proceeded to their fine property, Glenmark, where, during the drainage of some swampy ground, large quantities of moa bones had been discovered. That gentleman, on my arrival, not only presented most generously the large and unique collection on hand to the Museum, but, in order that I might judge for myself of the mode of occurrence, he placed several workmen at my disposal, with whom, for a number of days, I made some very successful excavations, the results of which surpassed my highest expectations. The generous gift of Mr. Moore, and the bones excavated under my direction, filled a large American four-horse waggon. From this material the first seven moa skeletons in the Museum were articulated. About the same time a large collection of skins of North American mammals arrived from Professor L. Agassiz, so that we now had also some representative specimens from the American Continent.

The collections at the end of 1866 had become so extensive, that it was utterly impossible to find space for them in the rooms occupied by me as offices. The Provincial Government, therefore, at my earnest request, put at my disposal the small cottage on the eastern side of Kilmore Street, close to the Government Buildings, afterwards occupied by the Emigration and Charitable Aid offices. Here in one room I had my office, the rest of the building being used as a storeroom. I succeeded, also, in having the fine room above Bellamy's—the so-called coffee-room, afterwards used as the Superintendent's office—set apart for Museum purposes. It was here that the first seven moa skeletons were articulated. The small room with the fine bow window, adjoining the coffee-room, was made the work-room of the taxidermist.

We had now fairly invaded the Government buildings, and could expect that this further step in enlarging the opportunity of examining the public collections would lead to the final success of having a separate Museum building erected. The Provincial Government of the day, of which Mr. F. Stewart was Provincial Secretary and President of the Executive, proposed in the session of that year a vote of £2,500 for the erection of a Museum building. A plan was provisionally prepared by Mr. W. B. Mountfort, and, as many of the opposition members had now seen that there was ample material for exhibition, the seven moa skeletons already articulated being the principal objects, their antagonism seemed to have at last been overcome. But alas! our hopes were again dashed to the ground, the proposed vote having been negatived on July 4, 1867. However, during the same session, on July 16, £200 were voted for further show-cases, and our hopes were again renewed that in another year, when the rooms now at our disposal might be full to overflowing, the members of the opposition who did not wish to divert any public money from roads and bridges and other purely utilitarian objects would relent at last.

So we went on working with renewed hope, the more so as further excavations in Glenmark under my directions, in August of the same year, were again very successful, so that our stock of moa bones became larger still. Some more skeletons were now articulated, and a series of others, more or less complete, were prepared for exchange with foreign countries. In September two large collections were shipped to the Australian Museum in Sydney, and to the Museum of Comparative Zoology in Cambridge, United States of North America, and a month afterwards the former Museum sent fine and valuable return collections, consisting of skins, and some mounted specimens of Australian mammals, birds, and reptiles, together with others in spirits of wine, so that we became then possessed of a fair representation of the Australian fauna.

At last, on December 3rd of the same year, the Museum could be opened to the public. The principal room as before stated was situated above Bellamy's. At its southern end the seven moa skeletons were placed, whilst in three high cases along the western and northern walls, the collection of stuffed birds and mammals, the former mostly belonging to New Zealand, were exhibited. On the eastern side of the room in desk-cases, unmounted skins and other smaller objects were shown. The tower-room in the north-eastern corner of the building contained the geological collections, both from New Zealand and foreign countries. In the bow-window stood the large desk-case containing the interesting and valuable specimens from the New Zealand goldfields. The more westerly room was filled with table cases, in which the collection of fossils, minerals, ores, recent shells, and Echinodermata, both New Zealand and foreign, had been placed. The number of specimens all properly labelled amounted to 7,886, of which 4,312 were collected by me during the progress of the geological survey, 3,575 specimens having been obtained from foreign countries.

Thus one great object, the opening of the collections for inspection, was gained, and the eager interest the public took in the Museum, although a guide was almost necessary to lead the visitors from one part to the other, gave us new encouragement to proceed with our endeavours to have a separate building erected, worthy of the position Canterbury gradually assumed amongst the provinces of New Zealand.

During the first four months of the year 1868 I was again in the field, of which six weeks were devoted to the southern portion of Westland, whence I returned with considerable collections, both geological and zoological.

Another journey to Glenmark was made in the end of April, 1868, and large quantities of moa bones exhumed, of which a number formed a welcome addition to our own collections, the rest proving of great value for further exchanges. About this time we received a fine collection of recent molluscs, mostly from the tropics, an articulated human skeleton, and a number of bird-skins, principally African, from the Vienna Zoological Museum, as well as an extensive series of European pre-historic remains, from the late John W. Flower, of Croydon, Surrey, to whom we had sent some Dinornithic remains previously. It was this fine collection by which our pre-historic series was fairly begun. I cannot help noticing here that four of our first correspondents or friends with whom I initiated exchanges, have already departed from this earth, although only a comparatively short period of time has elapsed. Whilst Agassiz, as a great naturalist, stood in an exceptionally prominent position amongst his fellow-labourers, Frauenfeld, Krefft, and Flower were all three remarkable and distinguished men in their own sphere of research.

On 30th June, 1868, my contract as Provincial Geologist having terminated, I handed the whole collections over to the Provincial Government. Mr. R. L. Holmes, who since 1862 had first been my companion on several of my journeys, and afterwards had acted as Meteorological Observer to the province, and as Clerk to the Geological Survey, left also on the same day. His departure was much regretted by me, as this gentleman, possessing great zeal and energy, had been of considerable assistance to me in arranging the collections, and although now settled a number of years in the Fijis as a planter, he still continues to take a lively interest in the welfare of the Museum, and sends, as opportunities offer, valuable contributions from those interesting islands.

No provision having been made for the proper custody of the Museum, and being anxious that the collection, which I had had so much trouble in bringing together, should be cared for, I offered my gratuitous services as Honorary Director until the meeting of the Provincial Council, when final arrangements might be made for the purpose—an offer which was accepted by the Provincial Government. A new Executive had in the meantime taken the reins of the Government, of which Mr. W. Montgomery was the head of the Executive, and Mr. E. Jollie, Provincial Secretary, who consented to try again if they could not obtain a vote for the erection of a proper museum. The Provincial Council having the year previous refused a vote of £2,500 for a substantial building in stone, only the sum of £800 was placed on the estimates for a wooden building.

That portion of the Provincial Council which looked upon museums, libraries, and similar institutions as luxuries, in which the Province could only indulge after more than ample provision had been made for roads and bridges, demurred again, this time on the ground that the collections belonging to the Province were now too valuable to be placed in a building of such dangerous character, so the Executive seeing its way to carry the object in view, at once raised the proposed vote to £1,200, promising at the same time to erect a stone building, and carried the vote rather unexpectedly in that form. And thus the accomplishment of such a desirable object, towards which a great deal of energy had been expended, was at last brought to a favourable termination. A further sum of £150 was voted for show-cases, and during the same session I was appointed Director of the Museum.

If there had been a proper bridge leading into the park near Christ's College, a piece of ground in the park would have been set aside for museum purposes, but as it did not exist the only other desirable position available was in the Public Domain. One or two members of the Domain Board, of whom Mr. C. C. Bowen was principal spokesman, thought that the Museum should not only be erected in the centre of the grass-plot near the chief entrance of the garden, but that a plan for a more extensive museum building should at once be adopted, of which a small portion could be built with the amount voted, and as new grants of money were obtained, further buildings would be added. Mr. E. Jollie, however, whose opinion was shared by other members of the Domain Board, knowing, from his own experience, with what trouble the vote for the building had been carried, firmly believed that, at least for a considerable time to come, no more money for further additions could be obtained. He therefore decided that the building should be erected on a small triangular piece of grass-land in the north-eastern corner of the domain, and that the small path leading to the nurseries should not be disturbed. Of course this path had afterwards to be removed, and, consequently, such a small matter decided, as it were, the position of the present pile of buildings. Having been instructed that, as there would be very little chance to obtain further grants, I should make the building as large as possible, I appealed, by circular and through the newspapers—the proprietors of which have always lent me a willing hand—to the inhabitants of the Province, and in a few months I raised the sum of £483 11s. The list of subscriptions was headed by our fellow-citizen, Mr. George Gould, with £30, and was the first of the many valuable gifts with which this large-hearted man, always willing and ready to render assistance at every opportunity when help is required, enriched the Canterbury Museum. We had therefore a sum of £1,683 11s. at our disposal, and as the Provincial Government gave also the stone wanted for the building, we were enabled to erect a room 70 feet long and 35 feet broad, with a gallery running round the walls, thus giving additional space, and a lean-to 35 feet long and 12 feet broad for an office and a work-room. The building was begun in March of 1869, and handed over by the contractor at the end of the same year.

Like a number of observing men, I had long ago come to the conclusion that the days of Provincialism would soon be numbered, and that Centralization would supersede the former system. The Superintendents, Members of Executives, and Provincial Councils in the General Assembly, formed such a powerful party that any Ministry, even with the most Provincial tendencies, found it impossible to steer the General Government barque without suffering constantly from the influence of Provincial cross seas. At the same time it became evident that at the rate the waste lands were being sold, such an easy source of revenue would some day come to an end, and that then those institutions which were more or less regarded as a luxury would suffer most seriously, the more so if central institutions of the same character had to be maintained at the public cost.

Consequently, at the end of February, 1869, I handed another memorandum to the Provincial Secretary, in which the cause of the Museum in connection with technical science and education was pleaded, urging upon the Government to make reserves for the purpose in good time. However, the proposal of the Provincial Government in that direction, made to the Council in May of the same year, did not lead to any result, although only an endowment of 5,000 acres of agricultural land was asked for. Nevertheless we did not lose all hope, and the Philosophical Institute, together with other friends of science, continued to move in that direction, till at last—thanks to the enlightened policy of the Executive of which Mr. Walter Kennaway was the head, and Mr. W. P. Cowlishaw the Provincial Solicitor—the necessary reserves of waste lands were made for that purpose in the session of 1872.

The first step towards this desirable object was, however, made on the 24th November, during the meeting of the Provincial Council in 1870, during which Mr. W. Kennaway succeeded Mr. E. Jollie as Provincial

Secretary, when the Canterbury Museum was placed under trustees, of whom the following six gentlemen were appointed life-members:—Messrs. Thomas Henry Potts, Alfred Charles Barker, Julius Haast, Charles Fraser, Henry Richard Webb, and John Davies Enys. Previously Mr. J. D. Enys had proposed, as member of the Provincial Council, that reserves of 10,000 acres should be made for Museum purposes, but his motion was thrown out by 18 against 4.

During the year 1869, and before the Museum was opened to the public, large and valuable additions arrived from various sources, of which those from Dr. Otto Finsch, Director of the Bremen Museum, and the late Professor A. Kaup, Director of the Darmstadt Museum, were the most extensive and interesting. We lost, however, a number of valuable exchanges sent in the Matoaka, in February of the same year, by the foundering of that ill-fated ship.

The discovery of a moa-hunter encampment at the mouth of the Rakaia, visited twice during the same year, on the property of Mr. T. Cannon, to whose generosity we are greatly indebted, and renewed excavations in Glenmark, furnished again valuable additions and material for exchanges. The new Museum building being ready for use in the beginning of 1870, it was thought desirable before it was occupied by the public collections that an Art Exhibition should be held in it. This first exhibition was opened on 8th February, and was a great success, proving full of attraction to the public. It was kept open to 7th April. On 15th April the first new show cases were delivered, and the work of arranging the collection went on now without interruption.

During the year 1870, before the opening of the Museum building, a number of valuable additions arrived from Vienna, Darmstadt, Munich, Stockholm, Calcutta, Cambridge (United States), and London, the system of exchange, consisting principally of moa bones, having now been well established by me. The visitors showed great appreciation of our endeavours to possess collections worthy of the Province. In the year 1867, 32 persons made donations; in 1868 the number reached 59, which diminished in 1869 to 47, rising again in 1870 up to 6th October, to 72. It would be invidious to particularize, but I might be allowed to mention here a few gentlemen, who from the very beginning took great interest in the welfare of the Museum, to whom I have not yet alluded, and who have by repeated valuable gifts enriched our collections,—Messrs. T. H. Potts, E. P. Sealy, J. D. Enys, B. W. Mountfort, Hon. John Hall, Hon. William Rolleston, and H. Meinertzhagen.

On 1st October, 1870, the Museum was at last opened to the public by Mr. W. Rolleston, the Superintendent of the Province. At the time of the opening it contained 25,353 specimens, of which 16,055 were exhibited, thus leaving 9,298 specimens in the store-room. Amongst them were 35 skins of quadrupeds and 733 skins of birds. These 25,353 specimens consisted of 7,134 specimens of geology and palæontology, 11,218 specimens of zoology, the rest being botanical and ethnological.

With the opening of the first building, now hidden by the first addition in 1872, I wish to bring my address to a close. That part contains now, on the ground floor, moa skeletons and other zoological collections, and the gallery is devoted to the geological and mineralogical series. This building ought always to be looked upon by our successors with a feeling akin to reverence, and as a proof of the enlightened policy of their forefathers, who fought many a battle before its erection could be accomplished.

Having offered you a short history of the origin and early progress of the Canterbury Museum, you will perhaps allow me to allude, I must confess rather diffidently, to an accusation frequently brought against me, that I was, when there was an opportunity, too greedy to obtain specimens for the Museum. In self-defence, I may appeal to the members present, who, I am sure, will acquit me of the charge, that I bored them inopportunely to obtain what they wished to keep. On the contrary, I have lived long enough to know that there is a great charm in giving, and that this pleasurable feeling is enhanced when one is a little pressed to do so, thus making the enjoyment of the donor still greater, as it shows him that the presentation is valued. However, there may be a few exceptions to the rule, and wishing to unburden at once my conscience in this repect, you will perhaps allow me to close my address with the narration of one incident in the pursuit of my vocation bearing upon this point.

Having been informed that a large whale had been stranded a few miles south of the mouth of the Rakaia, I proceeded with an assistant to secure, if possible, the skeleton, and to gain other information. Taking a vehicle at the South Rakaia township, we reached the locality after some mishaps, the principal one of which was that the horses broke the pole, got clear of the harness, and ran away. However, a farmer in the neighbourhood was kind enough to drive us to the spot, where I found the carcass of a large sperm whale had been stranded. In examining it we observed that seven of the large front teeth in the lower jaw had been knocked out and carried away by previous visitors; and as I had not time to stay till the skeleton could be cut out, I returned to the Rakaia township the same evening, after having ascertained where the despoilers of the whale's mouth lived. So on my way back I visited these settlers, and with little trouble got four of the teeth back before reaching the Rakaia township. Here two more were returned to me, but the seventh was in the hands of a tradesman, whom I only found out when people generally go to bed. However, I ventured to pay him a visit, but he lent a deaf ear to my wish, and my persuasive powers seemed to fail, although I had tried in various ways to convince him that the tooth was of no value to him, when at last a female voice from the inner room was heard to say—"Give the beggar that unfortunate tooth and let me go to sleep." And so I got my tooth and the good housewife got her sleep.

NEW ZEALAND INSTITUTE.

# NEW ZEALAND INSTITUTE.

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Thirteenth Annual Report.

The following are the dates upon which meetings of the Board have been held: 21st July and 31st December, 1880.

The retiring members from the Board, in conformity with the Act, were Mr. W. T. L. Travers, the Hon. G. R. Johnson, and Dr. Hector, all of whom were reappointed by His Excellency the Governor.

The elected governors under clause 7 of the Act are:—Dr. Newman, Captain Russell, M.H.R., and Mr. J. McKerrow.

The vacancy on the roll of honorary members, caused by the death of Dr. Garrod, was filled by the election of the Marquis of Normanby. Two other vacancies have occurred in the roll of honorary members, through the death of Dr. Lauder Lindsay and Dr. Filhol.

The members on the roll of the Institute now number as follows:—

| | |
|---|---|
| Honorary members ... ... ... ... ... | 28 |
| Ordinary members— | |
| Auckland Institute ... ... ... ... ... | 277 |
| Hawke's Bay Philosophical Society ... ... ... | 85 |
| Wellington Philosophical Society ... ... ... | 274 |
| Nelson Association ... ... ... ... ... | 50 |
| Westland Institute ... ... ... ... ... | 100 |
| Philosophical Institute of Canterbury ... ... | 219 |
| Otago Institute ... ... ... ... ... | 216 |
| Southland Institute ... ... ... ... ... | 66 |
| | 1,315 |

Since the last report the Southland Institute has been incorporated, in terms of the Act, with the New Zealand Institute.

The printing of Vol. XIII. was commenced on the 18th January, and completed on the 28th March, and a portion of the edition ready for issue early in May. The volume contains sixty-two articles, also Presidents' Addresses, and abstracts of papers which appear in the Proceedings and Appendix. There are 503 pages of letter-press and eighteen plates.

The following division of the contents of the volume, under the various subjects, is given for comparison with last year's work :—

| | 1881. Pages. | 1880. Pages. |
|---|---|---|
| Miscellaneous ... ... ... ... | 170 | 240 |
| Zoology ... ... ... ... ... | 79 | 76 |
| Botany ... ... ... ... ... | 147 | 84 |
| Chemistry ... ... ... ... | 4 | 14 |
| Geology ... ... ... ... ... | 21 | 6 |
| Proceedings ... ... ... ... | 42 | 52 |
| Appendix... ... ... ... ... | 40 | 66 |
| | 503 | 538 |

The volumes of the Transactions now on hand are—

Vol. I., second edition, 420; vol. II., none; vol. III., none; vol. IV., none; vol. V., 60; vol. VI., 55; vol. VII., 160; vol. VIII., 25; vol. IX., 165; vol. X., 15; vol. XI., 80; vol. XII., 80; vol. XIII., not yet fully distributed.

It will be seen from the Honorary Treasurer's balance-sheet that there is a sum of £49 2s. 1d. to the credit of the Board.

