TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE

1880.

VOL. XIII.

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

BY

JAMES HECTOR, C.M.G., M.D., F.R.S.

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PREFACE.

THE Editor desires to acknowledge the assistance received from Mr. Buchanan, of the Geological Survey Department, and from the officers of the Lithographic Department, in the production of the plates.

He also wishes to say that, in all but a few instances, a marked improvement has taken place in the character of the manuscript, which has greatly facilitated the printing of the work.

ADDENDA ET CORRIGENDA.

PAGE

8, line 21, *for* esculenta *read* esculentum
10, line 11, *for* stove *read* store
12, line 7, *for* tubes *read* tubers
last line, *for* Dow *read* Don
20, line 11 from bottom, *for* Tate *read* Yate
36, line 16 ,, ,, *for* Pongo *read* Pongi
48, line 6, *after* Koherearuhe *insert* = the mass of pounded fernroot: its meaning signifying preparation for war.
60, last line, *for* 46 *read* 44
65, line 18 from bottom, *for* friend *read* fiend
112, line 9 from bottom, *for* exudes *read* extrudes
,, line 8 ,, *for* Animalcula *read* Animalcule
115, line 11, *for* seplicum *read* septicum
,, line 8 from bottom, *for* exude *read* extrude
,, line 7 ,, *for* peplic *read* peptic
177, line 12, *for* Edchaig *read* Eachaig
182, line 3, *for* sinuous, margin and *read* sinuous margin, and
211, line 8 from bottom, *for* Copper *read* Cooper
324, line 10, *for* gravels *read* grasses
,, line 8 from bottom, *for* others *read* other
365, line 2 ,, *for* noma *read* nana
368, line 12 ,, *for* Bæoniyces *read* Bæomyces
369, line 3 ,, *for* constaceous *read* crustaceous
376, line 5 ,, *for* com- *read* compound
380, line 7 and 10, *for* brisily *read* bristly
381, line 15 from bottom, *for* habitat *read* habit
,, line 2 ,, *for* hair, *read* thin
399, line 2, *for* Ruapepu *read* Ruapehu
,, line 6, *for* latter *read* later
,, line 9, *for* traditions *read* traditional
406, line 12, *for* surface and geologists' *read* surface geologist's
,, line 7 from bottom, *for* pressure *read* presence
407, line 13 ,, *for* Opotiki Cliffs, which *read* Opotiki. Cliffs which

CONTENTS.

TRANSACTIONS.

I.—Miscellaneous.

II.—Zoology.

III.—Botany.

PROCEEDINGS.

NEW ZEALAND INSTITUTE.

WELLINGTON PHILOSOPHICAL SOCIETY.

AUCKLAND INSTITUTE.

A

SOUTHLAND INSTITUTE.

LIST OF PLATES.

NEW ZEALAND INSTITUTE.

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

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 INCORPARATED 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.

WELLINGTON PHILOSOPHICAL SOCIETY.

Office-bearers for 1880 :—*President*—Martin Chapman ; *Vice-presidents*—Dr. Hector, C.M.G., F.R.S., Dr. Buller, C.M.G., F.R.S. ; *Council*—F. W. Frankland, S. H. Cox, F.G.S., F.C.S., Hon. G. Randall Johnson, M.L.C., 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. ; *Auditor*—Arthur Baker ; *Secretary and Treasurer*—B. B. Gore.

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. N. Bannatyne ;—*Secretary and Treasurer*—R. B. Gore.

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.

AUCKLAND INSTITUTE.

Office-bearers for 1880 :—*President*—F. D. Fenton ; *Council*—G. Aickin, Rev. J. Bates, J. L. Campbell, M.D., J. C. Firth, Hon. Colonel Haultain, Neil Heath, F.G.S., E. A. Mackechnie, J. A. Pond, Rev. Dr. Purchas, J. Stewart, M. Inst. C.E., S. P. Smith ; *Auditor*—T. Macffarlane ; *Secretary* and *Treasurer*—T. F. Cheeseman, F.L.S.

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. Machechnie, 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.

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 balloted 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.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Office-bearers for 1880:—*President*—E. Dobson, C.E.; *Vice-presidents*—Professor Julius von Haast, F.R.S., the Rev. J. W. Stack; *Council*—Professer Bickerton, R. W. Fereday, J. Inglis, A. D. Dobson, G. Gray, J. S. Lambert; *Hon. Treasurer*—W. M. Maskell; *Hon. Secretary*—Nelson K. Cherrill.

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. Blackiston, W. D. Carruthers.

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.

OTAGO INSTITUTE.

Office-bearers for 1880:—*President*—Dr. Hocken; *Vice-presidents*—Professor Ulrich, D. Petrie, M.A.; *Council*—W. Arthur, C.E., W. N. Blair, C.E., A. Montgomery, R. Gillies, F.L.S., W. Macdonald, L.L.D., Bishop Nevill, D.D., J. S. Webb; *Hon. Secretary*—G. M. Thomson; *Hon. Treasurer*—H. Skey; *Auditor*—D. Brent, M.A.

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.

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.

WESTLAND INSTITUTE.

Office-bearers for 1880:—*President*—His Honor Judge Weston; *Vice-presidents*—Dr. Giles, R.M.; *Council*—Dr. James, J. Pearson, J. Nicholson, H. L. Robinson, R. W. Wade, D. McDonald, J. Anderson, T. O. W. Croft, C. E. Tempest, F. A. Learmonth, J. H. Hankins, A. H. King; *Hon. Treasurer*—W. A. Spence; *Secretary*—R. Hilldrup.

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.

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 mee ing (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.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

Office-bearers for 1880:—*President*—The Right Rev. the Bishop of Waiapu; *Vice-president*—W. I. Spencer; *Council*—H. Baker, E. H. Bold, W. Colenso, H. R. Holder, J. G. Kinross, M. R. Miller, F. W. C. Sturm; *Hon. Secretary* and *Treasurer*—W. Colenso; *Auditor*—T. K. Newton.

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.

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.

APPENDIX.

COMPARATIVE ABSTRACT for 1880 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. n 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	30·009	1·316	60·1	14·0	48·1	152·7	31·2	·395	75	38·890	193	270	728—7 Aug.	6·3
Previous 16 years	29·949	—	59·4	—	—	—	—	·406	78	44·007	189	—	—	—
Wellington	29·964	1·370	56·2	12·1	45·7	146·0	29·0	·361	79	46·767	176	209	860—10 May	5·2
Previous 16 years	29·906	—	54·8	—	—	—	—	·334	72	52·208	160	—	21 Aug.	—
Dunedin	29·852	1·493	52·0	14·0	49·0	—	—	·297	74	33·063	179	149	535—20 Aug.	5·9
Previous 16 years	29·819	—	50·4	—	—	—	—	·278	74	35·289	161	—	—	—

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.	1879.	1880.	1879.	1880.	1879.	1880.	1879.
Auckland	58·1	59·3	67·0	65·6	62·9	60·8	52·3	51·8
Wellington	55·7	55·1	62·9	60·7	57·7	57·2	48·8	47·4
Dunedin	52·3	50·5	57·6	55·9	53·1	51·6	45·0	42·0

NOTES ON THE WEATHER DURING 1880.

January.—Very fine, bright, warm weather generally experienced, the temperature being rather above the average. Rain about the average, but chiefly occurring during middle of month. Winds moderate on the whole. Earthqnake at Queenstown on 9th, at 12.15 p.m., slight.