The Annual Reports of the various departments connected with the Institute are appended.

James Hector,
Manager.

Approved by the Board, 28th July, 1881:

Arthur Stock,
Chairman.

## Accounts of the New Zealand Institute, 1880-81.

| Receipts. | £ | s. | d. | Expenditure. | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Balance in hand, 21st July, 1880 | 4 | 8 | 3 | Balance of account for printing vol. xii. .. .. .. | 66 | 6 | 6 |
| Vote for 1880-81 .. .. | 500 | 0 | 0 | Printing vol. xiii. .. .. | 498 | 18 | 5 |
| Contributions from societies in aid of printing vols. xi. and xii., under clause *d* of Regulations of Institute .. .. | 79 | 18 | 0 | Miscellaneous items, including binding, &c. .. .. .. | 2 | 5 | 1 |
| Contribution from Wellington Philosophical Society (one-sixth of annual revenue) .. | 28 | 1 | 10 | Balance .. .. .. | 49 | 2 | 1 |
| Sale of volumes .. .. | 4 | 4 | 0 | | | | |
| | £616 | 12 | 1 | | £616 | 12 | 1 |

Arthur Stock,
Treasurer.

28th July, 1881.

## MUSEUM.

The number of names entered in the Visitors' Book during the year is 12,000, but as comparatively few make use of this register, it does not give even an approximate idea of the number of persons who visit the Museum, and it is very desirable that some mechanism should be provided for recording, as is done in other similar institutions. The additions to the Museum will be found in the usual report, printed in pamphlet form (Sixteenth Annual Report, 1880-1).

### Natural History Collections.

The additions to the Natural History collections have not been very extensive, but, nevertheless, comprise some specimens of high scientific interest.

*Mammalia.*—The most important items under this head are: (1) a very fine skeleton of the killer-whale (*Orca pacifica*), which was stranded near Wanganui, and secured for the Museum through the kindness of Mr. S. H. Drew; (2) skins of the sea-lion (*Otaria hookeri*), from the Auckland Islands, and a skeleton of the sea-elephant (*Morunga elephantina*), collected by Mr. Burton, Taxidermist to the Museum.

*Aves.*—Amongst the birds recently added to the collections, and specially worthy of notice, are (1) a very fine capercailzie (*Tetrao urogallus*), purchased by Dr. Hector; (2) a series of gannets (*Dysporus serrator*), showing the nestling, young in the first year's plumage, and the adult, obtained at Gannet Island, and presented by Captain Fairchild, of the Government steamer "Hinemoa"; (3) specimens of the merganser (*Mergus australis*), the flightless duck (*Nesonetta aucklandica*), and a series of shags, collected at the Auckland Islands by Mr. Burton.

*Pisces.*—(1) A cask of Australian fishes, received in exchange from the Curator of the Australian Museum; (2) a fine specimen of *Ophisurus serpens* from Mahia Lagoon, captured and presented by Mr. J. Cunningham; (3) a splendid collection, consisting of 205 specimens, illustrative of the Ichthyology of North America, presented by the United States National Museum;—have been received and placed in the "stock room" until accommodation can be provided in the Museum.

*Reptilia.*—A magnificent collection of North American reptiles, comprising 50 species and 92 specimens, has been received from the United States National Museum, but, like the fishes, cannot be displayed for want of proper accommodation.

*Invertebrata.*—The additions to this section have been somewhat extensive, the most noticeable being (1) specimens of *Glaucus antlanticus* and *G. pacificus*, presented by Captain Renaut; (2) a very large specimen of the common eight-armed cuttlefish (*Octopus maorum*); (3) a fine collection, comprising 183 species of the marine Invertebrata of North America, presented by the United States Fish Commission.

### Ethnological.

Very few additions have been made under this head, but the extensive collections sent to the Sydney and Melbourne Exhibitions have been replaced in the cases, as far as space will allow; but here, as in all other parts of the Museum, the accommodation is sadly deficient.

A large collection of Indian articles, consisting of mats, baskets, earthenware, etc., has been presented by the Executive Commission for India at the Melbourne Exhibition.

### Melbourne Exhibition.

A series of physical and geological maps of the colony were exhibited, together with sections and plans illustrative of the gold and coal mines and other mineral resources. As evidence in support of these was a collection of rocks, minerals and fossils, numbering nearly 3,000 specimens, with catalogues, reports, and monographs, on the various branches of the subject. The collections were very carefully studied by a jury of scientific men, and their report will appear in the official records of the Exhibition. The collection was awarded a first-class certificate and a silver medal. The preparation of these exhibits required the expenditure of much time and labour, but this was warranted by the opportunity which it afforded of bringing prominently before the public the results of the scientific investigations which have been made of the resources of the colony.

### Herbarium.

During the past summer the Alpine ranges west of the Wanaka Lake, which afforded so many new species of plants when first botanically explored by Dr. Hector and Mr. Buchanan in 1862, have again been visited by the latter collector, assisted by Mr. A. McKay, who was at work on the geological survey of the same district, and the result has been the addition to the Colonial Herbarium of 25,000 specimens, some of which are wholly new species, and nearly all rare and valuable for purposes of exchange. Unfortunately the arrangement in the Museum for the preservation of the herbarium will not be satisfactory until there has been a considerable expenditure in providing proper insect-proof cabinets. Owing to the want of cabinets, the valuable collection of 28,000 specimens of plants presented by the Trustees of the British Museum, in 1876, still remains in the original packing-cases, and is not accessible for reference and study.

### Palæontology.

During the year upwards of 7,000 specimens of fossils, collected in the course of the Geological Survey, have been placed in the Museum, and a large amount of work has been done towards the critical examination of the whole collections, preparatory to their publication. The collection of foreign fossils has received extensive additions, particularly nine cases presented by the Trustees of the British Museum, which are not yet unpacked.

## GEOLOGICAL SURVEY BRANCH.

During the year the following extensions of the survey have been made, the special reports on which are printed in the annual progress report of this department (Fifteenth Annual Report, 1880-81) :—

*On the Chrome Deposits in the vicinity of Nelson.*—The discovery of several new applications of chrome salts in the arts, and notably the proposal to use it for tanning leather, having revived an interest in this ore, various lodes, some of which have recently been discovered, were carefully examined with a view of determining if they could supply the market successfully at the present prices. The result shows that there are lodes of chromic iron ore in ten different localities, containing from 36 to 64 per cent. of chromic oxide, but that many of them are in such inaccessible positions that they would not pay the expense of carriage. As to this must be added the freight to London, which is 15s. per ton, Mr. Cox is of opinion that, instead of shipping the crude ore, works should be established for the local production of the bichromate of potash. Mr. Cox also examined the further exploratory works that have been made for opening up the copper lodes in Aniseed Valley, and reports that, as a mining venture, its prospects are still somewhat speculative, as for want of capital the exploration of the lodes has not been carried on in a sufficiently satisfactory manner.

*The Richmond Hill Silver Mine* was also re-examined as far as possible, considering that the main shaft is full of water. It is pointed out that an expenditure of £100 should be sufficient to repair the water-race, and that the present water-wheel would be then sufficient to pump the mine, and afterwards to compress air for working rock-drills, the past failure of the mine being evidently due to the use of hand-drilling alone, which is not suitable for following patchy ore shoots in such hard ground. As besides silver varying from 21 to 179 ozs. per ton, the ore contains lead, copper, antimony, bismuth, nickel, and zinc, it is certainly worth following up, but it is considered that it would not be advisable to commence with a less paid-up capital than £10,000.

*The Collingwood Coal Mine* was examined with the view of advising on the most judicious manner of extending the workings.

Mr. Cox spent three months in continuing the survey of the North Auckland District, and in examining certain mineral deposits at Kawau, Coromandel, and the Thames ; also Drury and Waikato Coal Fields ; and he obtained valuable results that are detailed in his reports. Two months were next occupied by Mr. Cox in the examination of the geology of the mountains lying between the Takaka and Aorere Valleys in the north-west part of Nelson District, and, in his report, he points out the importance of the mineral deposits which occur in the Lower Devonian rocks.

From September to April, Mr. McKay was engaged in geologically mapping a section between the east coast at the mouth of the Waitaki River, and the main watershed lying west of the Wanaka Lake. In the course of this survey, he examined in detail the structure of a strip of country about 10 miles in average width, and extending for a distance of 120 miles inland from the east coast. In the Waitaki Valley he completely cleared up the evidence on which the subdivision of the Lower Tertiary and Upper Cretaceous strata had been proposed, and obtained a large addition to the collection of fossils. He also proved the existence in the first-named range of mountains of the Permian and Upper Devonian formations, and refers the highly-altered slates and sandstones of the Kurow Mountains to the Lower Devonian group, identifying them with the rocks of the Walter Cecil Peaks south-west of Wakatipu Lake. He further found that the silicious rocks charged with mineral veins, at the source of the Arrow and Shotover Rivers, overlie the older schists of Central Otago, and in the higher points of the Black Peak Range found them to be traversed by dykes of igneous rocks, and to afford other indications of their being probably intersected by rich mineral lodes. In the Devonian formation in South-east Canterbury he found a local development of white felspathic rocks charged with auriferous pyrites, which in their mineral character closely approach the auriferous rocks of Coromandel Peninsula, and which, on further examination, may prove of importance to the miner.

## PUBLICATIONS.

The following publications have been issued by the department during the year: (1.) Fifteenth Annual Report of the Colonial Museum and Laboratory, together with the List of Additions, etc., and an Abstract of the Results of Analyses, 56 pp. 8vo. (2.) Fourteenth Progress Report of the Geological Survey of New Zealand for the Season 1879-80. By Dr. Hector, with maps and sections, including Reports on Riwaka (Cox), Mount Arthur Reefs (Cox), Rimutaka Reefs (Cox), Rodney and Marsden Counties (Cox), Southland County (McKay), Chalk in Ashley County (McKay), Selwyn County, Trelissic and Curiosity Shop Beds (McKay), Ashley and Amuri Counties (McKay), Lake County (McKay), Picton Coal (McKay), Dusky Sound Copper Lode (Rowe), Hindon Antimony Lode (Rowe), Waipori Copper Lode (Rowe), Further Report on Dusky Sound (Rowe). 200 pp. 8vo. (3.) Manual of New Zealand Coleoptera; Part II. By Captain

Thomas Broun. 102 pp. 8vo. (4.) Catalogue of New Zealand Diptera, Orthoptera and Hymenoptera. By Professor Hutton. 142 pp. 8vo. (5.) Biological Exercises for New Zealand Students: No. 1, The Shepherd's Purse, by Professor Hutton; No. 2, The Bean, by Professor Parker. (6.) Meteorological Report for 1877–79, with abstracts of all returns prior to that date. 130 pp. 8vo. (7.) New Zealand Palæontology. Part IV., Fossil Corals, by the Rev. J. E. Tenison-Woods, Pres. Lin. Soc. N. S. W. 50 pp. 8vo., 4 plates. (8.) Handbook of New Zealand. New edition, prepared for the Melbourne Exhibition, with geological and other maps. By Dr. Hector. 112 pp., 9 plates and maps.

*In the Press.*

(1.) Manual of New Zealand Birds, illustrated with lithographs and woodcuts, by Dr. Buller, C.M.G., F.R.S. (2.) Fifteenth Progress Report of the Geological Survey of New Zealand for 1880–81, by Dr. Hector, with maps and sections, and including Special Reports on the Chrome Deposits of New Zealand (Hector, Cox); On the Aniseed Valley Copper Mine (Cox); On the Richmond Hill Silver Mine (Cox); On the Wallsend Colliery, Collingwood (Cox); On the North Auckland District, including Thames and Coromandel Gold Fields, Island of Kawau, and Drury Coal Field (Cox); On the Aorere and Takaka Districts, Nelson (Cox); On the Waitaki Valley, Lindis, and Wanaka Lake District (McKay); Index to the Localities where Fossils have been collected in New Zealand, with their Stratigraphical Position.

## METEOROLOGY.

Important changes were introduced on the 1st January in the Meteorological Department, with the view of retrenchment, in order to continue the Weather Signal Branch, the vote for which was disallowed last session of Parliament. As far as possible the recommendations of the Conference held in Sydney in 1870 have been adopted in this reorganization.

1. The number of first-class Meteorological Stations has been reduced from eighteen to the three at Auckland, Wellington, and Dunedin, but statistics are also furnished by the Director of the School of Agriculture, at Lincoln, near Christchurch.

2. Thirty-seven reporting stations are now fitted with reliable instruments, and supply information by telegraph at 9 a.m. on every day but Sunday, as to the wind, pressure, temperature, humidity, and general state of the weather. These telegrams are grouped according to the aspects decided on by the Conference, viz.: (*a.*) North-east, from the North Cape to the East Cape. (*b.*) North-west, from the North Cape to the West Cape. (*c.*) Southern, from the West Cape to Moeraki. (*d.*) South-east, from Moeraki to the East Cape. (*e.*) Cook Strait. From the data thus obtained, and from

extra telegrams when necessary, an isobaric map is constructed for each day, and a general report for each of the above aspects is prepared, and warnings are telegraphed to any part of the coast when dangerous winds or heavy seas are apprehended. This local weather signalling is still performed as efficiently as hitherto by Captain Edwin, R.N., whose services have now been transferred from the Marine to the Meteorological Department. These observations are also in part used as second-class station returns, for statistical purposes.

3. A large number of third-class stations are being established, at which Government officials and amateurs will record the rain-fall, temperature, wind, and weather changes.

4. At the second meeting of the Conference, held in Melbourne in April last, a system of intercolonial weather exchanges was agreed upon, and telegrams are exchanged daily between Sydney and Wellington in a special code, the former giving an abstract of the weather, particularly the movement of storm centres and atmospheric disturbances in Australia, and the latter the same for New Zealand. These abstracts are supplied to the Press Agencies, and are telegraphed to the morning papers throughout the colony.

The experience of two months has proved that this system will be of especial value to New Zealand, as the progress of nearly all storms appears to be from west to east, so that after the system has been more fully studied it will be capable of affording from three to five days' warning of the approach of marked atmospheric disturbances.

## OBSERVATORY.

The new sidereal clock has been placed in position for some months, and the chronograph having now arrived, the work of observation and distribution of correct time will be greatly facilitated as soon as the instruments have been thoroughly established.

The time-signals have been given with fair regularity, the transit observations being taken, as hitherto, by the Ven. Archdeacon Stock, B.A., who also personally superintends the setting of the local time-ball on those days for which time is notified in the morning paper; signals are also sent on those days to Lyttelton for the purpose of rating the clock which drops the time-ball at that port; but the utility and accuracy of the system might be greatly increased if it were extended to the other chief ports of the colony, and if a direct mechanical control of the local clocks were effected from the Observatory, as is done in other countries.

## LABORATORY.

During the past year 357 analyses have been performed in the Colonial Laboratory, so that the laboratory number now arrived at is 3,034.

These are classified as follows: Coals, 14; rocks and minerals, 50; metals and ores, 95; examination for silver and gold, 152; water, 11; miscellaneous, 35. Total 357.

The results of all analyses having any general interest are stated in full in the Laboratory Report, together with the information given by the contributors of the specimens upon which these results have been obtained.

*Weights and Measures.*—Only a few sets of standard weights and measures have been verified and re-issued, according to the requirements of the Act, during the past year; but the majority of the sets at present in use by the local Inspectors will have to be verified, as the statutory term for which they were issued will have terminated.

## LIBRARY.

Two hundred and fifty volumes have been added to the Library of the Institute, which is now in such a crowded state as to render the provision of further accommodation absolutely necessary. Together with the Library of the Philosophical Society, it now comprises over 4,000 volumes, nearly all of which are valuable works of reference.

*Patent Office Library.*—This Library has been arranged in the Lecture Hall, and is now accessible to the public, on application to the Curator. It contains 1,420 volumes.

*Public Library.*—This Library, formerly the property of the Provincial Council, has been arranged and catalogued, and comprises 1,200 volumes, but unfortunately, in many cases, important works are rendered incomplete through volumes having been taken away before the collection was removed to the Museum, and, as no record appears to have been kept of persons to whom books were lent, it is now impossible to enforce their return.

Including private collections of books which are deposited in the Museum, the library available for reference and study numbers about 8,500 volumes

20th July, 1881. JAMES HECTOR.

# PROCEEDINGS.

# WELLINGTON PHILOSOPHICAL SOCIETY.

First Meeting. *6th August*, 1881.

Dr. Hector, President, in the chair.

*New Members.*—R. G. Toulson, T. Lidbetter, W. G. Thistle, B.A., and Rev. La Menant des Chesnais.

The President delivered an opening address:

ABSTRACT.

He reviewed the remarkable progress which had been made in the colony in scientific pursuits since the time when the New Zealand Institute was first established, and pointed out that while most branches of education—primary, secondary, and University—were now well provided for, there was still a great want of facilities for technical education. The constitution of the New Zealand Institute provided for this; but that part of the Act had remained a dead letter, owing, in part, to the mistaken notion that the Universities could provide such training. This, however, was not the case, as the University student must devote the whole of his time to studying for his degree. What is wanted is the teaching of applied science and other branches of education, by means of evening lectures, to those who are engaged in business during the day. Such provision is now being made in the other colonies, and New Zealand should not be behindhand, as it would do more for developing colonial industries on a sound basis than the mere granting of bonuses or the imposition of protective duties. In describing the present state of our knowledge in various branches of science, he gave an account of the conclusions arrived at in Wallace's recent work on "Island Life" with regard to the origin of the New Zealand fauna and flora, which he considers to have been in part derived from the eastern part of Australia when it formed an island separated from the western portion by an extension of the tropical sea. When these two islands were joined, the western forms of life displaced the eastern, and caused the great dissimilarity which now exists between Australia as a whole and New Zealand. He (Dr. Hector) showed reasons, however, for still maintaining that New Zealand was at one time a portion of an extended antarctic continent that included part of South America, which was the view brought before the Society by Professor Hutton, but which Mr. Wallace considers untenable. Referring to the work of the Meteorological Department, he gave a description, with diagrams, of the operations of the intercolonial weather exchanges which have been lately instituted, and explained the manner in which it had been found from experience that storms skirting the south coast of Australia approach New Zealand from the westward, travelling at the rate of about 400 miles a day. After dealing with this subject in detail, he drew attention to the advantages which would be gained from the establishment of a magnetical observatory in New Zealand.

The address, which occupied about an hour, was listened to with great interest.

1. Dr. Hector then described a number of recent additions to the Museum, which were on the table, the chief of which were the results of the geological explorations during the past few months. Among these were further remains of the *Kekenodon*, a large fossil

cetacean, discovered in the Waitaki District, of which the teeth were described at the last meeting. Three complete skeletons have since been worked out by Mr. McKay, but unfortunately many of the bones are very friable. Enough, however, have been obtained to prove that the structure was very different from any animal previously described.

2. "On Pseudo-scab and Lung-worm in Sheep," by John Buchanan, F.L.S. (*Transactions*, p. 269).

Mr. Travers stated that he recognized this parasitic worm as one with which he had been long familiar in the Marlborough district, and he had always attributed its propagation to the sheep drinking water from stagnant pools, in which these worms abounded. He considered that the animal which produced the disease in the skin of the sheep was a different one from that which infested the lungs, and offered to assist Mr. Buchanan in his further investigation of this most important subject.

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Second Meeting. 20*th August*, 1881.

Dr. Hector, President, in the Chair.

1. "Remarks on the Sand Dunes of the West Coast of the Provincial District of Wellington," by W. T. L. Travers, F.L.S. (*Transactions*, p. 89).

Dr. Buller stated that the sandhills around Wanganui, which previously had caused such damage in drifting, had been successfully fixed by the planting of the common *Mesembryanthemum*. At Manawatu, the railway line, which was frequently covered with sand, had been protected by hedges of flax plants.

Dr. Hector agreed with Mr. Travers that something ought at once to be done to fix and utilize these dunes. He mentioned other districts where great inconvenience was caused by the shifting of the sandhills. He had some years ago advised the authorities at Carlisle how best to plant such hills, with grass as a border and pines inside, which had answered well. He had, in the early days, suggested the planting of the steep cutting on the Wellington Terrace with the plant mentioned by Dr. Buller, and, had it been done, they would have looked pleasant to the eye, and averted the damage by the heavy rains.

In reply, Mr. Travers added that perhaps, where practicable, water channels would arrest the progress of the sand.

2. "On the Alpine Flora of New Zealand," by John Buchanan, F.L.S. (*Transactions*, p. 342).

Dr. Hector explained that this was the first of a series of papers by the author, the result of a botanical expedition which he made last year in the Otago Alps. It was curious that comparatively few new species had been added to the New Zealand flora from this locality, although it had not been visited since 1863, when Mr. Buchanan, in company with himself, had examined and collected from it.

An interesting discussion took place with regard to the spear-grass and its properties.

Mr. Travers pointed out the wonderful manner in which the flower-stalk is protected by spines, without any obvious purpose.

Dr. Hector thought it must have protected the plant from being destroyed by the moa in former times.

3. "On some new Marine Planarians," by T. W. Kirk. (*Transactions*, p. 267).

4. "Additions to the List of New Zealand Shells," by T. W. Kirk. (*Transactions*, p. 268).

5. "On the supposed Paraffin Deposit at Waiapu," by W. Skey. (*Transactions*, p. 397).

Dr. Hector gave an interesting account of the locality and of how the substance occurred, being the petroleum that escapes from surface-wells altered by oxidation into a kind of mineral grease.

6. "On a Search for the Poisonous Principle of *Brachyglottis repanda* and *B. rangiora*," by W. Skey. (*Transactions*, p. 400).

7. "Further Information bearing on the Subject of the Lung-worm in Sheep," by Dr. Hector.

Mr. Travers stated that in France experiments had been made by Pasteaur, an eminent scientific man, to cure this disease by inoculation, which had proved most successful. This was of the greatest importance, as by this means thousands of sheep had been saved in France.

8. Dr. Hector then drew attention to several interesting additions to the Museum, which were on the table:—among others extracts from the barks of New Zealand woods, used for tanning purposes by Mr. Grayling of Taranaki, which had been highly spoken of at the Exhibitions at Sydney and Melbourne: fossil bones from Australia, one nearly allied to our moa: cast of a medal struck by the Admiralty for Captain Cook to distribute to the natives of various islands, which was found in Queen Charlotte's Sound, in 1878. Attention was also called to the two casts of the statues of "Hermes" and the "Boy and Goose," lately presented to the Colonial Museum by the German Government.

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Third Meeting. *3rd September*, 1881.

Dr. Hector, President, in the Chair.

*New Member.*—E. R. Chudleigh.

1. "On the *Notornis*," by W. L. Buller, C.M.G., Sc.D., F.R.S. (*Transactions*, p. 238).

Sir William Fox mentioned that he had frequently seen the two first specimens alluded to by the author in the galleries of the British Museum, where, on account of their rarity, they evidently attracted a considerable amount of attention.

Mr. Travers mentioned a circumstance which had come to his knowledge, on the authority of a Mr. Goddard, proving, as he thought, the existence of *Notornis* at no very distant period in other parts of the South Island.

Mr. Henry Travers gave some supplementary information on the same authority.

Dr. Hector said he had made enquiries in 1863 about Mr. Mantell's specimens, and, from the Natives who actually caught them, learnt the precise localities, as stated by the author, to whom he had communicated the information. He considered it very remarkable that the only three specimens of such a large and conspicuous bird had been obtained in places so far apart, and thought it most likely that there were still plenty of survivors in the south-west of Otago, where there was over 600 square miles of country that had never yet been explored.

Dr. Buller said he was glad his paper had evoked so much interesting discussion. In vindication of the name by which this bird was now distinguished *(Notornis mantelli)*, he wished to explain that, more than a year before the discovery of the bird itself on Resolution Island, Professor Owen had drawn the generic characters of a large brevi-pennate rail, then supposed to be extinct, from the fossil remains collected by Mr. Mantell, and had named it *Notornis*, dedicating the species to the discoverer of the bones. It was somewhat curious that it should have fallen to the lot of the same scientific explorer to discover the living bird itself, and although Mr. Mantell now modestly disclaimed any merit, it seemed to have been peculiarly fitting and right that, in commemoration of his services, his name should be permanently associated with the species.

2. "Notes upon the Great Flood of February, 1868," by W. T. L. Travers, F.L.S. (*Transactions*, p. 76.)

On the motion of Dr. Buller, seconded by Mr. Chapman, the debate upon this paper was adjourned until next meeting.

3. Dr. Buller called the attention of the meeting to the following specimens which he had presented to the Colonial Museum :—

(1.) *Himantopus albicollis*, Buller.—Immature state. Specimen obtained by Mr. C. H. Robson in the vicinity of Cape Campbell.

(2.) *Anas superciliosa*.—Partial albino from Marlborough. In this specimen the primaries and secondaries in both wings are almost entirely white in their apical portions; a broad band of white meets the upper margin of the speculum; the wing-coverts are irregularly marked with white, and some of the scapulars are entirely white.

(3.) Hybrids between wild and domestic duck, ♂ and ♀.—These specimens were received from Mr. Taylor of Petane, Hawke's Bay, who bred them on his premises, and vouches for their authenticity. The wild parent would appear, from the pronounced alar bar in the male, and the speckled markings in the female, to have been *Anas gibberifrons*, the white-winged duck.

(4.) *Synoïcus australis*, Gould.—Three specimens of the swamp quail, introduced from Australia, and obtained by the Hon. Dr. Pollen on the East Coast. Two of these are in the normal plumage of the ♂ and ♀; the other is a remarkable instance of melanism. The entire plumage is a brownish slate-colour, paler on the under parts; on the crown and nape there are obsolete shaft-lines, and the whole of the upper surface is obscurely varied and mottled with blackish-brown, washed with chestnut-brown on the wings. It is slightly smaller than the other specimens, and proved on dissection to be a male.

4. The President called attention to a specimen of Tin Ore found near Reefton, and stated that this was the first authentic discovery of this mineral in New Zealand.

Fourth Meeting. 17*th September*, 1881.

Dr. Hector, President, in the Chair.

1. Discussion on Mr. Travers's paper "On the Great Flood of February, 1868," read at the previous meeting.

The President explained, for the information of those who had not been present when the paper was read, that the chief points brought forward by the author were, that the flood referred to was of such magnitude as had probably never occurred previously in the particular locality, and had been so destructive as to alter the surface features of the country, thereby leaving a permanent record of its severity.

Mr. Chapman agreed that the flood in question was exceptional, but there was not sufficient evidence brought forward to prove that such had not previously occurred—indeed, he believed there had been quite as severe floods in the south and west, but not doing such damage, probably because the rivers in those localities were better adapted to carry off such heavy rains. Such a flood as the author described would on the West Coast have been unimportant.

Mr. Maxwell gave instances of exceptional floods, which had been due to the occurrence of great land-slips, and, from his knowledge of the locality and the enormous masses of driftwood reported, he thought that the extraordinary effects produced by this flood had been produced by heavy land-slips, blocking up the rivers temporarily, rather than the exceptional amount of rainfall. In the construction of public works, it would never do to provide against exceptional extremes, but only average extremes ; such a rainfall as 13in. in twenty-four hours could only be local, and it would not pay to construct works to provide in all parts of the country against the effects of such rainfall.

Mr. Marchant had surveyed that block of country, and believed that the destruction of the timber had a baneful effect in increasing the rapidity with which the storm water ran off the mountatns. He instanced the case of the Rimutaka and Tararua ranges, and stated that if the clearing of the forests was continued, the result would be the scouring out of all the valuable lands in the Hutt and Wairarapa valleys. Bush reserves were now being made to avert this disastrous result.

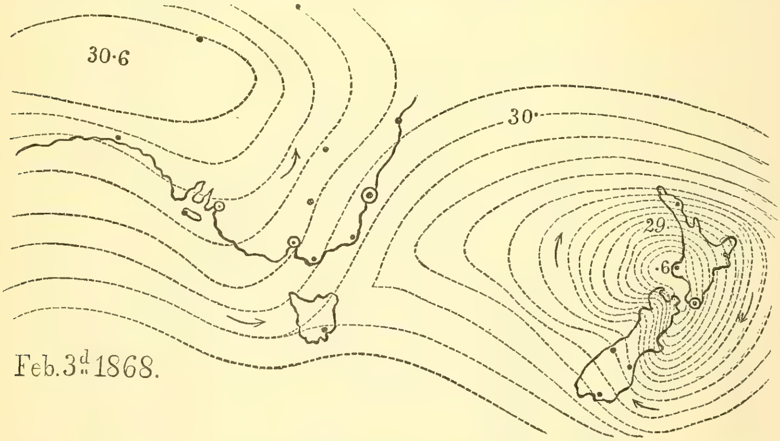
Mr. Cox took exception to the geological reasoning in the paper, and thought that the proofs of this flood being of an unexampled character were not sufficient. He argued that the formation of secondary cones in lateral streams, on which Mr. Travers chiefly relied for support of his argument, was in reality no proof, as it was only when these lateral streams had cut sufficiently deep through the main terrace to be dammed back by the floods in the main river, that they would have any tendency to cut fresh outlets for themselves, and thus form fresh cones. It thus came to be a question of years, and not thousands of years, since the conditions were favourable for the formation of fresh cones, and in reality, before this was brought about, these lateral creeks might have carried far greater volumes of water in flood-time, and yet left no trace of their having done so.

Mr. Bull was in the Ashley district at the time of the flood, and gave an account of its enormous spread, destroying farms by covering them over many square miles with a thick deposit of shingle. The Maoris had told him that there had been a similar flood about 50 years before, but there was no evidence of the deposit of drift-wood or shingle to anything like the same extent. The storm was preceded by remarkable water-spouts and whirlwinds which he described.

Mr. Travers, junr., mentioned the floods in the Motueka district in 1876, which were caused by land-slips damming the rivers, so that the hill-sides were cleared of timber, and the driftwood thickly covered the sea in Blind Bay.

Mr. McKay pointed out that the evidence derived from the thickness of the silt deposit at the mouth of the Pahau River, instanced by the author, was only proof of the extent to which it had been dammed back by the flood in the Hurunui, and that the flood was not due to landslips amongst the mountains in which the larger rivers take their rise, as streams such as the Pahau, which rise much nearer to the east coast, were relatively as much flooded as the Hurunui and the Waiau-ua. He was of the opinion that the new shingle-fans formed by some of the creeks in the Waiau-ua Gorge were not necessarily evidence that the flood was of a wholly unprecedented character, and endeavoured to show how circumstances irrespective of the mere amount of rainfall might have brought about the results mentioned by Mr. Travers. Viewed as a geological fact, he thought it likely that greater floods had occurred within the recent period, or since the gravel terraces were formed within the Waiau-ua Gorge.

The President, before calling on Mr. Travers to reply, remarked that he thought the paper was one of great importance to those in charge of public works that were proposed, especially in this particular district. He had since last meeting looked up the meteorological records for the period when this flood took place. These early records were not so complete as those now made, but he had obtained sufficient proof of the passage over the middle part of New Zealand of a great atmospheric depression, from the 2nd to 4th February, 1868, and that the centre passed N.E. of that part of the islands which suffered most, which fully accounted for the unusual direction of the wet wind, which on this occasion came from the eastward. The depression revolved round a low pressure of 28·6, and by means of the accompanying diagram of the isobaric lines he showed reasons for believing




that it reached New Zealand from the tropical parts of the Pacific Ocean lying to the N.E. of New Zealand, instead of having had the more common course from the westward. At the period referred to an extensive anticyclonic area prevailed over Australia, producing a difference of pressure of no less than two inches between there and New Zealand. The cyclonic disturbance that produced the floods was revolving along the eastern edge of this area of high pressure as it did not affect Australia. The translation of a mass of warm and moisture-laden tropical air to higher latitudes, and its impingement on the eastern flanks of the New Zealand mountains, sufficiently accounts for the extraordinary character of this flood.

Mr. Travers, in reply, thought that it was immaterial to attribute the effects he had described to landslips—these were an effect, not a cause. The fact was that the rain was so great that the river channels could not carry the waters. It was during the first few hours that the rivers rose most rapidly. All the driftwood was dead and seemed to have been the accumulation of years. The flood was not by any means local, as the Hutt River also brought down driftwood, so as to cover the whole harbour and discolour the sea outside the Heads for two miles, for several days. Mr. Cox, he thought, misunderstood his argument, as the accumulations of detritus formed during the flood were entirely new at that date, and now form permanent objects in the district. Such a flood could never have occurred before, or similar marks would have been left. He gave further particulars respecting the whirlwinds mentioned by Mr. Bull, and stated that large tracts of forest in the Nelson district had been completely overthrown by them.

2. "Notes on the Mineralogy of New Zealand," by S. Herbert Cox, F.C.S., F.G.S., Assistant Geologist. (*Transactions*, p. 418).

3. On the Alpine Flora of New Zealand," by John Buchanan, F.L.S. (*Transactions*, p. 342).

4. " On the Occurrence of of the Salmon Trout *(Salmo trutta)* in Nelson Harbour," by Dr. Hector. (*Transactions*, p. 211).

Mr. Travers said he had reason to believe that similar fish occurred in the lower part of the Hutt River.

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Fifth Meeting. 22*nd October*, 1881.

Dr. Hector, President, in the chair.

*New Members*.—G. B. Williamson, C. Gillespie.

1. Mr. Martin Chapman was chosen to vote in the election of Governors of the New Zealand Institute for the ensuing year, in conformity with clause 7 of the New Zealand Institute Act.

2. "Notes on the Mineralogy of New Zealand," by S. H. Cox, F.G.S. (*Transactions*, p. 418).

The minerals dealt with on this occasion were the ores of arsenic, antimony, tellurium, and bismuth.

Dr. Hector remarked on the importance of this paper, and said that although some of the minerals might not appear of much value, yet they indicated the presence of other and more important minerals. In speaking of the Thames and Coromandel districts, he pointed out the similarity which exists between the mineral deposits there and at the Comstock in America, and Schemnitz in Hungary. Twelve years ago the Comstock lode was worked for gold, which occurred in the form of electrum, a natural alloy of gold and silver; but now the lodes have passed in depth into silver lodes, and are worked at nearly 2,000 feet from the surface, and the nature of the rocks and associated minerals affords reasonable grounds for expecting that a similar development may take place at the Thames, as mining works are carried on. The minerals mentioned by the author show the influence of hydro-thermal action similar to that which is still in activity at Rotomahana, denudation having removed the superficial rocks at the Thames, and exposed the core into which the mineral veins have been infiltrated. The same minerals described as found on the West Coast occur under different conditions, and in an older formation, similar to that at Gympie Creek in Queensland. He pointed out the importance of the diamond drill in exploring such deposits, and stated that New Zealand was yet only on the threshold of its true mining development.

2. Mr. Romilly, Deputy Commissioner for the Pacific, then gave an interesting account of a recent inspection of some of the less-known islands of Western Polynesia, illustrated by the exhibition and description of a large collection, numbering several hundred objects of ethnological interest. The islands visited were San Christoval and Carteret, in the Solomon group; Fischer's Island, in New Ireland; Jesus Maria, in the Admiralty group; Astrolabe Bay, in New Guinea; New Britain, Woodlark Island, and Teste Island, in the Louisiades. From all these places articles used in warfare and domestic life were exhibited, and their uses explained. He pointed out that Mr. Wallace was in error in supposing that the Natives at Astrolabe Bay were to be distinguished as a race that did not use bows and arrows, or manufacture pottery. The latter he had seen the women making, and he produced specimens of both pots and powerful bows and arrows, the latter with bamboo tips, which he had obtained there. Among the articles shown was a singularly massive coat of armour, made out of cocoanut fibre by the Natives of the Hermit Group, and some magnificent mats, woven by the Natives of Rotumah from the leaves of the screw pine, one being highly ornamented with featherwork.