February.—Remarkably fine, warm, weather throughout; temperature greatly in excess of average, and rainfall much less. Winds moderate; very high atmospheric pressure. Earthquake felt at Napier on the 10th, at 1 p.m., slight, and at Hokitika on 22nd, at 9.30 p.m., slight. A large comet observed in S.W. on 2nd, and visible for many days; several meteors observed during this period.

March.—At some stations exceedingly fine with little rain, while at others the rain was in excess and the temperature throughout high. The winds were on the whole moderate, and the weather generally agreeable. At some places it was very warm and sultry. Earthquakes at Wanganui on 10th, 5.30 a.m., sharp with noise, and 11th, at 11.20 p.m., long heavy roll and noise; at Christchurch, early on 6th, smart, N. to S.; at Dunedin on 5th; at Queenstown on 4th, at 11.51 a.m., smart, and on 5th, at 12.35 a.m.

April.—Fine, bright, dry weather almost throughout; remarkably high atmospheric pressure and high temperature; very small rainfall; moderate winds. Earthquakes reported at Wanganui on the 17th, slight shock; at Wellington on 20th, at 12.39 p.m., a noise followed by a smart shake N. to S.; at Queenstown on 29th, at 2.30 a.m., sharp. Meteors observed on 10th, 18th, and 23rd.

May.—Generally stormy, wet, and unpleasant weather experienced throughout during this period, with much thunder and hail at several stations; in most places the rain was greatly in excess, but the temperature was generally high; the atmospheric pressure was low throughout. Earthquakes reported at Wanganui on 9th, two shakes at 8 p.m. and 8.10 p.m., smart; at Queenstown on 4th, at 4.45 a.m., and on 27th, at 11.30 a.m., both slight.

June.—For the time of year the weather throughout has been mild, with generally small rainfall and moderate winds; at some of the southern stations unusually fine. Earthquake at Queenstown on 8th, at 6.30 p.m., slight.

July.—Although the rain has been in excess at most places, and some strong gales have occurred, yet on the whole the weather has been mild, and at times very pleasant for the time of year. Earthquakes at Wanganui on 4th at 10 p.m., and 28th, at 5.12 p.m., very sharp; at Wellington on 28th at 5.15 p.m., smart; at Nelson on 28th, at 5.5 p.m., slight; at New Plymouth on 28th, at 5.12 p.m., sharp; and at Hokitika on 12th, at 11.30 p.m., slight, N.W. to S.E. Also, by telegram, earthquakes reported as occurring on 28th, at Napier, Waipawa, and Porangahau, at about 5.15 p.m., severe; at Bull's at 5.14 p.m., direction N.W. to S.E., very heavy shake preceded by loud noise; Palmerston North at 5.13 p.m., sharp; Foxton at 5.13 p.m., sharp; Turakina at 5.13 p.m., violent, shake lasting some time. On the 31st at Gisborne, two shocks at 1.18 and 1.25 a.m., N.E. by W., severe.

August.—About average weather for the time of year, the winds rather high and chiefly from W.; a good deal of thunder; rain and temperature, on the whole about the average. Earthquakes: Wellington, on 4th, at 2.57 a.m., two smart movements; Blenheim, on 4th, at 2.56 a.m., sharp. Meteors, Mongonui, 19th, large, Dunedin on 2nd.

September.—Remarkably fine and pleasant weather for time of year. In every case the temperature is above the average; the rainfall on the whole is much less than is usual for this month. Winds generally moderate.

OCTOBER.—Rainfall in the North generally in excess of average, while in the South it was less than usual; but for the time of year the weather has been fine throughout.

NOVEMBER.—The weather throughout was fine and seasonable with a rather higher temperature than usual, and about the average rainfall. The winds were principally northerly, and with few exceptions moderate. Earthquakes occurred at Wanganui on 27th, slight, at 1.15 p.m., and Nelson on 27th in afternoon, slight.

DECEMBER.—On the whole rather unpleasant stormy weather throughout for the time of year, with much thunder, hail, and rain. In the South it was very unseasonable.

EARTHQUKES reported in NEW ZEALAND during 1880.

PLACE.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
New Plymouth	..	..	..	..	..	..	28*	..	..	..	..	..	1
Napier	..	10*	..	..	..	..	28*	..	..	..	..	..	2
Waipawa	..	..	..	..	..	..	28*	..	..	..	..	..	1
Poraugahau	..	..	..	..	..	..	28*	..	..	..	..	..	1
Turakina	..	..	..	..	..	..	28†	..	..	..	..	..	1
Gisborne	..	..	..	..	..	..	31†	..	..	..	..	..	1
Wanganui ..	..	..	10* 11*	17′	9*	..	4* 28*	..	..	..	27″	..	7
Wellington	..	..	..	24*	..	..	28*	4*	..	..	..	..	3
Palmerston North ..	..	..	..	..	..	..	28*	..	..	..	..	..	1
Foxton	..	..	..	..	..	..	28*	..	..	..	..	..	1
Bulls	..	..	..	..	..	..	28	..	..	..	..	..	1
Nelson	..	..	..	..	..	..	28†	..	..	..	27′	..	2
Blenheim	..	..	..	..	..	..	..	4*	..	..	..	..	1
Christchurch.. ..	..	..	6*	..	..	..	..	..	..	..	..	..	1
Hokitika	..	22′	..	..	..	..	12″	..	..	..	..	..	2
Dunedin	..	..	5′	..	..	..	..	..	..	..	..	..	1
Queenstown ..	9″	..	4* 5″	29*	4′ 27′	8″	..	..	..	..	..	..	7

The figures denote the days of the month on which one or more shocks were felt. Those with an asterisk affixed were described as *smart*; those with a dagger as *severe shocks.* The remainder were only slight tremors, and no doubt escaped record 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.

HONORARY MEMBERS.

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 Sir Ferdinand von, K.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.
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1874.

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1875.

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1876.

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1877.

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1878.

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1880.

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TRANSACTIONS

OF THE

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1880.

I.—MISCELLANEOUS.

Art. I.—*On the Vegetable Food of the Ancient New Zealanders before Cook's Visit.*

By W. Colenso, F.L.S.

[*Read before the Hawke's Bay Philosophical Institute, 9th August and 13th September*, 1880.]

Two gross errors have largely and repeatedly been industriously published concerning the ancient Maoris, and these, too, from our first knowledge of them:—(1) their utter ignorance of almost every art pertaining to society; and (2) their great want of food. Hence, it has been also said, almost as a necessary deduction therefrom, that the poor creatures were necessarily in a savage and starving state; from which their subsequent intercourse with Europeans had gradually served to raise them. For my own part, I more than doubt all this elevated assertion of their civilized Northern visitors; indeed, I am quite prepared wholly to deny it, as far as relates to the Maoris of the North Island. In some of my former papers concerning the Maoris, read before you, I have endeavoured to show, plainly and truly, a little of what they really were as to very many of the useful and the ornamental arts which once flourished among them (and more I yet hope to bring forward as bearing on this head); this serves to meet the first-mentioned of those two errors: while, to-night, I purpose in part taking up the second, and, in doing so, shall confine myself to a consideration of their vegetable food in the olden time (a subject but very imperfectly known); and also show that they, the natives of this North Island, had attained to a very high system of agriculture, which was purely national and loved, and passionately, judiciously, and universally followed everywhere among them.