Mr. Chapman asked whether Mr. Romilly had made any observations comparing the races on the seaboard and interior of these Islands, as to which was the most powerful and likely to prevail and displace the other in the constant warfare going on.

Mr. Romilly said that the Natives in the interior were smaller and darker-coloured men, but were much better armed, especially with stone weapons. Although always at war with the coast Natives, each seemed to maintain their own districts.

His Excellency Sir Arthur Gordon said that apart from the mere interest of examining any large collection of curious and unfamiliar articles which had been made from such an extensive archipelago, two facts were suggested. The first was the extraordinary similarity of form in objects made in places furthest apart, while on the other hand each little group of islands, even when quite close, had produced objects having distinctive and peculiar characters. It was easy to understand how a novel form is adopted, but what is difficult to account for is the similarity between articles in the possession of different races separated by many thousand miles. This might at first sight suggest a common origin for the people who designed these works, but he thought it unreasonable to suppose it must always be so, and that the similarity should rather be attributed to the gradual development of the designs under similar circumstances. For instance, stone axes, whether they belonged to the prehistoric period in Europe or the existing time in New Zealand, were identical in form so long as the material of which they are made is of the same nature. As an instance, he might mention that the earthern pots made in Fiji were identical in form with those made by the Natives on the Upper Orinoco. The inhabitants of these countries have not the least affinity, and the similarity in design arises from their having both taken for their model the nest of the mason wasp. The proof of affinity between races should not therefore rest upon the designs of their handiwork, which is often quite opposed to the results of an examination of the structure of their language, which, of course, is a much surer guide. He spoke of the affinities of race which really do exist as most wondrous and suggestive, and mentioned that one form of the *Malagash* (*i.e.* Madagascar) numerals was identical with those of Fiji, which again closely resemble those of New Zealand.

A discussion of a conversational character ensued, Dr. Hector pointing out the interest of the observation made by Mr. Romilly, that, after battling for many days with a strong adverse current, a sudden change in its direction had carried them in the wished-for course without a change of wind, as bearing on the intercourse of the inhabitants of the different islands.

The thanks of the Society were recorded to Mr. Romilly for his interesting address.

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Sixth Meeting. 21*st January*, 1882.

Dr. Hector, President, in the chair.

*New Members.*—E. Best, Allen Hogg, M. Fearnley, C. Hedley, J. McLennan, A. F. Somerville, and Dr. T. R. King.

A list of the additions to the library since last meeting (some 40 volumes) was laid on the table, and the principal objects added to the Museum were exhibited.

1. "A Study of the Causes leading to the Extinction of the Maori," by Alfred K. Newman, M.B., M.R.C.P. (*Transactions*, p. 459.)

Dr. Grace agreed with a good deal in the paper, but did not accept the statement that the Maori race were dying out so fast as the author seemed to think. No doubt they were decreasing, and the fundamental cause was their indolent habits. If it were possible to make the Maoris do a fair share of work for their existence the race would improve. In Jamaica, which was a fertile country, the natives were lazy, and they were decreasing; but in Barbadoes, where the soil and climate were not so good, and where they were obliged to work for their living, they were increasing. We had a duty to perform in improving the race. We had to a certain extent deprived them of their vigorous habits, and have not succeeded in impressing upon them the benefits to be derived from true industry and virtue. He did not think they suffered much more from introduced diseases than did Europeans. The need for healthy manual labour was at the root of the evil, especially in a humid climate like ours, where such habits are necessary. He did not look with despair at the future of the Maori, and he thought that in fifty years hence we should have a larger population of natives than we have now.

The President, in thanking Dr. Newman for his eloquent address, said he was inclined to agree with Dr. Grace, except that he appeared to underrate the effect of the great epidemics of measles and such diseases in former times; but the Maori race was not at present decreasing so fast as formerly, except in the vicinity of towns and large settled districts. In the King country he had seen large families of healthy children. He therefore could not agree with the author in attributing the decrease of the Maoris to an inherent tendency to decay. We were really to blame, and chiefly from having induced the natives to abandon their old habits and customs. We have destroyed their social organization, and not replaced it with ours. In serving our own purposes we have undermined the authority of the chiefs, without being able to establish European authority among them as a substitute. There appears to be no reason why the race should have decayed if it had been left alone, or only gradually assimilated to our own, and it is no use trying to excuse ourselves by any other natural law but that of might.

Dr. Newman, in replying, said that he still believed the race was disappearing, and that evidence to bear out that fact would be found in his paper.

2. "Fallacies in the Theory of Circular Motion," by T. Wakelin, B.A. Univ. N.Z. (*Transactions*, p. 134).

3. "On the Extinction of the Moa," by H. C. Field, of Wanganui.

This was an account of the finding of moa bones in the sand-hills at Wanganui, and an exhibition of some of these bones, showing sharp clean cuts in them, which the author thought must have been made with a steel weapon while the bones were fresh, and therefore that the bird had lived since the arrival of the Europeans.

Dr. Hector, although agreeing with the author as to the survival of moas to a comparatively late date, thought that such bones might have been originally in swampy ground and soft, in which state they are easily cut with any tool like a spade or mattock, and afterwards harden on exposure and bleaching in sand.

4. "On an Abnormal Growth of New Zealand Flax (*Phormium tenax*)," by the Rev. Philip Walsh. (*Transactions*, p. 374).

5. "On a Deposit of Moa Bones, near Motanau, North Canterbury," by A. McKay, of the Geological Department. (*Transactions*, p. 410).

Specimens were placed on the table, and Dr. Hector explained the locality, and stated that this was probably the oldest moa deposit yet found. A skull and other bones of the extinct gigantic eagle, *Harpagornis*, first discovered by Dr. Haast, were also found in this locality, this being the first skull secured of this interesting bird. The deposit is of early Pleistocene age, and the moa bones belonged exclusively to the species *Dinornis elephantopus*, *D. casuarinus* and *D. didiformis*. There are also some bones of a large Ralline bird not yet determined.

6. "Descriptions of New Shells," by T. W. Kirk, Assistant in the Colonial Museum. (*Transactions*, p. 282).

7. "On some Plants new to New Zealand, and Description of a new Species," by John Buchanan, F.L.S. (*Transactions*, pp. 342 and 356).

These were mostly obtained during a recent exploration of the Tararua ranges.

Dr. Hector stated that during the recent expedition to the Tararua Mountains, Mr. Buchanan, in company with Mr. H. Logan and party, had procured about 1500 live plants, which had been divided between the various domains in the colony, a portion also being sent to Kew. Many of them will be most beautiful additions to gardens.

8. Specimens of a Lichen collected on the Island of Kapiti, where it is abundant, with samples of dyes made from it were exhibited by Mr. W. H. Levin, M.H.R.

The Lichen belongs to the genus *Leuconora*, which was formerly used as a dye-stuff under the name of Archil, till displaced by the less fugitive Aniline dyes.

9. "Suggestions relative to the Rabbit Nuisance," by Henry Tryon.

ABSTRACT.

The author suggests the use of Barium Chloride, mixed with four times its weight of meal, as a poisonous agent. Also the introduction of the peculiar scab insect *Sarcoptes cati*, which attacks cats, and is fatal to rabbits, but does not affect other animals.

10. "On Solar Heat," by J. C. Crawford, F.G.S.

ABSTRACT.

This was a short paper in which the author draws attention, and to some extent accepts, the views put forward by Mr. W. P. Wilson in the "Victorian Review" of January 1st, 1881.

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Annual Meeting. 11*th February*, 1882.

Dr. Hector, President, in the Chair.

*New Members*—J. S. Reid, Chas. Monaghan.

Abstract of Report for 1881.—Seven meetings, the same as in the previous year, have been held since last annual meeting in February, 1881, on the following dates: 12th February, 6th and 20th August, 3rd and 17th September, 22nd October, 1881, and 21st January, 1882; the average attendance being greater than in the previous year. Thirty-five papers were read, five in excess of last year, on the following subjects:—Geology, 9; Zoology, 9; Botany, 7; Chemistry, 4; Miscellaneous, 6.

Sixteen additional members had been elected during the year, making a total at the present time of 303 members on the roll. Thirty volumes, besides many periodicals and pamphlets, had been added to the library, and a large number of the latter had been recently bound. From the statement of receipts and expenditure submitted by the Treasurer, it appeared that there was a credit balance of £75 15s. 8d.

The report and balance-sheet were adopted.

Election of Officers for 1882.—*President*—W. T. L. Travers, F.L.S.; *Vice-Presidents*—Hon. G. R. Johnson, Dr. Buller, C.M.G., F.R.S.; *Council*—Dr. Newman, J. P. Maxwell, M.I.C.E., R. Govett, M. Chapman, Dr. Hector, S. H. Cox, T. King; *Secretary and Treasurer*—R. B. Gore; *Auditor*—Oliver Wakefield; *Librarian*—T. W. Kirk.

Dr. Hector, the retiring President, then delivered an address.

Abstract.

He thought, from the report just read, that the Society might be congratulated upon the work done during the past year. It had not been brilliant work, and they had missed the lectures of previous years on special subjects interesting and instructive. This had been the case chiefly because the hall had been required for other purposes, and their meetings could not be held regularly. He trusted before next year that one of the great drawbacks to making these lectures attractive would be removed, and that the lime-light apparatus would be completed, so that it would be possible to make illustrations visible to all present. Great improvements had been effected in the Library arrangements, and Mr. Kirk had been appointed Librarian, and would be responsible for the books of the Society. They had now a really very excellent library of 5,000 volumes, and the catalogue was available in manuscript for the use of members. In connection with the Museum, it had always seemed to him to be a great drawback that there had not been more scope given for rendering the large collection and library more available for the purposes of direct tuition, but he might say that arrangements were now in contemplation by which lectures would be carried on in connection with the College. Collegians who desired to study these subjects would, under the arrangements he contemplated being given effect to, be able to attend classes at the Museum and Library, which would be conducted by competent persons. He hoped these classes might be open to members of the Society, and to such of the general public as desired such a course of study. With reference to the work of the past year, it had been chiefly the reading of papers. This kind of work required the co-operation of members residing in different parts of the colony in order that the results might be useful. As an instance of this he might particularly refer to the paper by Mr. Buchanan on "Some diseases of sheep and cattle in New Zealand." These diseases were propagated by the development of certain minute forms of animal life, and the symptoms ought to be studied by the different flock-owners in the colony, and the observations communicated to the Society, or to some person engaged in these investigations, for the purpose of comparing results. The progress of these diseases had been studied to a remarkable degree of late. As had been stated by Mr. Travers during the discussion on one of these papers, there were already signs of our acquiring the means of warding off these diseases and protecting animals from their inroads in the same way as we now—though very imperfectly here—protect the community from the attacks of smallpox. This important matter was well worth the attention of all members of the Society who took an interest in scientific researches which had a direct bearing upon the welfare of the human race. With reference to smallpox, the apathy displayed as to the best means of protecting ourselves from the scourge appeared to him to be almost criminal. We were naturally protected against the incursion of a vast number of diseases, but an outbreak of smallpox here would be disastrous. In the first place, comparatively few of the people of New Zealand realised the horrible nature of this disease, and vaccination is a matter in which only partial interest is taken. If the matter were brought more prominently before the public by proper means, aided by compulsory vaccination, he thought it quite possible that we might get rid of the necessity for the quarantine system. We might then take our chance of the small number of cases which might occur in the community. There had been a great cry raised of late in favour of what was called animal vaccination, that was vaccination with lymph taken direct from the calf, instead of with lymph taken from the arm of an infant. In his opinion there was a good deal of misapprehension in this matter. Vaccination was really sowing the seed of smallpox in the system in the same way that carrots or turnips were sown in a garden. These germs of disease lost power by passing through a certain diluting process; and some time ago a proposition was even made to dilute the virus with milk. There was no doubt that lymph could be passed through a calf and then used; but in any case everything depended on having pure seed. Those who advocated animal vaccination must take care that the body of the animal selected did not contain the seeds of other diseases; and those who were in favour of human vaccination said that the dread of other diseases arose from careless vaccination, and the taking of lymph from the arms of unhealthy children. In both cases it was necessary to take great care that the seeds of any other form of disease were not introduced by vaccination; and for his part he did not see any greater risk attending arm-to-arm vaccination than in what was termed animal vaccination. The Government had been put to great expense in providing the means of vaccination, and it was to be hoped that an unreasonable prejudice against it would not exist much longer. He had been led to make these observations because he had been thinking over the subject a great deal of late. It was a subject open to much discussion and calm thought for the purpose of getting rid of the cobwebs of prejudice which surrounded it in the public mind. Another interesting paper is one by Mr. Travers upon the effects of certain floods. In arranging the papers of the "Transactions" for the printer, he found that a valuable paper was read before the Otago Institute by Mr. Arthur on a similar subject, and both opened up a question of great importance and interest. Mr. Arthur had shown that storms could be gauged in such a manner that we could ascertain what amount of rain was likely to be deposited upon a certain area of country. Advantage might be taken of this knowledge to erect dams to hold the quantity of water that might fall within a given time. These dams might be placed in favourable positions for trapping the water, and by performing the same functions as Lakes in Alpine districts, and only allowing it to flow slowly to the sea, would thus prevent the damage done by floods. Every person could find time to take the reading of a rain gauge, and by a comparison of results much valuable information might be thus gathered. He again adverted to the necessity for systematic Magnetical observations in New Zealand. Not long ago Professor Stokes, one of the secretaries of the Royal Society read a remarkable paper on the effect of electrical storms caused by revolving currents of air which passed over distant parts of the earth's surface possessing extremes of temperature. He (Dr. Hector) thought we might be on the brink of discovering some link between these electrical storms and earthquakes, but to solve this question would necessitate a much more complete equipment in our observatories than we possess at present. We must take some more accurate means of recording the passage of earthquake shocks, their duration and locality. In the matter of zoological work the past year would be known as the *Notornis* year. This bird was once supposed to be extinct like the moa, but now it was to be hoped that more specimens would soon be available for their inspection and study. He might mention that Dr. Buller's new "Manual of the Birds of New Zealand" was now through the press. The last sheets had been corrected, and the work would, in a few days, be in the hands of the public. In botanical work the Society had placed on record some very interesting discoveries, most of which had been in relation to the alpine flora of New Zealand. They had now got a very complete collection of live plants from the mountain ranges, specimens of which had been distributed by the Government to the different gardens in the colony. They had also just received from Mr. Kirk a very complete collection from Stewart Island. A most valuable series of observations commenced by the late Mr. Ludlam had not been carried out, and no one had again taken the matter up. These observations were in connection with the periods of budding and fruiting of various kinds of introduced trees and plants. Much valuable information might be obtained in this manner, and might prevent us making mistakes in the introduction of forest and other trees. After further remarks on various attacks recently made on the uniformitarian school of geologists founded by the late Sir Charles Lyell, Dr. Hector concluded by thanking the members of the Society for the manner in which they had supported him during his term of office as President.

1. "On a Fundamental Error in Dynamics, the Theory of Gravitation, and the Nebular Hypothesis," by Victor Falkner.

ABSTRACT.

The paper dealt with Newton's explanation of Kepler's laws and that part of the nebular hypothesis that hinges on it. The writer contended that dynamics was essentially an experimental and inductive science, and that little reliance could be placed on the results of deduction in it. He

argued that such an important problem as that involved in the Newtonian theory should never have been accepted as proved without experimental demonstration. After entering fully into Newton's and Laplace's theories, Mr. Falkner stated that the hypotheses assumed that the path of a body propelled in free space by an impulse, or travelling tangentially at uniform velocity, and attracted to a centre with a force varying inversely as the square of its distance from that centre, is an ellipse of which the attracting centre is in one focus (or a similar conic section), and an orbit similar to the planetary and cometary. This assumption he denied, and affirmed that the path of a body subject to an impulse, or its equivalent, moving in free space, and subject to any central force, is such a figure that the attracting point is in its centre, or at the intersection of its axes. He supported this affirmation by viewing the assumption in its extremes, and endeavoured to show it as contradicting the axiom that "action and re-action are contrary and equal," and explaining his own conclusions and their agreement with the results of his experiments. He then reviewed current graphic methods, and pointed out where he considered the errors had been made, and explained and discussed the apparatus.

Mr. M. Chapman contended that the matter was not one that could be dealt with by experiment, but must be dealt with by mathematical investigation. He could not believe in Mr. Falkner's results for a single instant.

The Chairman expressed a hope that Mr. Falkner would not upset the "Nautical Almanack."

Mr. Falkner then advanced the statement that astronomy really rested on Kepler's laws, and not on Newton's explanations of them, the most important of which, like so many previous problems in dynamics solved deductively, when put to the test proved quite erroneous.

2. "New Cuttle Fish," by T. W. Kirk. (*Transactions*, p. 283).

3. "List of Sertularians collected in Wellington," by T. W. Kirk.

4. "Abnormal Colouring in the Kokako," by T. W. Kirk.

(1.) *Glaucopis wilsoni.*—The first notice of albinism in New Zealand representatives of this genus will be found on page 154 of Dr. Buller's "Birds of New Zealand." The specimen is a *partial albino* shot by Mr. H. H. Travers at the foot of Mount Franklin, and is of the usual colour with the exception of a few white feathers on the neck, head, back, and one or two partially white in each wing.