To me—after so long a residence as mine, of nearly half a century—the origin of this belief of their having been greatly in want of food is clear and plain. 1. Cook first visited them at the very period of their planting season; or, rather, when he anchored in Tolaga Bay, it was just over, as he himself states; so that of their cultivated vegetable roots they could not possibly spare any—that particular time being with them always one of scarcity of crop-vegetable food, from the fact of their one principal cultivated root (the produce of seed from the previous autumnal season) not keeping sound beyond the regular period of setting it in the earth. Moreover, two things must here be steadily borne in mind:—(1) their cultivations were always strictly tabooed, and therefore could not be intruded on; and (2) every chief had several plantations, and always far apart from each other, for prudent political reasons. Notwithstanding this, Cook says that he saw, at Tolaga Bay alone, "from 150 to 200 acres under crop," and that, too, in a place with a small population; for, he adds, "we never saw there 100 people."* 2. At all of Cook's visits (with the one exception of his touching, on his first voyage, at Tolaga Bay, and his subsequent call in at the Bay of Islands) he anchored and staid in places where the Maoris did not have any cultivations; indeed, it is doubtful whether the Maoris of the Southern Island ever had any. Hence, when they visited his ships in their canoes, and often from a distance, they had little or nothing in the shape of vegetable food with them save fern-root, and were therefore supposed to be in great need of victuals, and not unfrequently experienced the generosity of their visitors, which (as we ourselves have subsequently too often found) encouraged them to adopt and persist in a habit of systematic begging. 3. And this, too, has been often the case with them in their subsequent intercourse with shipping and with visitors, and also in the early years of the Colony,—the Maoris in visiting or coming among the Whites have been without food, just because they were away from their homes and cultivations; much, indeed, as it is with ourselves in travelling, etc., in a new or unsettled country. 4. There still, however, remains the fact that modern writers on the Maoris (as Manning and Taylor †) who have resided a long time in New Zealand, state the same; all I can say is, that they are altogether wrong in their conclusions; they, not having witnessed it themselves in the past, suppose

* Cook's Voyages, 1st Voyage, Vol. II., p. 313.

† Here is a specimen:—"Formerly they were much pinched for food in winter; that period went by the name of the *grumbling months*, they had no other name for them, being a blank in their calendar, as they could do nothing but sit in their smoky huts with eyes always filled with tears." [What horrid stuff!] Again:—"In times of scarcity, the only food they had to depend upon was fern-root and shell-fish. The traveller is often surprised, as he journeys along the coast, by the large heaps of shells which he sees on almost every mound he passes; these are records of by-gone scarcity, &c."—*Taylor's New Zealand*, 2nd Ed., p. 341

it to have been so, from what little they have seen around them during the modern transition period of the Maoris, and from their own English ideas. The old, intelligent, thoughtful, industrious Maoris of the North Island have always denied it. What they said, was (1) they had not such good natural gifts—fruits, roots, vegetables, cereals, etc.—as the Europeans; and (2) they had vastly more labour in obtaining and preparing for food what they really had around them, particularly in the matter of vegetables.

The ancient New Zealander had great plenty of good and wholesome food, both animal and vegetable, but all such with them was only to be obtained by *labour*, in one shape or the other, almost unremitting. To them Nature has not been over-indulgent as she had been to their relatives in the more Eastern and tropical Isles of the South Pacific—where the bread-fruit and the banana, the cocoanut and the plantain grew spontaneously, and yielded, without toil, their delightful fruits to man! But all such constant labour and industry was doubtless in their favour, helping to "the survival of the fittest," and causing the development of a finer race, both physically and intellectually. The old Maoris were great fishers and fowlers—and hunters too, in their diligent snaring of their prized, fat, frugivorous forest rat; but, for the present, I shall omit all reference to their animal food, confining myself to their being industrious and successful agriculturalists and cultivators of the soil.

And this one chief and noble industry duly considered shows how far, how very far, they were in advance of the mere hunter, or fisher; the true savage man of both ancient and modern times,—whether we look for him (his remains) in Europe, among pre-historic cave relics of days long gone by, or among the modern inhabitants of Patagonia and Magellan Straits, or those nearer neighbours of South Australia and Tasmania.

Indeed, their being great cultivators, and that from very ancient times, places them high in the true scale of civilization and real advance. Far even beyond that state to which our own forefathers the Britons, and also the Germans, had advanced when Cæsar first led his victorious Roman legions among them.* I know of no ancient people who, without the knowledge or use of metals, had advanced so far in this direction. In this respect they serve to remind me of the Peruvians under their Incas, though

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To this I reply:—1. They were *not* pinched for food in winter. 2. The winter months were *not* so named. 3. Their "*only* food in times of scarcity" was *not* merely fern-root and shell-fish. 4. Those mounds are *not* "records of by-gone scarcity"—rather of plenty! The shell-fish were collected in bushels, or cart-loads, in the summer, in their proper season, and cooked, and the flesh *dried* and often strung on long threads of New Zealand flax, and carried off in baskets to their homes for stores.

* Tacitus, Germania, c. 26; and Cæsar, Bell. Gall., VI. 21, etc.

that people possessed both metals and beasts of burden. All Eastern nations, from their earliest annals, were ever famed for their attachment to the cultivation of the soil. The Egyptians and the Phœnicians, the little nation of the Jews, the Persians,* and the Chinese,—and afterwards (and from them) the Greeks and the Romans, not only supported and patronized it, and wrote books in praise of it,† but actually followed it themselves, each noble labouring on his respective farm, much as the Maori chiefs themselves did.

And this national custom long-continued (as I have already mentioned) was, in my opinion, the reason why the New Zealander also excelled in so many of the arts practised by him—agriculture being, in its primitive and rudest form, the first step in civilization; and this industry once practised and liked is sure to improve, and to lead on gradually to its own rich development. Xenophon has truly remarked that "Agriculture is the nursing-mother of the Arts; for where Agriculture succeeds prosperously there the Arts thrive; but where the earth necessarily lies uncultivated, there the other Arts are destroyed." *(Œconomics.)* And a learned modern writer (Dr. Kalisch) has judiciously observed, in remarking on the early agriculture of the world,—"It is a deep trait in the Biblical account to ascribe the origin of cities to none but the agriculturist. Unlike the nomad, who changes his temporary tents whenever the state of the pasture requires it, the husbandman is bound to the glebe which he cultivates; the soil to which he devotes his strength and his anxieties becomes dear to him; and that part of the earth to which he owes his sustenance assumes a character of holiness in his eyes,‡—he fixes there his permanent abode, and considers its loss a curse of God. Thus the agriculturist was compelled to build houses and to form a town. Many inventions of mechanical skill are inseparable from the building of towns; ingenuity was aroused and exercised; and whilst engaged in satisfying the moral desire of sociability, man

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* It is related of the ancient Persians, "that their kings laid aside their grandeur once a month to eat with husbandmen;" this is a striking instance of the high estimation in which they held agriculture; for at that time the fine arts were practised among that people to great perfection. The precepts of the religion taught by their ancient magi, or priests, included the practice of agriculture. The *saint* among them was obliged to work out his salvation by pursuing all the labours of agriculture; and it was a maxim of the Zendavesta,—that "he who cultivates the ground with care and diligence, acquires a greater degree of religious merit than he could have gained by the repetition of 10,000 prayers." I would that such a doctrine were believed in now-a-days!

† Among the Greeks, Hesiod in "Works and Days," and Xenophon in "Œconomics," and among the Romans, Cato, and Varro, and Virgil in his "Georgics."

‡ See the Maori proverb, No. 22, p. 118, "Trans. N.Z. Inst.," Vol. XII.

brought many of his intellectual powers into efficient operation." (*Com. on Gen.*, IV.) No doubt such, or similar, was the case here in New Zealand of old—in ages long past! Hence, too, arose their towns possessing really good houses, strong and well fortified places of strength, etc.,—such as their neighbours the Australians and Tasmanians never knew! such as this generation of Maoris has scarcely ever seen or dreamt of! Hence, too, the very strong attachment shown by not a few of the older Maoris in our days, to the homes and to the cultivations of their forefathers; a fine and estimable feeling, which, in not a few instances, has been rudely mocked and opposed!

In a former paper on the ancient Maoris,* I brought before you several of their fit and pertinent proverbs relating to Industry and to Agriculture (which I merely refer to here in passing); and to the same subjects, in addition thereto, some of their traditional incidents, historical and legendary, in their oldest legends undoubtedly belong;—*e.g.*, that of their favourite and beneficent hero Maui catching and binding the sun, to prevent his travelling so fast, "*so that man might have longer day-light to work in*;" and that of another hero named Tamatea, who "first set fire to and burnt up the rank vegetation of tangled weeds and jungle, *that man might have a clear space of ground wherein to grow food;*" two beautiful and worthy ideas, which could only have proceeded from an agricultural and working race. Hence, too, very possibly, under similar ideas and feelings, may we look for the peculiar derivation of their verb and noun for laziness, and to be lazy, —especially with respect to active work, viz., *mangere* (*ma* and *ngere*),—*ma*, the active preposition "for," and *ngere*, their name for any hideous or disagreeable cancer or corroding ulcer,—*i.e.*, the lazy fellow is food for the *ngere!* A term ever greatly disliked among them.

I.—Of Plants formerly cultivated for Food.

1. *Of their Plantations.*

Before however I speak of the plants themselves, their plantations should be considered. These, as it has already been observed, were, for wise political reasons, scattered, and often some were situated in half-concealed out-of-the-way places; this was done on account of the danger the Maoris were continually exposed to, namely the sudden visit of a *taua*—war party (often from their own friends and relatives), to demand satisfaction for some offence,—generally an insult, or a breach of *tapu* = *taboo* restrictions; at which times the crops, being almost the only available personal property, were sure to suffer, often being wantonly rooted up,

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* Contributions towards a better knowledge of the Maori Race, "Trans. N.Z. Inst.," Vol. XII., p. 115, etc.

etc.* Notwithstanding, they had large plantations also, which might be called tribal, or communal; and sometimes these were a few acres in extent.

For the *kumara—Ipomœa chrysorrhiza*—a dry and light sandy, or rather gravelly soil, was selected; and if it were not so naturally, it would be sure to become such, as every year they laboriously carried on to it many a weary back-load of fine gravel, obtained from pits or river beds in the neighbourhood, and borne away in large and peculiarly close-woven baskets specially prepared for that purpose only. This labour, however, was the principal heavy one attending their cultivations; as, before they knew the Europeans and for some time after, they never strongly fenced their plantations, not having any need to do so; the highly laborious and additional work of making wooden fences around their cultivations in after years arose from the introduction of the pig. They did, however, put up fences and screens of reeds, etc.; this was done to break the force of the winds which blow strongly in the early summer, the young *kumara* plant being tender, and the *taro* possessing large semi-pendulous leaves. Cook also noticed this; he says, "Each district" (*qu.* plantation, or division of a plantation) "was fenced in, generally with reeds, which were placed so close together that there was scarcely room for a mouse to creep between." (*loc. cit.*)

For the *taro — Colocasia antiquorum*, or *Caladium esculenta* — a very different soil and damp situation was required; light and deep yet loamy, or alluvial, often on the banks of streams or lagoons, and sometimes at the foot of high cliffs near the sea.

For their valuable gourd the *hue—Cucurbita* sp.—a damp rich soil, with warmth to bring it to perfection, was required; this was often sown in, and

* The last two occasions (known to me) of this being done, may be briefly noticed in a note—seeing that well-known Maori chiefs of Hawke's Bay were concerned. (1.) Te Hapuku, in 1847, rooted up and destroyed the young growing crop of kumara belonging to Takamoana, (afterwards baptized and named Karaitiana=Christian, and, in years long after, one of the Maori Members in the House of Representatives), owing to a severe quarrel between them, or rather between Te Hapuku and Takamoana's tribe; to show his pre-eminent right to the land where they grew, not far from their respective *pas* on the east bank of the river Ngaruroro. (2.) Te Hapuku again, in 1850, tore up and destroyed the kumara crop, and killed the tame pigs, of the venerable old Melchizedeck Te Motu, at Te Haukee (near Te Aute), where the old man then lived almost alone. The offence in this case was, that Te Motu was Te Hapuku's old family and tribal priest, (and there was now not another left!) and he had dared to become a Christian and to be baptized, and subsequently refused to perform some of his old ceremonies when required to do so by Te Hapuku, saying, that "all such now were of no use whatever!" "I would not have done so," said Te Hapuku to me, afterwards, when expostulating with him, "had he but listened to me for a short time longer, and performed the ceremony of *horohoro* over my children before that he left me; now there is no one left to do it!"

near to their *taro* plantations, and sometimes on the outsides of woods and thickets.

In those plantations all worked alike: the chief, the lady and the slave; and all, while so engaged, were under a rigid law of minute ceremonial restrictions, or *taboo*, which were invariably observed. Fortunately for them, the modern unnecessary and expensive indulgence, or evil, of tobacco was wholly unknown! And there was nothing of a similar time-consuming nature known to them to have taken its place. It was a pretty sight to see a chief and his followers at work in preparing the ground for the planting of the *kumara*. They worked together, naked, (save a small mat or fragment of one about their loins), in a regular line or band, each armed with a long-handled narrow wooden spade (*koo*), and like ourselves in performing spade labour, worked backwards, keeping rank and time in all their movements, often enlivening their labour with a suitable chaunt or song, in the chorus of which all joined.