(2.) *Glaucopis cinerea.*—An albino of this species was caught on the Rimutaka Range in 1877, and kept alive for several months by Mr. G. Elliotte, proprietor of the Pakuratahi Hotel, during which time it became quite tame, and would, I am informed, feed from the hand. The whole of the plumage was *pure white*, the eyes and wattles *pink*, the latter being very small.

(3.) Two specimens recently purchased for the Museum may be said to be intermediate between (1) and (2). They were obtained on the Rimutaka Mountain near Featherston. Both specimens are alike, and about the usual size. Breast and abdomen pale slaty-grey, back and top of head same colour, but of a lighter shade, almost white in places. Wings and tail white, under surface of wings slaty-grey; shafts of quills white.

5. "Reported Capture of a Californian Salmon at Riverton," by Dr. Hector.

6. "Fossil Cetaceans," by Dr. Hector.

ABSTRACT.

The author describes the remains of seventeen different Cetaceans that had been discovered in the fossil state in New Zealand. One of them is from the Upper Cretaceous; seven of them from the Lower Eocene; five from the Upper Eocene; and four from the Lower Miocene.

7. "New System of Telegraphic Weather Reports," by Dr. Hector.

8. "On a new Theory of the mode by which Photographic Effects are produced with Silver Salts," by W. Skey. (*Transactions*, p. 403).

9. A number of interesting exhibits were brought under the notice of members. Among them were specimens of New Zealand crows, showing abnormal colouring; New Zealand sponges, presented by Mr. J. A. Smith of Napier; specimens of coal from Coal Creek; specimens of quartz from Langdon's Reef, Collingwood Ranges; Welcome Mine, Reefton; Fiery Cross, and Just in Time Mines, Reefton; and Alpine Mine, Lyell; a certificate of the First Order of Merit awarded at the Melbourne Exhibition to the Colonial Museum; the First Silver Seal for the Colony of New Zealand, defaced by Her Majesty in Council, and presented to the Museum by the Colonial Secretary.

Dr. Hector said that the sponges exhibited might have a very considerable commercial value, as it had been ascertained that sponges could be propagated and improved by artificial culture.

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# AUCKLAND INSTITUTE.

First Meeting. 13*th June*, 1881.

T. Peacock, President, in the chair.

*New Members*.—C. Alexander, J. M. Alexander, A. Buckland, H. Campbell, M. A. Clark, W. C. Coleman, P. Comisky, J. Fisher, T. T. Gamble, D. Goldie, G. Johnstone, G. Hemus, T. W. Hickson, T. Mahoney, A. McGregor, T. Mackay, D. Nathan, E. B. Parsons, A. Saunders, G. Sibbin, J. C. Sharland, R. H. Stevenson, E. H. Whitaker, W. R. Waddel, Major T. Benton, N. Kenny, G. T. Wilkinson, T. P. Moody.

The President then delivered the anniversary address.

ABSTRACT.

In accordance with the usual custom, it now becomes my duty to deliver the inaugural address. In the first place, I desire to express my appreciation of the honour which the members of the Institute have conferred upon me in electing me to fill the President's chair—an honour to which my own feelings would not have prompted me to aspire. Standing on the threshold of our fourteenth session, and looking back to the meeting in November, 1867, at which, with zealous intentions, not unmingled with misgiving as to its permanence, our society was launched, I feel that there is true cause for congratulation at the progress made and the success achieved. And looking forward, there is every reason for encouragement. With a membership numbering 305—the largest roll of any of the affiliated societies—including 28 names just added, we have the evidence of a sustained interest in our important operations. Having been associated with the Institute as a member of council at its beginning, I know that much of the success has been owing to the fostering care and ever willing assistance rendered by Mr. Kirk and Professor Hutton in the early years of our existence.

Our aims embrace the cultivation of science, art, literature, and philosophy, a range of subjects which gives ample scope for the indulgence of every taste, while our meetings afford a congenial sphere where each votary can minister to the pleasure and edification of his fellows, receiving in return an impulse to fresh exertion, whether it be to study, to assimilate, and profit by the wealth of thought, feeling, and wisdom, treasured up in our national literature; or in the field of Nature, animate and inanimate, to observe and classify her phenomena, and evolve the laws that regulate her processes,

"With curious eye
To glance at beauteous things that give delight:
Objects of earth or air, or sea or sky,
That bring the very senses in the sight
To relish what they see."

SCIENCE.

But granting that art, literature, and philosophy are wisely included in the aims of the Institute, and well deserving of attention and encouragement, science must naturally occupy a prominent place in our deliberations. During the present century alone it has received a development so enormous in its extent and so fruitful in its influences on our civilization as to be unparalleled in the history of mankind. So multitudinous are the facts observed, so numerous the generalizations formed, and so fertile the deductions made therefrom in suggesting fresh enquiries, that the subdivisions have become special studies. Division of labour has become essential to further progress. Never before have the sayings and doings of scientific men had so large an auditory, or received more enlightened attention. It is true that the bold theories and far-reaching generalizations which have been put forth in some departments have caused uneasiness and opposition on the part of many. Especially is this the case in biology, in the well known

THEORY OF EVOLUTION.

I will only say in passing that it is vain to object to the indulgence in theory. No one can intelligently observe natural phenomena without theorizing or endeavouring to conceive the mode in which they have been brought about. Following after the preliminary collection of facts, theory offers a connecting link, a centre of aggregation, round which other facts may be orderly grouped, or their divergence be clearly perceived. Let hypothesis be freely submitted to the scorching heat and glare of criticism, to the crucial test of comparison with the manifold facts and observations of keen and competent men, bearing directly or indirectly thereon, and truth, which should be ever welcome, will be the resultant. Should the hypothesis fail to account for, or be in accord with, all the facts, then must it be discarded for a better. That which is true will stand, while that which is false will be done away. But even if a theory which at first appeared plausible has to be modified or set aside, it may have subserved a useful purpose in stimulating and guiding enquiry, concentrating attention, and methodizing observation.

To revert to the theory to which I have just alluded, it must be admitted by candid minds that the intense activity displayed in the field of biology is limited at two important points. On the one hand there is the gap between the inorganic and organic forms of matter, the production of that protoplasm which is the basis of all living bodies, with its wonderful potential qualities. The general testimony of science is that the innumerable forms of existing life spring only from antecedent life; that there is no such thing as spontaneous generation from dead matter; that no chemical attractions or affinities can avail us here, and so if we go back in imagination to one primordial cell or germ as the beginning of life we must still look to a pre-existing life or active agent for its production. On the other hand, there is the impassable chasm which exists between organic matter and the profoundly mysterious thinking part of man. Their close relationship and interdependence may indeed be studied, but the nature of the mind itself, so distinct from matter in its independence of extension in space, so widely apart from the objective phenomena of the external world, and so evidently antecedent to the sensations which they produce within it—this, notwithstanding elaborate groupings of words in explanation, is likely to remain an insoluble mystery, and defy conception to the present powers of man.

GROUPS OF SCIENTIFIC SUBJECTS.

From a colonial point of view, there are two groups of scientific subjects that may engross our attention, which, apart from the relative interest derivable from their pursuit, present differences in the facilities for their study, and the original or intrinsic value of their results. In the first, we may place botany, zoology, geology, mineralogy, meteorology, and ethnology. In a new country there is abundance of scope for useful and accurate observations on its flora and fauna, its geological formations, its meteorological phenomena, and the ethnological peculiarities and history of the native race. These are within the reach of all, and offer opportunities for giving some original contribution to the stock of human knowledge, facts of observation which may supply some missing link, or throw a gleam of light athwart some obscure point, or which, from their local and distinctive character, will be as stones which the great European master-builders in each department will gladly accept as necessary components in the great and noble edifice of science. The other group may be said to include applied mathematics, the general science of biology, the physical sciences, astronomy, heat, light, electricity, magnetism, chemistry, mechanics, hydrostatics, and pneumatics. In these branches, in which the investigations are either general in their character, or demand for original research appliances and leisure not readily available in the colonies, we must be content to keep abreast of the knowledge attained and the discoveries made. But to do this is an important function of this Institute, and it is worthy of consideration, whether, without disparaging the good work which has been done and still requires doing, in preparing and accommodating our zoological specimens in the Museum, it might not be desirable to acquire, by gradual steps, an equipment of physical apparatus which would be suitable for the purpose of exposition, and possibly for original research on the part of some of the members. Meantime, the magazines procured for the use of the members, the library of reference, and occasional lectures, have rendered good service.

With regard to the first group of subjects, the New Zealand Institute has done good work in every department of natural history, and no inconsiderable part has been done by the Auckland Institute, while, thanks to the liberality of members and citizens, led by the spirited example of one of our leading members (I allude to Mr. Justice Gillies), our valuable specimens have received worthy shelter in this excellent building. By the system of exchanges, too, we have been enabled to confer a favour upon European and American museums, receiving in return representative specimens from various countries.

The President then reviewed the recent progress of scientific philosophy, and described the various discoveries that have been recently made in the application of electricity to the ordinary wants of daily life, giving a *résumé* of the subjects which have occupied the minds of scientific men in some branches of physical science, with the conclusions arrived at, and the progress made during the year.

In concluding, he remarked that with the ever increasing refinements in the instruments at his command, the natural philosopher is enabled to attain a delicacy, an accuracy, and a range of results impossible to his predecessors, but with extended scope and wider generalizations there come new problems to solve, new mysteries to unravel.

Vast and comprehensive as is the knowledge acquired in every branch of science, what is known is but an infinitesimal portion compared with what there is beyond, while much will ever remain inexplicable to the finite faculties of man. But in seeking earnestly and fearlessly to know the sequence of events, the relationship of things, and the mode of action of that all-pervading energy which it has pleased the Creator to impart to the existing universe, there is no necessary connection with atheistic principles or materialistic philosophy. On the contrary there may (as in the case of the late distinguished Professor Clark Maxwell) exist the most profound learning and scientific genius with Christian humility and enlightened reverence. Let us ever remember that in the field of natural science, apart from the ameliorating influences that follow in its train, it is the pursuit and attainment of truth rather than its possession which affords the keenest enjoyment. Of the scientist, too, it may be said that, leaving the things which are behind, he reaches forth to those which are before, assured that with increasing knowledge there will ever be opened up fresh avenues of investigation to stimulate his zeal, to exercise his powers, and minister to his mental delight.

If our Institute be successful in inspiring and maintaining a taste for the acquisition of learning, and encouraging habits of observation and thought among its members, then will the sense of its importance and the height of its aims grow with the growth of the community, and in its career of usefulness it will be privileged to assist in laying the foundation of accurate knowledge concerning the natural history and traditions of our adopted country, while exercizing a healthful and elevating influence on succeeding generations.

PAPERS.

1. "On the Occurrence of the Eastern Golden Plover *(Charadrius fulvus)* in New Zealand," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 265).

2. "On the New Zealand *Carabidæ*," by Captain T. Broun, M.E.S. (Reserved for separate publication).

3. Mr. E. A. Mackechnie exhibited some branches of the common furze covered with a large scale-insect, and stated that a number of oranges, lemons, and other trees in his garden had been completely destroyed by the same insect. It appeared to be rapidly spreading.

Dr. Purchas pointed out that he had previously brought this pest under the notice of the Institute, as having destroyed some hedges of kangaroo acacia in the Ponsonby district. It had since been described by Mr. Maskell in vol. xi. of the "Transactions," under the name of *Icerya purchasi.*

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Second Meeting. 11*th July*, 1881.

T. Peacock, President, in the chair.

1. "Notes on New Zealand Mollusca," by Mr. Justice Gillies. (*Transactions*, p. 169).

2. "On Crystalline Rocks," by W. D. Campbell, F.G.S. (*Transactions*, p. 450).

Mr. Pond was sorry to see so many of Mr. Campbell's illustrations taken from foreign rocks. Many of the metamorphic rocks existing in the province would repay a little attention. Dr. Purchas and Mr. Martin also spoke on the subject.

3. "On some Additions to the Flora of New Zealand," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 299).

4. "New Species of Coleoptera," by Captain T. Broun. (Reserved for separate publication).

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Third Meeting. 8*th August*, 1881.

T. Peacock, President, in the chair.

*New Members.*—E. T. Dufaur, W. J. Palmer.

1. "Notes on Experiments with *Sorghum* Cultivation," by Mr. Justice Gillies. (*Transactions*, p. 373).

Mr. Firth considered that the whole of the northern portion of the North Island was eminently suitable for the cultivation of *Sorghum*. It had this great advantage, that, unlike the sugar-cane or beetroot, it required no very expensive plant of machinery to extract the sugar. During late years its cultivation had increased in an enormous degree in the United States, and there was every probability that in a short time a very large proportion of the sugar consumed there would be produced by it. Sorghum had a further advantage over beet, in the fact that the sugar it yielded was from the very first grateful and acceptable to the palate, while in the case of beet-sugar the taste had to be trained to like it.

Mr. Pond was sorry that the discussion had turned on the comparative advantages of *Sorghum* and beet, for he considered that there was ample room for the cultivation of both in the Colony. As for the statement respecting the objectionable taste of beet-sugar, it was quite certain that with proper methods of refining it was as pleasant to the taste as sugar prepared from the sugar-cane or *Sorghum*.

Mr. W. D. Campbell corroborated Mr. Pond's statement respecting the taste of refined beet-sugar.

2. "The Shadow of Justice," by E. A. Mackechnie.

ABSTRACT.

The object of this paper was to show that perfect justice is not attainable (1) in consequence of the imperfection of the human mind itself; (2) from the different effects produced upon different minds by the same fact or set of facts; and (3) from the character of legal procedure in Courts of Justice.

3. "The New Zealand *Dascyllidæ*," by Captain Broun. (Reserved for separate publication).

ABSTRACT.

The author remarked that we are indebted to Dr. Sharp, of Dumfries, for most of our information on this difficult family of beetles. Dr. Sharp enumerates 8 genera and 24 species. In the "Manual of the New Zealand Coleoptera," 11 new species are added, and in the present paper 16 more, making a total of 56 species known to inhabit New Zealand. Only 14 kinds are known to exist in Great Britain.

4. Mr. Josiah Martin exhibited some photographs taken by the new platinum process.

On the motion of Mr. Peacock, seconded by Mr. Firth, Mr. J. T. Mackelvie, F.R.G.S., and Mr. T. Russell, C.M.G., were elected honorary members of the Auckland Institute.

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Fourth Meeting. *5th September*, 1881.

T. Peacock, President, in the chair.

*New Members.*—S. Coombes, R. Cranwell, E. C. Goldsmith, W. J. Offer.

A long discussion arose on Mr. Gillies' paper on *Sorghum* cultivation, read at the last meeting.

1. "On a Pseudomorphous Form of Gold," by W. D. Campbell, F.G.S. (*Transactions*, p. 457).

2. "Notice of the Occurrence of *Epacris microphylla* in New Zealand," by A. T. Urquhart. (*Transactions*, p. 364).

3. "On two Species of Nudibranchiate Mollusca from Auckland Harbour," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 213).

4. "New Species of *Curculionidæ*," by Captain T. Broun, M.E.S. (Reserved for separate publication).

5. "On the Sugar Values of Beetroots grown in the Waikato District," by J. A. Pond. (*Transactions*, p. 365).

Remarks on this paper were made by Mr. Gillies, Mr. Martin, Mr. Aickin, Dr. Purchas, and the President. Mr. Pond briefly replied.

6. "On Evolution considered from its Religious Side," by the Rev. S. Edgar.

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FIFTH MEETING. *3rd October*, 1881.

T. Peacock, President, in the chair.

*New Members.*—A. Bull, Captain Thomas.

1. "On the Swiss Lake Dwellings," by Neil Heath.

ABSTRACT.

This paper was prepared mainly to illustrate a collection of remains from the Swiss Lake Dwellings, presented to the Museum by Mr. J. T. Mackelvie, and which are as follows:—

Three stone axes, with stag-horn handle.
Four ,, ,, without handle.
One weight for weaving.
One round piece of burned clay, with hole in it.
Three round pieces of stone, like buttons, supposed weights for nets.
Five flint arrow-heads.
Five working tools.
Five chippings or flakes.
Six bone needles.
Three bone chisels, sharp at both ends.
Six pieces of stag-horn.
Five glass bottles, containing seeds, etc.
Two pieces of wood, supposed to have been used in wattling.
One bone knife.
One piece of cloth.
Two photographs of Möringen and Lättringen.

To give you some idea of the number of articles that have been found from time to time, and belonging to this period, I shall quote from a table drawn up by Sir John Lubbock:—Axes, 2,676; arrows, 161; flakes and chippings, etc., 5,100; other objects, 1,239; besides many corn-crushers, whetstones, and weights.

The axe must have been one of the most valuable and valued implements. It was useful in war, useful in peace. They were not very large, varying in length from one to six inches, and with a cutting edge varying from one to three inches. Serpentine and diorite are the principal materials of which they were made, though flint and jade were sometimes used. Jade is not found in the west of Europe, and hence it is supposed that axes made of it must have come from the East, being passed on from tribe to tribe by way of barter. The flint found in Switzerland was not suitable for axes, but France had abundance for all, and it is generally supposed that the flint used in Switzerland was obtained from Pressigny. Considerable doubt exists as to the way in which these axes were made. The generally accepted theory is, that they were made by blows of a hammer on the stone that had been carefully selected, and that when by skilfully repeated blows the required size had been attained the ridges between the grooves formed by the fracture were ground down by means of sandstone. The small ones, such as we have on the table, were inserted along with bitumen in a socket of stag-horn, which in turn fitted a hole in a handle of hard wood. The larger ones were fastened in various ways to handles. Adzes were formed in a similar manner, and attached to an angular piece of wood, as the Maoris used to do a few years ago. Obviously there would be a considerable number of chips, the best of which were selected for arrow-heads and knives, while those that could not be so used, and which we call flakes, were useful for a variety of purposes. They used them as scrapers—as spokeshaves amongst other things. I think the Lake Dwellers must have found them as useful as the Maoris do their pipi and other shells.