If it were a pleasing sight to notice the regularity of their working, it was a still more charming one to inspect their plantations of growing crops: 1. The *kumara* plants, springing each separately from its own little hemispherical hillock—just the size and shape of a small neat mole-hill. 2. The *taro* plants (each one beautiful in itself) rising from the plain carefully levelled surface, which was sometimes even strewed with white sand brought from a distance, and patted smooth with their hand; * and 3. the *hue*, in its convex bowl-shaped pits, or "dishes," as Cook calls them. The whole *tout ensemble* was really admirable! The extreme regularity of their planting, the *kumara* and the *taro* being generally set about two feet apart, in true quincunx order, with no deviation from a straight line when viewed in any direction, (to effect this they carefully use a line or cord for every row of *kumara* in making up the little hillocks into which the seed-tuber was afterwards warily set with its sprouting end towards the north); the total absence of weeds, the care in which all was kept—even to the sticking into the ground, when required, leafy and yielding branches of *manuka*—*Leptospermum scoparium*, (owing to the high westerly winds, or to the situation being rather exposed), and last, though in their eyes by no means the least,

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* "Leaving Te Kawakawa and travelling south by the seaside, I passed by several of the taro plantations of those natives. These plantations were large, in nice condition, and looked very neat, the plants being planted in true quincunx order, and the ground strewed with fine white sand, with which the large pendulous and dark-green shield-shaped leaves of the plants beautifully contrasted; some of the leaves measuring more than two feet in length—the blade only. Small screens formed of the young branches of *Leptospermum scoparium*, to shelter the young plants from the violence of the winds, intersected the grounds in every direction."—*Excursion in N.Z., in 1841:*—"Tasmanian Journal of Science," Vol. II., p. 217.

were spells, and charms, and invocations, recited by their priests—*tohungas*—to ensure a good crop; for this purpose alone a priest of renown was often fetched from a distance and at a high price. Instances, too, are known, in their ancient history, of some of such *tohungas* having been killed by the chiefs, through some alleged, or real, oversight or fault, or omission, in the performance of their ceremonial taboo. All, however, clearly showed much forethought, and that no amount of pains, both natural and supernatural, had been spared, and that their agricultural work was truly with them a labour of love!

Nor did their labour end here: there was still the *kumara* barn, or stove, to be built, and this was almost universally the well made, handsome house of the village; the one sure to catch the eye of the European visitor, from its size, shape, neatness, and profusion of ornamental carved works inlaid with pearl shell *(Haliotis)* and stained red. Its walls were made of yellow reeds of the *Arundo*, placed neatly together, with a squared plinth of the dark stems of the fern tree set at the base to keep out the rats and wet, while its roof was well secured with loosely twisted ropes, composed of the airy, elastic, climbing stems of the durable *mangemange* fern *(Lygodium articulatum)*, and a drain cut round it, to throw off the rain and other waters. Sometimes those stores were also elevated on squared and dubbed and ornamented posts; and sometimes even built up in the forks of the main branches of a dead tree. All those storehouses were rigidly tabooed, as were also those few persons who were allowed to visit them for any purpose; all visits being formal and necessary. The labour bestowed in those early times, before the use of iron, was immense, and they were mostly renewed as to the reed work every year.

I have already alluded to the large amount of extra heavy labour imposed upon the Maori cultivators of the soil through the introduction of the pig; much also arose from the coming among them of the unwelcome European rat! their own little indigenous animal not doing them any harm. I remember when at the Rotorua Lakes, nearly forty-five years' ago, visiting a very large *kumara* plantation (that neighbourhood being a principal and noted one of all New Zealand for its fine and prolific kumara crops, said to be owing to the extra warmth of its heated volcanic soil). In the midst of the cultivation was a little hut (reminding one forcibly of "a lodge in a garden of cucumbers"), and this by night was inhabited by two old men, watchers, who had a great number of flax lines extending all over the plantation in all directions, to which lines shells of the fresh-water mussel *(Unio (?) menziesii)* were thickly strung in bunches; these lines were all tied firmly together into one handle of knotted rope, which those two old men had to pull vigorously, every few minutes throughout the night, to cause a jingling noise, and so frighten and scare away the thievish rats from gnawing and injuring the growing kumara roots.

One striking peculiarity, however, should not be omitted—in which, too, I think, they differed from all agricultural races—their national non-usage of all and every kind of manure ; unless, indeed, their fresh annual layers of dry gravel in their kumara plantations may be classed under this head. But their whole inner-man revolted at such a thing ; and when the early missionaries first used such substances in their kitchen-gardens it was brought against them as a charge of high opprobrium.* And even in their own potato planting in after years they would not use anything of the kind, although they saw in the gardens of the missionaries the beneficial effects arising from the use of manure ; and, as the potato loves a virgin, or a strongly manured, soil, the Maoris chose rather to prepare fresh ground every year, generally by felling and burning on the outskirts of forests, with all the extra labour of fencing against the pigs, rather than to use the abominated manure. They also never watered their plants, not even in times of great drought, with their plantations close to a river, when by doing so they might have saved their crops.

2. *Of their Cultivated Food Plants.*

1. The first in every respect and degree was the *kumara.* This plant is an annual of tender growth, and was one of their vegetable main-stays. Their use of this plant, as I take it, is from pre-historical times ; as their many legends about it evidently show, which I purpose hereafter to lay before you in a future paper. In suitable seasons and soils its yield was very plentiful. It had, however, one potent enemy of the insect tribe, in the form of a large larva of one of our largest moths.† This larva was named *anuhe, awhato, hawato,* and *hotete,* and as it rapidly devoured the leaves of the young kumara, it was quite abhorred by the Maoris, who

* A striking incident illustrating the above, which once happened to me, may not be out of place here. I was travelling, as usual, in the interior, where I had often been before, and having brought up at a small village for the night, in the morning early I went and gathered some remarkably fine succulent tops of the wild *Brassica* ("Maori cabbage" of the settlers) which was running up to flower, for my breakfast ; a thing I almost daily or oftener did ; these I brought to my tent, and gave to my Maori cook, who had travelled with me many years. At breakfast, however, I missed them, having, instead, only some very inferior leaves. On my enquiring after my fine vegetables, I was told that my gathering them had been seen by some of the people of the village, who ran and told him of it, and that he had therefore thrown them away, for they had grown on the river's bank not far from the village privy. I should also add that the young man himself was above all such notions, having often worked in my garden at home, and there used manure.

† See Trans. N. Z. Inst., Vol. XI., p. 303, and Vol. XII., p. 121.

always believed that they were rained down upon their plants. Sometimes their numbers were almost incredible, as some of us have also seen in the abundance of the more common caterpillar pests in certain seasons. I myself have often marvelled at them in their number, and where they could possibly have come from; baskets full being carefully gathered from the plants, and carried off and burnt. This job of gathering them, though necessary, was always greatly disliked.* Long before the roots, or tubes, of the kumara were of full size, they were regularly laid under contribution; each plant was visited by old women, with their little sharp-pointed spades or dibbles, who were quite up to their work, and a few of the largest young tubers selected and taken away, and the earth around the plant loosened, when it was again "hilled" up;—an operation not unlike that of our potato hoeing, only much more carefully performed, as at the same time they took away every withered leaf and upper outlying rootlet, and weak sprout. Those young tubers were carefully scraped, and half-dried on clean mattings in the sun—being turned every day and carefully covered from the dew, and when dry either eaten or put away in baskets as a kind of sweetish confection or preserved tuber,† greatly esteemed by them, either raw, or soaked and mashed up with a little warm water, and called *kao.*

At the general digging of the crop in the late autumn (called by the Maoris the *hauhakenga),* but always before the first frost, great care was taken in the taking up of the roots, when they were carefully sorted according to size and variety (if of two or more varieties in the one plantation), all bruised, broken, or slightly injured ones being put on one side for early use; then they were gathered up into large flax baskets, always newly made, and in due time stowed away in the proper store; taking great care of doing so only on a perfectly dry sun-shiny day, as they had to guard against mouldiness of every kind, which was destructive and dreaded.

It is impossible to estimate, even approximately, the immense quantity of this root which was annually raised by the old Maoris; especially before

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* A few years after I came to Hawke's Bay to reside—I think in 1846—the tribe of the late chief Karaitiana, who lived near me, had their large kumara plantation regularly set upon by those immense larvæ. The chiefs borrowed all my turkeys, which were put into their kumara plantation, and in a short time they cleared the whole ground of those destructive creatures.

† In an old work on *Gardening and Botany* I find the following:—"The sweet potato" *(Batatas edulis)*, Sir Joseph Banks observes, "was used in England as a delicacy long before the introduction of our potatoes; it was imported in considerable quantities from Spain and the Canaries, and was supposed to possess the power of restoring decayed vigour. The kissing comfits of Falstaff, and other confections of similar imaginary qualities with which our ancestors were duped, were principally made of these and *Eryngo* roots."—*Dow's General System*, Vol. IV., p. 401.

they took to the cultivation of the introduced potato. At their large and noted tribal feasts,* (*hakari*, at the north, *kaihaukai*, at the south,) enormous quantities were used, as well as at their commoner feasts held on account of births, betrothals, marriages, deaths, etc.; on such great occasions the quantity was often increased through profuse ostentation, for which, while the chief and the tribe gained a great name, they all (especially the women and children) subsequently suffered severely.

But, in my opinion, one of the most remarkable things pertaining to this useful root, or tuber, has yet to be noticed; namely, its many marked varieties, which were also old and permanent. I have, I think, known more than thirty varieties; and I have lists from the north and the south of several others; and have also heard of others, possibly ten more; while some old sorts were known to have been lost.† In this respect the tubers differed just as potatoes do with us. Some were red-skinned, some purple, and others white; some were rough-skinned, and others smooth; some had red flesh, or were pink, or dark purple throughout, others were white; some were even and cylindrical, others were deeply grooved or regularly channelled; some were short and thick with obtuse ends, others were long and tapering with pointed ends; and I never once noticed that there was any mixture (as it were) of the several varieties; all came true to sorts planted, as in the potato with us; their only sign of degeneration through soil or drought was in the size. Now all those several varieties were of old,

* That some correct idea may be formed of the large amount of cultivated vegetable food consumed at those great tribal feasts (*hakari*)—seeing all such has long gone into disuse, I may state that the food was generally piled up in the form of a pyramid, from 80 to 90 feet high, and 20 to 30 feet square at the base, gradually rising to its apex. To build up this, the straight trunk of a large tree was first obtained from the forest, and dragged out with no small difficulty to the spot fixed on for the feast, there it was disbarked or dubbed down and set up, other strong poles were then set up around it, a series of horizontal stages were then made all round the scaffolding at from 7 to 9 feet apart, and the whole was filled in and built up with food packed into baskets; presenting, when finished, one solid mass of food! The getting-up of one of those feasts always took a long time, often more than a year, though many willing hands were employed, and the labour expended was prodigious! At a small feast (comparatively) of this kind, and almost the last in those parts, held at the Waimate (Bay of Islands) in 1835, and given to the people of Hokianga, 2,000 one-bushel baskets of kumara were used; and at a similar feast given by the noted warrior chief Te Waharoa (father of the equally notable Wiremu Tamihana Tarapipipi), at Matamata, in 1837, to the people of Tauranga, the following inventory of the food was taken down at the time by a credible eye-witness:—"Upwards of 20,000 dried eels, several tons of sea-fish, principally young sharks (a great Maori delicacy), a large quantity of hogs, 19 big calabashes of shark oil, 6 albatrosses, and baskets of potatoes (sweet and common) *without number*."

† See Appendix A.

and only handed down by the strict preserving of the seed (or tuber); and the question with me has ever been, How were they first derived? From the Maoris themselves I never could learn anything satisfactory respecting them,—save that they had had them of old from their forefathers. (Of course, for the time, I set aside their legends concerning them).

I have carefully enquired if the old Maoris had ever known the kumara to flower, but they all said, "No; never heard of such a thing." And they never harvested their crop until after the withering of the leaves of the plant. I have also frequently enquired if any sort or variety had ever been newly raised by them, or their immediate fathers; to this they also replied, "No."

Is it not possible that in ancient times this plant did flower here, and that the old cultivators, either by design or accident, obtained their sorts by sowing its seed?* The northern tribes, especially the Ngapuhi, had, more than forty years ago, obtained several new varieties of potato by sowing its seed; to which, however, they were first led by accident, having noticed some young plants which had sprung from self-sown seeds of the ripe potato berries, and from them they had obtained several good and prized sorts.

Is it also not possible that this plant (kumara), through constant, assiduous, early, artificial cultivation, extending throughout centuries, has permanently changed in this respect of non-flowering, as it is known the early varieties of potato have done in England through repeated cultivation? There the earliest varieties do not produce flowers or seed. There is an excellent paper by Mr. T. A. Knight in the Philosophical Transactions for 1806 (London), bearing on this subject†, in which Mr. Knight shows, from experiments made by him, that the same fluid or sap gives existence alike to the tuber, the blossoms, and the seed, and that whenever a plant of the potato affords either seeds or blossoms, a diminution of the crop of tubers, or an increased expenditure of the riches of the soil, must necessarily take place. Following this out he succeeded in producing varieties of sufficiently luxuriant growth and large produce which never produced blossoms. I have already shown that the Maoris used no manure, and planted the kumara in poor gravelly soils devoid of all richness.

2. The second plant generally cultivated by them was the *taro.* This

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* Here may also be noticed that a striking peculiarity obtains among the Maoris generally with respect to the name given to the tubers of this plant when used for planting—*purapura*, which is the proper Maori name for all real *small* seeds, as of cabbage, etc. It seems strange, seeing they revel in such a multiplicity of names for every variety of natural objects, and for the several parts of any one thing. *Purapura* is also the name given to potatoes when used for planting.

† See Appendix B.

also was propagated by planting its roots or tubers, or, more properly speaking, its small offset shoots, which were carefully pinched off for that purpose; but, being a perennial, and always "in season," its tubers were not taken up and stowed away for future use, but were generally dug up when wanted for cooking, etc. Hence it was doubly useful to them, in some respects more so than the *kumara*. It was also very prolific, increasing its set tubers rapidly, both in size and in the offshoots, in a suitable soil, so that a clump of *taro* tubers passed into a proverb,* to show the number and resources of a strong tribe. Of this plant there are also more than twenty varieties or species,† which, like the kumara, differed greatly in size, in quality, and in the colour of its flesh; besides one which is known to have been introduced since the time of Cook's visit. This newer one is called *taro hoia;* it is a much larger root (tuber) and plant, and it is also coarser in its flesh, and is not so generally liked. Both the tubers and the thick succulent stems (petioles) of the large leaves of the plants were eaten, but only after being thoroughly cooked; a severe burning of the lips, mouth, and throat, attended by constriction, followed the imprudent eating of it when not fully dressed.

This esculent tuber was made to play an important part in many of their higher ceremonial observances—as, at the naming of a newly-born chief's child—at the death of a chief—at the exhumation, which in due time always followed—and also at the visits of welcome strangers. For each observance, or feast, the ancient Maoris used their particular varieties or sorts; a similar usage was also practised on such occasions with their varieties of animal food. This custom they could not so well have carried out with their kumara, as there were seasons when it was not to be had at all.