*Bone.*—In the present collection there are several implements made of bone. It will be seen that the particular bone selected is that of the stag, an animal which must have been found in considerable numbers, if we may judge from the great variety of articles made therefrom. The chisels which lie on the table are sharp at both ends. I very much fear they could not be of great service, for it is evident that the sharper the cutting edge is, just so much the less strong will it be. Authorities do not make their use quite clear. The needles would be extremely valuable for making holes in the skins with which they clothed themselves in the early part of the period. In the absence of thread at the same time, they appear to have found a fitting substitute in narrow strips of skin.

*Weight for Weaving.*—The stone weight, which was found at Nidau, is said to have been used for weaving. It is, I think more likely to have been used for sinking the nets.

The round piece of burned clay with the hole in it is generally understood to have been used as a spindle whorl. This implement brings us to the second half of the period, by which time it is evident that the people had acquired a knowledge of weaving, flax being cultivated and woven into tissues; agriculture had made a start, and such animals as the ox, sheep, goat, pig and dog were domesticated.

*Weaving.*—The piece of cloth we have here is apparently made of flax, the warp and the woof being wonderfully regular, and indicating a great advance in civilization. Hemp does not appear to have been known.

*Grain.*—One of the small bottles in the collection contains some carbonized cereal, whether wheat or barley I cannot say. Three varieties of wheat, two kinds of barley, and two of millet, were cultivated, but how the ground was prepared I cannot discover, no acknowledged agricultural implements having been found as yet. It is a fact that they made bread, apparently however without leaven. The specimens that have been found very closely resemble badly-made "damper." Sometimes they appear to have roasted the grains, pounded them between stones and stored them away in earthenware vessels made pointed at the bottom, so that they could easily stand upright in the ground. Carbonized apples have also been found. There are no traces of the grape; but what are supposed to be stones of the wild plum, seeds of the raspberry and blackberry, and shells of the hazel nut and beech nut, occur pretty frequently, while in one settlement peas have been discovered.

*Animals.*—Professor Rütimeyer, who has paid great attention to the fauna of this period, tells us that the total number of species amounts to 70, and that at least 6 of these, the dog, horse, pig, goat, sheep, and two varieties of oxen, were domesticated. He says, also, that the bones very seldom occur in a natural condition, those of domestic and wild animals are mixed together, the marks of knives are upon many, and almost all have been broken, evidently for their marrow. The stag and the ox seem to have been specially numerous, the stag in the older settlements exceeding the ox in the number of specimens, while in the more modern ones the converse is true. The hog appears to come next in order of abundance, followed by the goat and the sheep, which latter seems to have increased very rapidly. The dog is found less frequently than the fox. Remains of the bear, the wolf, the bison, and the elk have also been found. The stag and the boar of those times seem to have been much larger than they are now, the fox smaller, and the sheep about the same size as those now grazing on the mountain sides in Wales and Shetland. People were free from the presence of the common mouse and the house-rat, and as puss was not therefore required, so she did not appear. Professor Rütimeyer found a single bone of the common fowl, but this he assigns to a later period.

I have not been able to obtain any reliable information as to the race of men that inhabited these lake dwellings.

2. "Contributions to a Flora of the Nelson Provincial District," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 301).

3. "Revision of the New Zealand *Cossonidæ*, with Descriptions of new Species," by Captain T. Broun, M.E.S. (Reserved for separate publication).

4. "Recent Advances in Photography," by J. Martin, F.G.S."

ABSTRACT.

In this paper (which was fully illustrated with experiments) the author traced the progress of photography up to the present time, giving a full account of the new platinum process, by which pictures that are not affected by heat, acids, or light, can be readily produced, and which resemble mezzotint engravings rather than photographs.

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SIXTH MEETING. 15*th November*, 1881.

T. Peacock, President, in the chair.

*New Members.*—Captain Filder, H. N. Garland, W. H. Grace, J. Haslett, W. C. Kensington, Rev. D. W. Runciman, G. W. Williams, H. S. Smith.

1. "New Species of *Cerambycidæ*," by Captain T. Broun. (Reserved for separate publication).

2. "Notice of the Occurrence of the Australian Roller (*Eurystomus pacificus*) in New Zealand," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 265).

3. "Notes on various Subjects," by James Baber, C.E.

*Passiflora tetrandra.*

On allotment 86, East Waiuku, the property of Mr. Marshall, three years ago, I was passing a specimen of this climber so singular that I stopped to sketch and measure it.

Attached to a branch of a small taua tree, about 18 inches diameter at its butt, and at a height which I guessed to be 35 feet, depended a vine which reached the ground, and had a diameter of $3\frac{1}{2}$ inches. On the ground, like a rope cable, was spread a coil and a half of the plant. The coil was circular and its diameter 12 feet. By multiplying the diameter by $3\frac{1}{7}$, the length of the plant was 56 feet 6 inches lying on the ground, while the distance from the ground to the branch of attachment was not more than 35 feet; in other words, nearly two-thirds of the round stem of the vine were on the ground.

How came the plant to grow in this singular shape? Probably the vine grew up the stem of the taua, formed a firm attachment to the branch from which it still hangs, the branch bore it out into the air, having little prehensile power its weight caused it to leave the stem by which it had climbed. Borne further out horizontally by the growth of the branch, but not higher, the growth of the stem of the vine, as formed by the crown of leaves above, had to deposit itself on the ground, and the circle was the most easy shape it could assume. If this supposition be correct, this *Passiflora* affords an example of a plant availing itself of gravitation to accommodate its growth.

*The Centipede.*

Until I saw the contrary, I was not aware that this insect had any power of progression except by the use of its many legs.

One evening I found a centipede climbing the wall of an old room, it was of a yellowish-brown colour, about five inches long, and very thin. Brushing it down, I was about to crush it under my boot, when the creature clapt its head to its tail, formed a circle, and sprang a distance of 3 feet. In three bounds it cleared 10 feet, and escaped between floor and skirting before I could overtake it.

*Artesian Wells inverted.*

Water in an artesian well comes to the surface when an aperture is provided through a water-tight stratum which has kept it down.

At the request of two Highway Boards, I inverted this action, sunk through a water-tight stratum, and found below a porous one, which has provided drainage for the heaviest rainfalls. This has been done at Onehunga and Epsom, both volcanic districts. Depth of wells, 8 feet, 20 feet, and 34 feet, filled to the top with large stones.

*The Weka.*

It is refreshing to find that some of our indigenous birds thrive under the altered circumstances produced by civilization. The weka or Maori hen is an instance; twenty years ago, it was a very rare bird in the wooded districts north of Waikato. In the clearings of Waiuku and Pukekoke its evening cries show that though seldom seen the bird is plentiful. Twice I have lately heard one at Remuera. I do not know the habits of the bird, but it seems to follow settlement.

4. "On the Percentage of Citric Acid obtained from Limes grown in Auckland and Tahiti," by J. A. Pond. (*Transactions*, p. 405).

5. "Translation of the Maori Tradition of Maui," by F. E. Maning.

6. "On the Shore of the Unknown," by E. A. Mackechnie.

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Annual General Meeting. 21*st February*, 1882.

T. Peacock, President, in the chair.

The minutes of the last general meeting were read and confirmed.

ABSTRACT OF ANNUAL REPORT.

The number of members now on the the roll of the Society is 302, 48 new members having been elected, while 3 members have died, and 20 members have withdrawn.

Six ordinary meetings of the Society have been held, at which 26 papers have been read. The progress of the Museum has been highly satisfactory, and many valuable donations have been made to the collections. The expense of maintaining the Museum for the recreation and instruction of the Auckland public is wholly borne by the Society, and involves a very heavy charge on its funds.

Library.—During the year a catalogue of the library has been compiled and printed, and is now ready for distribution to the members. The usual grant under the Public Libraries Subsidies Act not having been voted by Parliament, the Council have been unable to make any addition of importance to the library themselves. They have, however, to express their indebtedness to Mr. J. T. Mackelvie for a most welcome and appropriate donation of 104 volumes relating to the early history of the colony. Mr. Mackelvie could hardly have forwarded a more useful addition, or one more likely to prove permanently valuable.

The balance sheet showed the receipts to be £513 1s. 5d., including a balance of £10 1s. 1d. carried forward from last account. The expenditure has been £503 6s. 4d., distributed as follows:—Library, £38; maintenance of Museum, including salaries, £350; ordinary expenses of the Society, £85.

Election of Officers for 1882:—*President*—E. A. Mackechnie; *Council*—G. Aickin, J. M. Clark, Rt. Rev. W. G. Cowie, D.D., His Honour Mr. Justice Gillies, Hon. Colonel Haultain, Neil Heath, J. Martin, F.G.S., T. Peacock, J. A. Pond, Rev. A. G. Purchas, M.R.C.S.E., S. Percy Smith, F.R.G.S.; *Auditor*—T. Macffarlane; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S.

# PHILOSOPHICAL INSTITUTE OF CANTERBURY.

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First Meeting. *2nd March*, 1881.

R. W. Fereday, Vice-President, in the chair.

1. "Description of a new Native Violet," by J. B. Armstrong. (*Transactions*, p. 360).

2. "Description of a new *Asplenium*," by J. B. Armstrong. (*Transactions*, p. 361).

3. "Description of a new Species of *Asperula*," by J. B. Armstrong. (*Transactions*, p. 359).

4. "Notes on the Anatomy of the Bitentaculate Slugs of New Zealand," by Professor F. W. Hutton. (*Transactions*, p. 158).

5. Professor F. W. Hutton made some interesting remarks on the Californian Salmon, showing the difference which existed between it and the European species.

6. A discussion also took place on the fertilization of red clover, which was taken part in by the Chairman, Professor Hutton, Messrs. Kirk and Armstrong.

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Second Meeting. *7th April*, 1881.

Professor J. von Haast, President, in the chair.

*New Member*.—E. Ford.

1. "Notes on some Pulmonate Mollusca," by Professor F. W. Hutton. (*Transactions*, p. 150).

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Third Meeting. *5th May*, 1881.

R. W. Fereday, Vice-President, in the chair.

*New Members*.—C. Chilton, C. W. Purnell.

1. "Notes on Refrigeration," by Professor A. W. Bickerton. (*Transactions*, p. 394).

2. Professor F. W. Hutton exhibited specimens of a marine spider, *Desis robsoni*, and the vegetable caterpillar.

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Fourth Meeting. *2nd June*, 1881.

Professor J. von Haast, President, in the chair.

1. "On the Reclamation of Waste River Beds," by A. D. Dobson. (*Transactions*, p. 100).

2. "Notes on some Pulmonate Mollusca," (Paper ii.) by Professor F. W. Hutton. (*Transactions*, p. 150).

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Fifth Meeting. 16*th June*, 1881.

The President delivered the anniversary address, being an account of the "Origin and Early History of the Canterbury Museum." (*Transactions*, p. 503).

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Sixth Meeting. 7*th July*, 1881.

Professor J. von Haast, President, in the chair.

*New Members.*—Dr. Wilkins, Rev. J. Westbrooke, T. Miller, S. H. Seager, F. Jones.

1. "Notes on some Branchiate Mollusca," by Professor F. W. Hutton. (*Transactions*, p. 162).

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Seventh Meeting. 4*th August*, 1881.

Professor J. von Haast, President, in the chair.

1. "Zoological Researches on the Chicken Islands, East Coast of New Zealand," by Andreas Reischek. (*Transactions*, p. 274).

2. "Further Notes on the Thermal Springs of the Hanmer Plains," by Professor J. von Haast. (*Transactions*, p. 414).

3. "On the Identity of *Amphicampa* with *Himantidium*, and Description of a new Species," by J. Inglis. (*Transactions*, p. 358).

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Eighth Meeting. 1*st September*, 1881.

Professor J. von Haast, President, in the chair.

*New Members.*—T. Kirby, G. Hogben, J. L. Scott.

1. Further Notes on *Coccidæ* in New Zealand, with Descriptions of new Species," by W. M. Maskell. (*Transactions*, p. 215).

2. "Notes on the Height of Mount Cook," by C. W. Adams. (*Transactions*, p. 106).

Professor F. W. Hutton was elected Vice-President in the place of Rev. J. W. Stack, resigned.

Drawings of rock paintings from South Africa were exhibited by the President.

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NINTH MEETING. *6th October*, 1881.

R. W. Fereday, Vice-President, in the chair.

*New Member.*—C. H. Bridge.

1. "On the Freshwater Bivalve Shells of New Zealand," by Professor F. W. Hutton. (*Transactions*, p. 148).

2. "Additions to the New Zealand Crustacea," by Charles Chilton, B.A. (*Transactions*, p. 171).

3. "On the Preparation of Spontaneously Inflammable Phosphine," by T. A. Mollet. (*Transactions*, p. 391).

4. "On a new Form of Burette," by T. A. Mollet. (*Transactions*, p. 392).

5. "Remarks on the Carved Stone Bird, named Korotangi by the Maoris," by Professor J. von Haast. (*Transactions*, p. 104).

6. "On a new Species of *Pleurosigma*," by J. Inglis. (*Transactions*, p. 359).

7. "On Vertical Triangulation," by C. W. Adams. (*Transactions*, p. 105).

8. Specimens of the large scale insects "*Icerya purchasi*," were exhibited by Mr. W. M. Maskell.

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ANNUAL MEETING. *3rd November*, 1881.

Professor J. von Haast, President, in the chair.

*New Members.*—Fred. Barkas, B. K. S. Laurence, Rev. J. Buller.

1. "On some Subterranean Crustacea," by C. Chilton. (*Transactions*, p. 174).

2. "On the New Zealand *Hydrobiinæ*," by Professor F. W. Hutton. (*Transactions*, p. 143).

3. "On a new Genus of *Rissoinæ*," by Professor F. W. Hutton. (*Transactions*, p. 147).

ABSTRACT OF ANNUAL REPORT.

Nine ordinary and one special meetings have been held, at which twenty-eight papers were read. These were contributed by thirteen members, and comprise fourteen on Zoology, nine on Miscellaneous subjects, three on Botany, and two on Chemistry. A detailed list of these papers is appended to this report.

In addition to the ordinary meetings of the Institute, the Council, as in the last few years, established a series of popular scientific lectures. The attendance at these was fair, but not such as might be desired. The lectures delivered were as follows:—(1) On Instinct, by Professor F. W. Hutton; (2) on the Construction of the Telescope, by Prof. C. H. H. Cook; (3) on the Immortality of the Cosmos, by Professor A. W. Bickerton; (4) on the Origin and Progress of the Canterbury Museum, by Professor J. von. Haast; (5) on the Recent Progress of Electric Science, by Professor Bickerton; (6) on the Ventilation of Buildings, by Mr. T. S. Lambert.

Sixteen new members have been elected during the year, making the number on the books at the present time 199.

Through the liberality of the Board of Governors of Canterbury College, arrangements have been made by which the Library of the Institute has been placed in a separate room, rendering it more convenient for the purpose of study. The Library is now open for the issue of books every Saturday evening from 7 to 9, and members requiring books at other times can obtain the same on application to the sub-librarian.

The donations of the year comprise twenty-two works which have been placed in the Library, and also three valuable type collections of microscopic objects:—one of New Zealand Polyzoa, presented by Professor F. W. Hutton; one of New Zealand Coccidæ, and one of New Zealand Desmidieæ, the last two presented by Mr. W. M. Maskell. A detailed list of the donations is appended to this report.

The report of the microscopical section shows favourable work during the year, and the Council would take this opportunity of drawing the attention of members to the facilities which are given for work by the establishment of sections, and expresses the hope that next year will find some of the other sections doing as good work as the microscopical. The report of the microscopical section is as follows:

The Microscopical section has held a number of meetings since the begining of the session; on an average two in each month. Numerous preparations connected with the work undertaken by various members have been exhibited at these meetings, chiefly in the following branches of Science:—

*Zoology.*—Mollusca, Crustacea, Homoptera, Rotifera.

*Botany.*—Freshwater Algæ, principally Diatomaceæ, and Desmidieæ.

Several new genera and species of the above have been investigated, and papers thereon have been submitted to the Institute. Other papers embodying original research are in course of preparation.

In accordance with the rule of the Institute, which directs that it shall devote one-third of its annual revenue to the formation or support of some public library or museum, the Council has, in lieu of such contributions for the year 1880, purchased and presented to the Canterbury Museum the series of imitation ivories issued by the Arundel Society of London.

The Honourable W. Rolleston has been chosen by the Council to represent the Institute at the annual election of the Board of Governors of the New Zealand Institute.

The Council recommends Professor Alphonse Milne-Edwards, of Paris, as an honorary member of the New Zealand Institute, in consideration of his scientific eminence.

The Honorary Treasurer submits the balance-sheet of accounts for the year, showing a balance in hand of £25 5s. 2d.; the receipts having been £193 16s. 3d., inclusive of a balance from last year of £7 6s. 9d., and the expenditure on books and collections, £168 9s. 1d.

Election of Officers for 1882.—*President*—Professor J. von Haast; *Vice-presidents*—R. W. Fereday, Professor F. W. Hutton; *Hon. Secretary*—G. Gray; *Hon. Treasurer*—W. M. Maskell; *Council*—E. Dobson, J. Inglis, Professor A. W. Bickerton, T. Crook, T. S. Lambert, H. R. Webb; *Auditors*—C. R. Blakiston, W. D. Carruthers.

# OTAGO INSTITUTE.

FIRST MEETING. *6th April*, 1881.

Dr. Hocken, Vice-President, in the chair.

*New Member.*—David White.

1. Professor Parker exhibited and made remarks upon the skin and skeleton of the Takahe (*Notornis mantelli*), the property of Mr. J. Connor, manager to Captain Hankinson, of Lynwood, Te Anau, where the bird was recently killed.