3. The third food plant cultivated by them was a fine one of the gourd family, called by them the *hue*. This noble and highly useful plant was annually raised from seed, and was their only one so propagated; and, curiously enough, of this plant, though yielding seed in great plenty, there was only one species and no varieties. Its seeds, before sowing, were wrapped up in a few dry fern fronds, *(Pteris esculenta)*, and steeped in running water for a few days. It was to them of great service, furnishing not only a prized and wholesome vegetable food (or rather fruit) during the whole of the hot summer days while it lasted, and before their kumara were ripe for use, but was also of great use in many other ways. It was always a pleasing sight to see it growing in a suitable soil, as it grew fast and

* See "Trans. N.Z. Inst.," Vol. XII., p. 140.

† See Appendix C.

looked so remarkably healthy with its numerous leaves, large white flowers and fruit, the latter often of all sizes, from that of a cricket ball up to that of a globular, pear-shaped, or spheroidal figure, capable of holding several gallons. As an article of food it was only used when young, and always cooked—baked like the *kumara* and *taro*, in their common earth-oven—and eaten, like them, both hot and cold. Prodigious numbers of them were formerly daily consumed in the summer season. It was from this plant that the Maoris obtained all their useful vessels, for holding water, oils, cooked animal food, etc. This was done by carefully drying and hardening the fully matured fruits with the heat of the sun and fire, and just as carefully scooping out all their contents, through a small hole made near the stalk end. In the very small calabashes so made, they kept their perfumed oils, and rouge, for anointing; of the medium sized and large ones they made useful dishes, and all their common water calabashes, while the few very largest were neatly manufactured into pots for holding preserved and potted birds. For this purpose the stalk end was cut off, and it was ingeniously fitted with a hollow cylindrical neck of carved hard wood, cut out of one piece, and always made large enough to admit a man's hand through it; this was firmly fixed on above, while below, the rotund vase was also fitted with three (or four) legs to stand on, and to keep it from off the ground. These big vessels were always prized and taken great care of, sometimes they were named, and some lasted a whole generation or longer, and were handed down as heirlooms.

4. Another plant which was also cultivated by the old Maoris as an article of food, was the *tiipara*, a species of *Cordyline*; this was propagated by its side-shoots and suckers. Its thick succulent stem, as big as, or bigger than, that of a very large cabbage or brocoli, was cooked and eaten. In these parts, however (Hawke's Bay), it has become very rare; indeed, I only know of the plants now growing in my own garden; which I raised from a single plant I found in an old Maori cultivation belonging to the father of the present aged chief Tareha, in 1845. I have had some dozen of plants from it, and although they were very healthy and grew well, not one of them ever flowered! in this respect resembling both the *kumara* and *taro*. It grows to 4–5 feet in height, never quite erect; and then it sends out suckers from below ground and from its stem, and dies. Thirty years ago, whenever some of the oldest chiefs here should happen to see this plant growing in my garden, they would invariably longingly beg for its stems to cook for a meal, saying how much they liked it. Its leaf is shorter and broader and of a finer texture than that of *C. australis*, with slightly recurved edges, and its bark is also much thinner, and smooth, not rugged. I sent specimens of it (leaves only) to Dr. Sir J. D. Hooker,

in 1850-2, and then hoped I should see both flowers and fruit! I provisionally named it *C. edulis*. It was formerly cultivated extensively, both at Waikato and Upper Whanganui, also here in Hawke's Bay, and in other places; and, from what I have heard from the Maoris, there also it did not produce flowers.

Is this another curious instance of a plant losing its powers of producing blossoms, etc., through long and continuous cultivation from its suckers?—a kind of vegetable breeding in-and-in.

I have also good reasons for believing there was yet another and a much smaller species of *Cordyline* formerly cultivated for the sake of its root. (It was in 1838-9, at Waikato.) Young seedlings were carefully selected and planted out, and in the following year the root was fit for use. The plant was then dug up, stacked in small piles, and dried in the sun; while drying the fibrous roots were burned off; and when sufficiently dry the roots were scraped and baked slowly, requiring 12–18 hours to cook them. These were chewed, or pounded and washed and squeezed, and used merely to extract the saccharine matter, which was eaten with their fern-root to give it a relish. I have never seen the plant itself, only its dried roots. It may be the same as *Cordyline pumilio*, but this I doubt.‡ By the Maoris of Waikato it was called *mauku*.

5. Two other food-yielding plants were, I believe, also cultivated by the ancient Maoris, viz., the *karaka (Corynocarpus lævigata)* and the *kohoho** *(Solanum aviculare)*. Occasionally, at least, they planted them both in their plantations, and also in their towns *(pas)*. And this will account for the *karaka* being often found isolated, or in small clumps of old trees, in many spots inland, away from its own natural habitat near the sea. I am the more inclined to believe that they did so, from the fact of my having been informed many years ago by an old priest *(tohunga)*, of the secret tabooed way to make a young *karaka* tree, on its being so transplanted, become fruitful. Nevertheless they always preferred the fruit of the wild or naturally growing ones; so, under that head, I shall mention its serviceable fruits and its uses. And just so of the *kohoho*, which may still be found of a large size in old *pas* and plantations. A cultivated *kohoho*, in ancient days, belonging to the Chief Uenuku, is made to play an important part in one of their legends.†

As I have prominently brought the old Maoris before you in this paper, as great cultivators of the soil, I will also briefly mention two other plants (not being food-producing plants) which they also cultivated for textile uses; seeing they were but of two kinds,—including the several varieties of one of them.

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* This is its name at the north, but *poporo* and *poroporo* at the south.

† See Grey's Mythology, p. 124.

‡ See Part III. of this paper.

II.—Of Plants formerly Cultivated for their Textile Uses.

1. I will first mention the *Aute* = Paper-mulberry (*Broussonetia papyrifera*), although, as far as I know, not a single vestige of this plant is now left in New Zealand! its name remains, and that is all. Few Maoris now living have ever seen it; and yet, in ancient days, it was commonly and largely cultivated throughout the country.* At the time of Cook's visit it was very common, and seen by those early voyagers everywhere, both growing in their plantations and worn in fillets by the chiefs in their hair; the thin white bleached paper-like bark contrasting excellently well with their ebon locks! Very many of the heads of Maoris, in the plates in both Cook's Voyages and Parkinson's Journal, are drawn thus ornamented with the *aute.* Yet though commonly cultivated, it was of small size, and never was used by the Maoris for clothing purposes, as it was by many other of the Polynesians. The chiefs also made ornamental paper-kites of it, which was one of their great diversions in times of peace, especially among the older men.†

2. The New Zealand Flax Plants (*Phormium tenax*, and *P. colensoi*) in some of their many prized varieties, were also largely cultivated by the ancient Maori. First—they always had planted near to, if not adjoining, their food cultivations and their towns and villages, the commoner sorts of this useful plant, which was constantly used by them in its green state for the daily making into baskets and dishes for cooked food (all such woven dishes not being used a second time), and, also, for common and hasty tying purposes; but those common kinds (which grew spontaneously almost everywhere, except in the deep forests,) they did not make use of for making thread, cord, fishing-lines, nets, and garment-weaving purposes; these superior kinds were cultivated. Second—of the varieties of New Zealand flax known (even now) to the Maoris, there are more than 50.‡ I have seen old plantations of this plant (or, rather,

* Parkinson, in his "Journal," has more particularly noticed this plant; he says (speaking of the Bay of Islands), "Saw many plantations of *kumara*, also *plantations of aute, or cloth trees*." I once saw this plant growing, in an old plantation at the head of the Kawakawa river in the Bay of Islands,—that was in 1835. There was however but one small tree left, which was about 6 feet high, with few branches and not many leaves on them, it appeared both aged and unhealthy, and it soon after died. On my finally leaving the Bay of Islands in 1844, to reside at Hawke's Bay, I heard of some *aute* trees still living at Hokianga. I wrote to a chief of my acquaintance there (E. M. Patuone), who kindly sent me several good cuttings; saying (in a letter) that the plant there was nearly totally destroyed by the cattle of the Europeans. Unfortunately, my removing was so greatly hindered, in not meeting readily with a vessel, and the summer also advancing, that I lost them all.