Mr. F. Chapman communicated some particulars as to the occurrence of *Notornis*, furnished to him by Mrs. Cameron, of Centre Island, Foveaux Strait. This lady stated that two specimens were killed and eaten by Maoris in 1878, who described them to her as resembling the pukeko, but of the size of a turkey. She had offered £20 for a specimen, but without success.

Dr. Hector said that as three specimens of the bird had now been obtained from widely separated localities, he thought it highly probable that others would be found. He mentioned having heard, in 1862, near the Matukituki River, a loud booming noise followed by a piercing shrill whistle, probably made by some large bird (possibly *Aptornis*). The noise had been heard again this year at the same place by one of his assistants.

2. Dr. Hector exhibited and made remark upon living specimens of the South Island tuatara (*Sphenodon güntheri*).

3. Professor Parker exhibited a simple form of dissecting microscope, made by Mr. Bourne, Assistant in the Museum.

4. "The Cause of Error in executing Minor Triangulation with Instruments of small Diameter," by J. Aitken Connell.

SECOND MEETING. *21st June*, 1881.

G. M. Thomson, President, in the chair.

*New Member.*—G. Anderson.

1. "The Birds of Macquarrie Island," by Professor Scott.

2. "On a new Species of *Cotula*," by D. Petrie. (*Transactions*, p. 362).

The President in commenting on this paper observed that the new species (*C. maniototo*) seemed to him to furnish a striking example of degeneration of structure.

3. "On a new Method of preserving Cartilaginous Skeletons and other soft Animal Structures," by Professor Parker. (*Transactions*, p. 258).

The paper was illustrated by skeletons of the Great Blue Shark (*Carcharodon*), Skate, etc., and intestine of skate, prepared by Mr. Jennings.

4. Professor Parker exhibited a model of the hypotrychous infusor, *Stylonichia mytilus*, made for the Museum by Mr. Bourne.

5. The President announced that the funds of the Institute had been augmented by the accession of three life-members, and remarked on the desirability of more members paying the life composition.

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Third Meeting. 19*th July*, 1881.

G. M. Thomson, President, in the chair.

*New Members.*—William Elder, Edmund Piper.

1. "On New *Carices*," by D. Petrie. (*Transactions*, p. 363).

2. "On the Development of the *Discomedusæ*," by Dr. Wilhelm Haacke.

Special attention was directed to Professor Häckel's recent discovery of the occasional occurrence of direct or abbreviated development in *Aurelia aurita.*

3. Professor Parker exhibited and remarked upon specimens of a species of *Saccharomyces* found in great quantity on the surface of tan-pits at Mornington, near Dunedin.

4. Professor Parker exhibited and made remarks upon sections of the stem of *Macrocystis*, showing sieve-tubes, like those of *Cucurbita.*

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Fourth Meeting. 30*th August*, 1881.

G. M. Thomson, President, in the chair.

1. "Electric Lighting," by R. Jones.

The lecture was copiously illustrated by apparatus and diagrams.

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Fifth Meeting. 21*st September*, 1881.

A. Montgomery, Vice-President, in the chair.

*New Member.*—William M. Cole.

1. Professor Parker exhibited two oil paintings of *Notornis*, coloured from the Te Anau specimen, recently executed by Miss F. M. Wimperis and Miss Maud McLaren, and presented to the Museum by the respective artists.

2. "On the Skeleton of *Notornis mantelli*," by Professor Parker. (*Transactions*, p. 245).

3. Professor Parker exhibited skeletons of the Trout and Barramunda (*Ceratodus forsteri)*, prepared for the Museum by Mr. Jennings, the cartilaginous parts being preserved by the glycerine jelly process.

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Sixth Meeting. 22*nd November*, 1881.

G. M. Thomson, President, in the chair.

1. "On a new *Carex*," by D. Petrie. (*Transactions*, p. 363).

2. "Additions to the Crustacean Fauna of New Zealand," by G. M. Thomson. (*Transactions*, p. 230).

3. "The Taieri Floods and their Prevention," by W. Arthur. (*Transactions*, p. 94).

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Annual Meeting. 31*st January*, 1882.

G. M. Thomson, President, in the chair.

1. "On the Origin of the New Zealand Flora" (Presidential address), by G. M. Thomson. (*Transactions*, p. 485).

2. Professor Parker exhibited skeletons of orang-utan, rabbit, crocodile, and iguana and skull of python, mounted for lecture purposes by Messrs. Jennings and Bourne; also skulls of Maori, male and female gorilla, and young orang, and skeleton of barracoota; all recent additions to the Museum.

ABSTRACT OF ANNUAL REPORT.

During the present session seven general meetings have been held, including the present annual meeting. Nine original papers have been read—four on zoological, three on botanical, and two on engineering and surveying subjects.

At two meetings lectures were delivered—one by Dr. W. Haacke, on the Development of Medusæ; the other by Mr. R. Jones, on Electric Lighting.

Five new members have joined the Institute during the year, bringing the total number of names on the roll to 223.

The number of important books purchased during the year has been so considerable as to necessitate a rearrangement of the library, which is now in progress. The Council desire to emphasise the fact, which seems to be largely lost sight of, that free use of the library is one of the privileges of membership.

The receipts of the year, including a balance of £12 8s. from last year, amount to £202 0s. 8d. The expenditure, amounting to £186 2s. 5d., includes £68 6s. 6d. for paying off the overdraft from the Union Bank of Australia. The usual payment to the Museum has, however, still to be made, and will have to be added to the year's expenditure. There is at present a clear balance in hand of £15 18s. 3d., besides which the reserve fund in the Post Office Savings Bank now amounts to £159 10s. 8d.

Election of Officers for 1882:—*President*—W. Arthur, C.E.; *Vice-presidents*—G. M. Thomson, F.L.S., G. Joachim; *Hon. Secretary*—Professor Parker; *Hon. Treasurer*—D. Petrie, M.A.; *Auditor*—D. Brent, M.A.; *Council*—Right Rev. Bishop Nevill, Rev. Dr. Roseby, Professor Mainwaring Brown, Professor Scott, W. N. Blair, C.E., A. Montgomery, R. Gillies, F.L.S.

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# HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

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Annual General Meeting. *7th February*, 1881.

The Right Rev. the Bishop of Waiapu, President, in the chair.

Election of Officers for 1881:—*President*—The Right Rev. the Bishop of Waiapu; *Vice-president*—E. H. Bold, C.E.; *Hon. Secretary* and *Treasurer*—W. Colenso; *Council*—Messrs. Baker, Carlile, Colenso, Locke, Spencer, Sturm, and Weber; *Auditor*—T. K. Newton.

ABSTRACT OF ANNUAL REPORT.

During the past winter session six ordinary meetings were held, at which nine papers prepared by members were read.

The number of members is 85, being an increase of 7 on the number of the previous year; but, in reality, the increase is 16, as three of the members whose names were printed in the annual report of last year, have since died, and six others have also left the Hawke's Bay District, and therefore resigned.

Throughout the year some Zoological, Botanical, Palæontological, and Geological specimens have been collected by a few of the members of the Institute for the Museum.

Thirty volumes of valuable scientific works (mentioned in the last annual report as being ordered from England) have been received and are now in the library of the society, together with a few others obtained here in New Zealand, and another large lot, to the amount of £60, has lately been ordered from London.

A further sum of £3 18s. 6d. has been contributed towards defraying expenses of publication of the "Transactions of the New Zealand Institute."

The audited statement of accounts shows a balance of £200 5s. 2d. remaining to the credit of the society.

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First Ordinary Meeting. *9th May*, 1881.

Dr. Spencer, in the chair.

1. "Historical Incidents and Traditions of the Ancient Maoris of this East Coast, showing much of their habits, customs, and ways of thinking in the olden times—ages before they were first visited by Europeans," Part II., by W. Colenso, F.L.S. (*Transactions*, p. 3).

2. The Hon. Secretary also showed several interesting specimens of insects, and of plants (Cryptogams), lately collected by him in the Seventy-Mile Bush; also, a very large flat white bone, artificially shaped into something like the form (and size) of the blade of a garden spade, measuring, extreme length 16 inches, breadth (at its broadest end) 7 inches, and 4 lines in thickness, which is very uniform throughout; the broad end is bevelled

down to a cutting edge, and the sides are square. This bone was found last year in the forest, near to the public works on the railway line at Kopua, lying under 10–12 feet of earth. None of the old Maoris of to-day, who have seen it, know anything of it, or of its probable use. It seems to be made out of a bone of a whale, and is (here, at least) unique.

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### Second Ordinary Meeting. 13*th June*, 1881.

Mr. Bold, Vice-President, in the chair.

1. "Historical Incidents and Traditions of the Ancient Maoris of this East Coast, showing much of their habits, customs, and ways of thinking in the olden time,—ages before they were first visited by Europeans," Part III., by W. Colenso, F.L.S. (*Transactions*, p. 3).

This paper, being particularly curious, archaic and recondite, was largely elucidated by explanatory remarks, and also by drawings in the Journal of Sydney Parkinson, who was Sir Joseph Banks' draughtsman, and here in New Zealand with him in Cook's *first* voyage.

2. The Hon. Secretary exhibited an interesting collection of tertiary fossils (probably from both Upper and Lower Eocene), containing many species of the classes Coral and Bryozoa, collected by Mr. J. Stewart, of Takapau, in that neighbourhood; and also by Mr. Colenso, at Waipawa.

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### Third Ordinary Meeting. 11*th July*, 1881.

The Right Rev. the Bishop of Waiapu, President, in the chair.

1. "On the Microscopical Fresh-water *Algæ* of Napier and its neighbourhood," accompanied with drawings, by W. I. Spencer, M.R.C.S. (*Transactions*, p. 287).

2. Some new exhibits were shown by the Hon. Secretary; among them were (1) a handsome green moth, probably of the genus *Tatosoma*, and the largest specimen of that genus yet noticed; (2) some ancient Maori stone axes (or chisels) of a very small size, and possessing a very fine edge, found hidden, with some wooden fish-hooks, in a cave near the Tukituki River; and (3) a large stone axe, of a peculiar and rude shape (probably only partly formed, or the work of a ruder and older race than the present Maoris, or by themselves at an early age), found by Mr. William Chambers, of Poverty Bay, at the Bluff in Southland, New Zealand, while travelling in those parts; the stone, too, being different to any known North Island kind.

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### Fourth Ordinary Meeting. 8*th August*, 1881.

Mr. Bold, Vice-President, in the chair.

1. "Contributions towards a better Knowledge of the Maori Race," Part IV.,—on their legends, myths, *quasi*-religious ceremonies, and invocations concerning the *Kumara* plant,—by W. Colenso, F.L.S. (*Transactions*, p. 33).

A few curious and pleasing old manufactures of the Maoris were also shown, further exemplifying their skill, taste, patience, and perseverance (alluded to in the paper read), in various industrial works; including (1) a remarkably finely carved and ornamented sea fish-hook of the old Maoris, made out of human and moa bones, and inlaid with mother-of-pearl shell ; (2) specimens of the hand-made cords of the olden time: one kind, though small, being also closely bound round with a still finer one, after the fashion of the silver-string of a violin: and (3) a tobacco-pipe, bowl and stem in one piece, neatly cut out of a hard, close-grained, white stone (obtained in 1835).

2. Some novel Zoological specimens were also exhibited; among them were several fine spiders, dug up from a depth of 15-20 inches, in swampy soil, at Ongaonga by Mr. John Drummond, and kindly presented by him. This spider is allied to the trap-door spider of Otago (Trans. N.Z. Inst., vols. viii. and x.) but is quite distinct. A paper describing it and its habits was promised by the exhibitor, the Honorary Secretary, at a future meeting.

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Fifth Ordinary Meeting. 10*th October*, 1881.

The Right Rev. the Bishop of Waiapu, President, in the chair.

1. "On the fine Perception of Colours possessed by the Ancient Maoris," by W. Colenso, F.L.S. (*Transactions*, p. 49 and p. 477).

A long and animated discussion followed the reading of this paper, in which the President, Mr. Colenso, Mr. Locke, and others, took part, and Mr. Stack's views were generally opposed and condemned. (See Trans. N.Z.I., vol. xii.)

Several curious Maori exhibits were shown and explained by Mr. Locke, which had been recently dug up out of some old Maori graves at Poverty Bay, comprising several small bone manufactures of the olden time,—including a long needle with a nicely formed eye, and a remarkably well-cut comb, both made out of fine white bone; also, a few large sky-blue globular glass beads, believed by the Maoris of Poverty Bay to have been given to their forefathers by Captain Cook. All those small *curios* were in excellent preservation, and were very interesting. The *blue* beads in particular, obtained from the grave, seemed as if opportunely exhumed to bear their silent yet powerful testimony against the colour theories which had been alluded to this evening—*e.g.*, that the old Maoris did not know or could not perceive the *blue* colour.

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Sixth Ordinary Meeting. 14*th November*, 1881.

The Right Rev. the Bishop of Waiapu, President, in the chair.

1. "A Description of some New Zealand Plants new to Science,—of the Genera *Clematis*, *Parsonsia*, *Sarcochilus*, *Astelia*, *Polypodium*, *Plagiochila*, and *Gymnanthe*,—lately discovered," by W. Colenso, F.L.S. (*Transactions*, p. 329).

Besides the specimens of the plants described in his paper, many other Cryptogamic species, mostly of the orders *Musci* and *Hepaticæ*, and including several believed to be wholly new, also lately obtained from the Seventy-mile Bush, were likewise shown by the Hon. Secretary, together with some fine insects (chiefly *Coleoptera*), collected at Elms-

Hill, Patangata, by Mr. G. W. Tiffen, and at Ongaonga by Mr. J. Drummond; and also a very fine living green lizard (*Naultinus* sp.) from Mr. D. P. Balfour of Glenross. This fine reptile, nearly 8 inches in length, ran about the table.

2. "A Description of two New Zealand Shells, of the Genera *Unio* and *Patella*, discovered long ago, and though early described and published, yet believed to be but little known to science," by W. Colenso, F.L.S. (*Transactions*, p. 168).

Specimens of those shells in excellent preservation were shown; although they had been forty years in a cabinet they still possessed their natural colours. This species of variegated *Unio* is rare, and is believed to be by far the largest known of that genus in New Zealand.

3. Two fossil teeth of some unknown mammal, obtained from the depth of 117 feet in sinking an artesian well at Meeanee, were also exhibited by the Honorary Secretary. These, from the very great scarcity of remains of fossil mammalia in New Zealand, excited much interest; they are lower-jaw incisors, nearly 2 inches long, perfect, and in excellent preservation.

Specimens of both plants and shells were set apart as donations to the Colonial Museum at Wellington.

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Council Meeting. *4th October*, 1881.

The Right Rev. the Bishop of Waiapu, President, in the chair.

Captain W. R. Russell, M.H.R., was again chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with clause 7 of the New Zealand Institute Act.

During the past year eight meetings of the Council have been held, and 11 new members elected, viz.:—Rev. W. Goodyear, Dr. Langer Carey, Major D. Scannell, and Messrs J. N. Bowerman, J. H. Brown, J. Chambers, jun., W. J. Ellison, F. Grant, C. D. Kennedy, W. Rainbow, and G. Rearden, making a total of 96, from which number, however, 2 have to be deducted (1 death, and 1 having left New Zealand), leaving 94; to this have now to be added 13 new members, nominated and elected at the annual and Council meetings, held on the 6th February, viz., Hon. J. N. Wilson, and Messrs. H. J. Baker, H. A. Banner, N. E. Beamish, B. Glass, P. Gow, R. C. Harding, E. W. Knowles, P. S. McLean, E. Moorhouse, R. Price, E. D. Tanner, and J. H. Vautier, making a present total of 107 members.

It was also resolved,—That steps should be taken forthwith to procure for the Society the permanent use of a suitable room, either by lease or by building, in which to keep their Library and Museum, and to hold their meetings; and that the Hon. Secretary be empowered to write to the Committee of the Athenæum on the matter.

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# SOUTHLAND INSTITUTE.

First Meeting. 11*th May*, 1881.

J. T. Thomson, F.R.G.S., President, in the chair.

*New Members*.—Dr. Grigor, J. W. Martin, G. Blanchflower, P. T. Finn, John Mchaffey, George Hardie, John Brown, F. Drabble, Captain T. Thomson.

1. The President delivered an address on "Recent Advances in Science."

ABSTRACT.

In commencing another session it appears to be appropriate that I should say a few words to you regarding subjects that affect us. In this remote part of the world, though we have not the privileges of such men as pursue science in old countries in their great opportunities for elaboration, differentiation, and generalization, yet we have an almost virgin field for exploration and research. Peculiarly to this district belong the unpenetrated great western snowy mountains, whose southern peaks are in sight of us on clear days; and the time will yet come, when this, as the nearest point of departure, will be made a base of operations for unravelling the mysteries of the great antarctic continent—as yet only once sighted by one of Britain's most celebrated navigators. It is not unlikely that the coast seen by Sir James Ross in 1848 will be made a station for the observation of the coming transit of Venus which will take place next year.

Our first session of last year we cannot put down as a barren one, several papers of interest having been read before the Institute, and the good attendance at our meetings was a proof that the subjects discussed were not without appreciation. The *conversazione* which terminated the session was eminently successful both in regard to attendance and the number of objects exhibited.

The President then gave an interesting review of the more interesting additions to scientific literature which had been recently made, touching on the discovery of the photophone, the voyage of the "Challenger," the latest work with the spectroscope, and the exploration of New Guinea by D'Albertis, as discussed by Wallace. He concluded by stating that many other subjects take up the attention of men of science at this present time—subjects affecting the health, physically as well as morally, of mankind. If probers and enquirers of these efforts be not at all times successful, or if their conclusions be not always agreeable to sections of society, yet the advantage of free scope is one much to be appreciated, and in our peculiar locality we need fear no influences when our object is honourable and humane.

The President then mentioned many other objects which are now engaging scientific attention, many of which, he said, have peculiar interest here, and which are open to the members to study and cultivate.

2. "On a Source of Water Supply for Invercargill," by J. R. Cuthbertson. (*Transactions*, p. 121).

Second Meeting. *3rd June*, 1881.

Dr. Galbraith, Vice-president, in the chair.

*New Members.*—Dr. Blair, Roderick McLeod.

1. "Buddhistic Philosophy," by J. T. Thomson.

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Third Meeting. *19th August*, 1881.

J. T. Thomson, President, in the chair.

*New Members.*—Robert Aitkin, Andrew Young, John Anderson, J. T. Martin, Rev. — Fairclough, W. Robertson, W. G. Dunsford, Geo. Joachim.

1. On "The Habits of Ants," by the Rev. James Paterson.

1. On "The Formation of Lake Wakatipu," by Wm. Stuart. (*Transactions*, p. 407).

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Fourth Meeting. *20th September*, 1881.

J. T. Thomson, President, in the chair.

*New Member.*—D. S. Stewart.

1. "On the Conversion and Civilization of the Maoris in the South of New Zealand," by the Rev. J. F. H. Wohlers. (*Transactions*, p. 123).

2. "On the Importance of Forestry," by D. McArthur.

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Fifth Meeting. *11th October*, 1881.

J. T. Thomson, President, in the chair.

1. "On Co-operation," by J. R. Cuthbertson.

2. "On Burns," by W. G. Mchaffey.

Election of Officers for 1882:—*President*—J. T. Thomson, F.R.G.S.; *Vice-President*—W. S. Hamilton; *Hon. Treasurer*—J. C. Thomson; *Hon. Secretary*—P. Goyen; *Council*—Dr. Galbraith, T. Denniston, W. B. Scandrett, — Robertson, W. G. Mchaffey.

ANNUAL REPORT.

During the year 19 new members were elected. The total membership is now 65, and of these one, Mr. Geo. Joachim, is a life member. The Council considered it due to Mr. Joachim to elect him to life membership for his handsome present of 18 volumes of the "Monthly Microscopical Journal." These volumes are very elegantly bound, and constitute a very valuable addition to the Institute's library. In accordance with Rule 7, £30 has been spent in new books and a series of mineralogical and geological specimens.

During the year five meetings were held and eight papers read. Considering the youth of the Society, the Council thinks a fair amount of work has been done. The balance-sheet shows that the receipts for the year (including a balance from last year) were £78 5s. 3d., and the expenditure £55 15s. 4d. To this expenditure should be added one or two small accounts, not yet rendered.

# APPENDIX.

COMPARATIVE ABSTRACT for 1881 and previous Years.

| STATIONS. | Barometer. | | Temperature from Self-registering Instruments read in Morning for Twenty-four Hours previously. | | | | | Computed from Observations. | | Rain. | | Wind. | | Cloud. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean. Reading. | Extreme Range. | Mean Temp. in Shade. | Mean Daily Range of Temp. | Extreme Range of Temp. | Max. Temp. in Sun's Rays. | Min. Temp. on Grass. | Mean Elastic Force of Vapour. | Mean Degree of Moisture. (Saturation=100) | Total Fall in inches. | No. of Days on which Rain fell. | Average Daily Force in Miles for Year. | Maximum Velocity in Miles in any 24 Hours, and Date. | Mean Amount (0 to 10). |
| Auckland .. .. .. | 30·000 | 1·254 | 59·6 | 14·6 | 50·7 | 150·0 | — | ·388 | 75 | 34·237 | 178 | — | — | 6·4 |
| Previous 17 years | 29·952 | — | 59·4 | — | — | — | — | ·405 | 77 | 43·706 | 189 | — | — | — |
| Wellington .. .. | 29·965 | 1·468 | 55·9 | 12·3 | 46·0 | 150·0 | 28·0 | ·356 | 79 | 50·132 | 137 | 201 | 570—26 May | 5·0 |
| Previous 17 years | 29·909 | — | 54·8 | — | — | — | — | ·335 | 72 | 51·888 | 160 | — | — | — |
| Dunedin .. .. .. | 30·067 | 1·581 | 52·0 | 14·4 | 55·0 | — | — | ·289 | 74 | 26·412 | 170 | 137 | 530—3 June | 6·1 |
| Previous 17 years | 29·820 | — | 50·4 | — | — | — | — | ·279 | 74 | 35·158 | 162 | — | — | — |

AVERAGE TEMPERATURE OF SEASONS, compared with those of the previous year.

| STATIONS. | SPRING. September, October, November. | | SUMMER. December, January, February. | | AUTUMN. March, April, May. | | WINTER. June, July, August. | |
|---|---|---|---|---|---|---|---|---|
| | 1880. | 1881. | 1880. | 1881. | 1880. | 1881. | 1880. | 1881. |
| Auckland .. .. | 58·1 | 58·0 | 67·0 | 65.2 | 62·9 | 61·9 | 52·3 | 53·4 |
| Wellington .. .. | 55·7 | 54·4 | 62·9 | 61·6 | 57·7 | 58·3 | 48·8 | 49·4 |
| Dunedin .. .. | 52·3 | 51·2 | 57·6 | 57·3 | 53·1 | 54·1 | 45·0 | 45·4 |

## NOTES ON THE WEATHER DURING 1881.

January.—Fine weather, small rainfall and moderate winds; temperature rather below average. Earthquake occurred at Wellington on 3rd, at 8.30 a.m., slight.

February.—Remarkably fine throughout; at times very hot; temperature in excess of average, and very small rainfall; light winds.

March.—Very warm and fine weather experienced; little rain, generally clear and bright, and moderate winds. Meteor observed in North on 27th.

April.—Fine weather, with little rain, except in the South, where it was rather in excess. Temperature above the average, and high barometer. Winds moderate and variable. On the 8th, at Castle Hill, Canterbury, smart shock of earthquake reported at 6.45 p.m.

May.—Fine weather throughout, rain below average and temperature above; barometric pressure high. Winds moderate from N.W. and S.W. Thunder at times. On 6th smart shock of earthquake reported at Castle Hill, Canterbury, at 6.45 p.m.; also on 14th, same place, at 11 p.m., slight; and 22nd, 23rd, and 24th, in Nelson District.

June.—This has been a wet stormy month throughout; rainfall considerably over the average. A rather severe earthquake was experienced throughout the colony, on the 26th about 5.25 a.m., followed by slight movements up to morning of 27th; another shock was felt on 29th, but slight.

July.—Early part of month generally fine, wind northerly, but latter part showery, very heavy rain occurring at Wellington; wind chiefly S.W. during this period; temperature in excess of average; earthquake at Wellington on 6th, at 5.15 a.m., and 12th, at 2.51 a.m., both slight.

August.—Showery and rather squally weather experienced; wind chiefly S.W.; rainfall slightly in excess, and temperature above the average, not severe for the time of year; earthquake on 8th, at Wellington, at 10.25 a.m., very slight.

September.—On the whole fine mild weather, with moderate rainfall, at times sudden changes from N.W. to S.E., bringing rain, wind, hail, and slight thunder, but no severe gales were experienced. Earthquake at Wellington on 1st, at 2.25 a.m., smart; on 14th, at 7.30 a.m., slight; and on 15th, at 7.37 p.m., very slight.

October.—Fine weather, with moderate N.W. and S.W. winds, and small rainfall.

November.—Except in the north the rainfall has been under the average and the weather on the whole fine, with moderate S.W. and W. winds prevailing.

December.—On the whole a wet month, with at times strong winds, chiefly from S.W. and N.W., and occasional thunder. Earthquakes occurred at Wellington on 3rd at 6.30 a.m., slight; on 23rd at 7.13 a.m. and 10.54 p.m., E. to W., slight; and 31st at 1 p.m., slight; at Lincoln on 5th at 7.37 a.m., on 6th at 5.6 a.m., and 9th at 5 22 a.m., all slight; at Dunedin a slight shock on 5th.

EARTHQUAKES reported in NEW ZEALAND during 1881.

| Place. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wellington | 3 | .. | .. | .. | .. | .. | 6, 12 | 8 | 1*, 14 15 | .. | .. | 3, 23, 31 |
| Canterbury Castle Hill | .. | .. | .. | 8* | 6*, 14 | .. | .. | .. | .. | .. | .. | .. |
| Nelson | .. | .. | .. | .. | 22, 23, 24 | .. | .. | .. | .. | .. | .. | .. |
| Lincoln | .. | .. | .. | .. | 27, 29 | .. | .. | .. | .. | .. | .. | 5, 6, 9 |
| Dunedin | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 5 |
| Both Islands | .. | .. | .. | .. | .. | 26†, 27, 29 | .. | .. | .. | .. | .. | .. |

The figures denote the days of the month on which one or more shocks were felt. Those with an asterisk were *sharp*, and those with a dagger *severe*. The remainder were only slight tremors, and no doubt escaped notice at most stations, there being no instrumental means employed for their detection. These tables are therefore not reliable so far as indicating the geographical distribution of the shocks.

## NEW ZEALAND INSTITUTE.

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1870.

Drury, Rr.-Admiral Byron, R.N.
Finsch, Otto, Ph.D., of Bremen
Flower, W. H., F.R.S., F.R.C.S.
Hochstetter, Dr. Ferdinand von
Hooker, Sir J. D., K.C.S.I., C.B., M.D., F.R.S.
Mueller, Baron Ferdinand von, C.M.G., M.D., F.R.S.
Owen, Richard, C.B., D.C.L., F.R.S.
Richards, Vice-Admiral Sir G. H., C.B., F.R.S.

1871.

Darwin, Charles, M.A., F.R.S.

1872.

Grey, Sir George, K.C.B., D.C.L.
Huxley, Thomas H., LL.D., F.R.S.
Stokes, Vice-Admiral J. L.

1873.

Bowen, Sir Geo. Ferguson, G.C.M.G.
Cambridge, The Rev. O. Pickard, M.A., C.M.Z.S.
Günther, A., M.D., M.A., Ph.D., F.R.S.

1874.

McLachlan, Robert, F.L.S.
Newton, Alfred, F.R.S.

1875.

Filhol, Dr.
Sclater, Philip Lutley, M.A., Ph.D., F.R.S.

1876.

Etheridge, Prof. Robert, F.R.S.
Berggren, Dr. S.

1877.

Weld, Frederick A., C.M.G.
Baird, Prof. Spencer F.
Sharp, Dr. D.

1878.

Müller, Prof. Max, F.R.S.
Tenison-Woods, Rev. J. E., F.L.S.
Garrod, Prof. A. H., F.R.S.

1880.

The Most Noble the Marquis of Normanby, G.C.M.G.

### ORDINARY MEMBERS.

1880-1.

[* Life Members.]

#### WELLINGTON PHILOSOPHICAL SOCIETY.

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Allen, F.
Allen, G.
Andrew, Rev. J. C. Wairarapa
Ashcroft, G.
Baillie, Hon. Capt. W. D. H.
Baird, J. D., C.E.
Baker, Arthur

Baker, C. A.
Baker, Ebenezer
Baker, J. E.
Ballance, Hon. John, M.H.R.
Bannatyne, W. M.
Barleyman, John, New Plymouth
Barraud, Noel
Barron, C. C. N.
Barton, Elliot L'Estrange
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Batkin, C. T.
Beetham, G., M.H.R.
Beetham, W., sen., Hutt
Bell, H. D.
Benzoni, C. T.
Berry, Wm.
Best, E., Gisborne
Betts, F. M., Wanganui
Bidwell, C. R., Wairarapa
Binns, G. J.
Birch, A. S.
Blackett, J., C.E.
Blundell, Henry
Bold, E. H., C.E., Napier
Borlase, C. H., Wanganui
Bothamley, A. T.
Braithwaite, A., Hutt
Brandon, A. de B., jun.
Brett, Hon. Col. de Renzie J.
Brewer, H. M., Wanganui
Brogden, James
Browne, Dominick
Brown, J.
Brown, W. R. E.
Buchanan, John, F.L.S.
Buchanan, T.
Bull, Frederick
Bull, James, Rangitikei
Buller, W. L., C.M.G., D. Sc., F.R.S.
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Burne, J.
Calders, Hugh, Wanganui
Callis, C.
Carkeek, Morgan
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Chapman, Martin
Chaytor, Brian Tunstall
Cherrett, J. J.
Chesnais, Rev. La Menant des
Chudleigh, E. R.
Clarke, Henry T.
Climie, Daniel, C.E.
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Coleridge, John Newton, C.E.
Collins, A. S., Nelson
Collins, Dr. H.E.C.
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Cutten, H.
Crawford, J. C., F.G.S.
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Diver, Dr.
Dobson, A., C.E.
Dransfield, J.
Drew, S. H., Wanganui
Drury, G.
Duigan, J., Wanganui
Edwards, —
Edwin, R. A., Commander, R.N.
Fearnley, M., Nelson
Ferard, B. A., Napier
Field, H. C., Wanganui
Field, E. P.
Feilding, Hon. Col. Wm., London
FitzGerald, William
Fitzherbert, H. S.
Fox, E.
Fox, J. G.
Fox, Hon. Sir W., K.C.M.G.
France, Charles, M.R.C.S.E.
France, W.
Frankland, F. W.
Fraser, The Hon. Capt., F.R.G.S., Dunedin
Fuller, T. E.
Gaby, Herbert
George, J. R., C.E.
Gerse, J. I., Wanganui
Gibson, —
Gillespie, C.
Gillon, Dr. G. Gore
Gore, R. B.
Gould, George, Christchurch
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Gower, J. W., Rangitikei
Grace, The Hon. M. S., M.D.
Graham, C. C.
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Hamilton, A.
Hardy, C. J., B.A.

Harris, J. Chantrey
Harrison, C. J.
Hart, The Hon. Robert
Hawkins, R. S., Masterton
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Heaps, Wilson
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Henley, J. W.
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Hodge, Matthew Vere, Wanganui
Hogg, Allen, Wanganui
Holdsworth, J. G.
*Holmes, R. L., F.M.S., Fiji
Holmes, R. T.
Holmes, W. H.
Hood, T. Cockburn, F.G.S., Waikato
Hulke, Charles, Wanganui
Hurley, J.
Hurst, James
Hutchison, W., M.H.R.
Inwood, D., Canterbury
Jackson, H., F.R.G.S., Hutt
Jebson, John, Canterbury
*Johnson, The Hon. G. Randall
Johnston, The Hon. John
Joseph, Joseph
Kebbell, Mrs. J.
Kenny, Captain Courtenay, M.H.R.
Kerr, Alexander, F.R.G.S.
King, T.
King, Dr. T. R.
Kirk, Thomas, F.L.S.
Kirk, T. W.
Knight, Charles, F.R.C.S., F.L.S.
Knight, C. G.
Knorpp, C. P., A.I.C.E.
Knowles, J.
Krull, F. A.
Larcombe, E.
Leckie, Colonel
Lee, J. E., Napier
Lee, R.
Levin, W. H., M.H.R.
Lidbetter, T.
Locke, Samuel, Napier
Logan, H. F.
Lomax, H. A., Wanganui
Lowe, E. W.
Luckie, D. M.
Macdermott, W. C.
Macdonald, W. C.
Macdonald, T. Kennedy
McKay, Alexander
MacKellar, H. S.
McKenzie, Thomas
McKenzie, James
McLennan, J., Manawatu
Macklin, H. P., Blenheim
McTavish, A.
McWilliam, Rev. W., Otaki
Maginnity, A. T., M.S.T.E.
Mantell, The Hon. W. B. D., F.G.S.
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Marchant, N.
Martin, J.
Mason, Thomas, Hutt
Maunsell, D.
Maxwell, J. P., A.I.C.E.
Mills, E. W.
Mills, D.
Moffitt, J. L.
Monaghan, C.
Monteith, J.
Moore, F. G.
Moorhouse, W. S., M.H.R.
Moreton, Gilles
Mowbray, W.
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Nathan, J. E.
Nation, George Michell
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Newman, A. K., M.B., M.R.C.P.
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Nicholl, Charles
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Pharazyn, The Hon. C. J.
Pharazyn, R., F.R.G.S., Wanganui
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Potts, T. H., F.L.S., Lyttelton
Powles, C. P.
Pownall, C. P.
Prendergast, His Honour J., Chief Justice
Prenderville, J. S.
Rawson, H. P.
Rees, J. R., M.I.C.E., New Plymouth
Reid, J. S.

Reid, W. S.
Richardson, C. T.
Richmond, His Honour Mr. Justice
Richmond, F. C.
Robson, Charles Hepburn
Rockstrow, Dr., Foxton
Rotherham, F. F., Wanganui
Rowan, Captain T. C.
Rowband, A.
Rutherfurd, W. G.
Samuels, W. R. G., M.R.C.S.E., F.A.S., San Francisco
Sauzeau, Rev. Father A. M. J., Blenheim
Saxby, Gordon
Saxton, H. W., New Plymouth
Seymour, A. P., M.H.R.
Sherwood, G. F., Patea
Simcox, W. H., Otaki
Skey, W.
Smith, Allison D., Christchurch
Smith, Benjamin
Smith, Charles, Wanganui
Somerville, A. F.
Stafford, Edward
Stewart, J. T., Manawatu
Stuart, A. P.
Thistle, W. B., B.A.
Tod, Andrew, Wanganui
Toomath, Edward
Toulson, R. G.
Toxward, C. J.
Travers, H. H.
Travers, W. T. L., F.L.S.
Triggs, W. H.
Tronson, F. H.
Tuckey, H. E., B.A.
Turnbull, Thomas
Turnbull, E.
Waite, H. W., Palmerston
Wakefield, O.
Walker, Capt. Campbell, F.R.G.S.
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