† For *proverbs* concerning it see "Trans. N.Z. Inst.," Vol. XII., p. 145.

‡ See the work on *Phormium tenax*, by Dr. Hector.

the remains of them) more than forty years ago in travelling.* The variety which was suited (in its prepared fibre) for making into fishing-lines, would not serve for making nets (which were made of unscraped flax); and what was required for the woof of their superior woven flax garments, would not serve for the warp of the same,—while another kind again was used for their dyed borders; they also used a different variety for the girdles of their chiefs; another variety for the hard, almost closely woven, sack-cloth-like lining of their prized dog-skin and kiwi-feather garments; another kind was used for the inner garment (or small apron) of the young girls of rank; another sort for the common shaggy rain-protecting shoulder mats; and yet another sort for making the all but impenetrable hard shield, or arm-buckler, used to receive and ward-off spear thrusts, in their assaulting of forts. The dressed fibre of some kinds was soft, of others glossy and silky, while of other kinds it was harsher and stronger, more linen-thread like; and the colours and lengths of their staple also greatly differed.

A similar question here arises in the mind, as has already been brought to our notice in considering both the *kumara* and the *taro* plants, namely—the old Maoris having many distinct and well-known varieties of their flax, how did they get them? And while this question is more easily and naturally answered, owing to the *Phormium* plants abundantly seeding, still, there is another (or more than one) remaining to be met:—Did the old Maoris, the ancient cultivators of the flax plant, did they accidentally discover all, or any, of those several sorts naturally produced? Or did they, in their cultivating of the plant, and so bringing together the finer and choicer specimens—did they, in their so doing, cause, or help to raise the new varieties?

This question, however, cannot readily be answered; although, duly considered, (especially in connection with what has preceded about those other cultivated plants), it will, I think, be found to have a good deal to do with that very important question which has yet to be solved—*the great antiquity of the Maori race.* Of which more anon.

III.—Of the Wild or Uncultivated Food-producing Plants of the Ancient New-Zealander.

These were many in kind, some strange and peculiar, yet mostly all common.

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* In travelling through the dense forests of the interior, on two occasions, I came suddenly upon a small cleared area of an acre in extent, which had been regularly planted with a fine variety named *oue*. At that time, and for many years, no one lived within miles of it, and my Maori companions gazed with wonder, some taking a leaf with them to show when they got home. So here, in Hawke's Bay, in 1845, there were the remains of old plantations of several varieties. In the spot where the township of Havelock now stands was a fine old plantation, and from it I obtained specimens of a prized sort, named *tapoto*, for Sir W. J. Hooker, which I thought to be a new species.

They were obtained from nearly all the great natural vegetable families, —trees, shrubs and herbs, ferns, algæ, and fungi. In fruits, leaves, and roots.

Strange to say, the trees and plants generally of this large and densely forested country,—blessed, too, with an excellent temperate and moist climate,— scarcely bore a single fruit worthy of being eaten by a European! Still, it was wrong to write—" In New Zealand there are no fruits or vegetables of indigenous and spontaneous growth; all they have must be cultivated and tended constantly." *

Nature was indeed niggard to the Maori people, as to fine fruits and edible vegetables, yet they made the best of it, and commonly used advantageously what she had provided for them. Certainly the preparation of several before that they were fit for eating was highly curious.

In remarking on their various kinds of vegetable food of spontaneous growth, I think the better way will be to take them as they valued them and used them; so setting aside both their natural and botanical sequence.

1. The first, then, is the world-renouned fern-root = *aruhe*, *roi*, or *marohi*, † = *Pteris esculenta*,—rightly so named by its first botanical discoverer, Forster; and though very well known by its common name to Europeans and to settlers (with whom, also, the plant itself is familiar), yet the edible fern-root is far from being rightly understood; I shall, therefore, have to offer a few remarks concerning it.

(1.) As to its proper localities :—

Good edible fern-root,—that which produced a large amount of *fecula*, was not to be found everywhere. In some districts, particularly at the north, it was comparatively scarce, and had to be dug and brought many a weary mile on the backs of the people to their homes, especially to their sea-side or fishing villages. ‡ Here, however, in Hawke's Bay (south side), in many patches of the low-lying rich alluvial grounds, on the banks of the rivers, it was more readily obtained. The best roots were produced in loose rich soil, where the plant had been undisturbed for years. I remember, many years

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* Tate's "Account of N.Z.," p. 106. Tate had also resided in New Zealand 7 years!

† It had also several other names, some of which were mythological, and some allegorical.

‡ As corroborating this, I may here mention that at the reading of this paper I exhibited some superior fern-root (though not of the best quality) which I had recently obtained from Pakowhai from the late chief Karaitiana's tribe. They had had three baskets of it sent to them as a present, some six months ago, from a place about 20 miles inland from Te Wairoa (Hawke's Bay); it had grown in volcanic soil, the roots being much pitted, and still having many bits of pumice adhering to them. They contained a very large amount of fecula, and commonly measured 12-15 inches in length, and 3 inches in circumference.

ago, travelling over an isolated hill of loose rich earth in the interior, which had been long famed for its fine fern-root; and for the occupancy and use of that hill for digging the root, several battles had been fought. The fern-root obtained from hard ground, was, at the north, collectively called *paetu*: while that got from soft, loose, red soils was called *koauau*. All fern-root diggings and places of good fern-root, were rigidly preserved; no trespassing was ever allowed.

(2.) As to the proper time of digging, and manner of drying it, etc.—

The old Maoris had their set fixed times of digging the root, in the spring and early summer months; they knew well when the roots were abounding in nutriment, and would no more have dug them up in the wrong season than we should our potatoes. They were also careful not to burn off the fern plants from their digging grounds, save at the proper time of the year, as such careless burning injured the roots; but burning off the fern in the proper season, in August, improved them. In doing so they were ceremonially careful (at the north) to use the wood of two plants for firing the fern,—the *kareao (Rhipogonum scandens)*, and the *mahoe (Melicytus ramiflorus)*. In digging it, which was always done with their long wooden sharp spade *(koo)*, they took care not to bruise or break it into pieces; at the same time they examined it by breaking, etc.,—if it were dry internally, then it was good, and they went on with their digging; if wet, inferior. They carefully put it up in loose stage-like piles, on wood, to dry in the wind, shading it from the sun. And when it was quite dry, at the end of a fortnight, they went over it, selecting and separating it into several kinds or qualities, of which they had many (just as with us, the various kinds of wheat, potatoes, etc.); some being for the chiefs, some for warriors, some for visitors, some for common daily use, and some for the slaves.* Each quality was put up separately, and carefully stored away in large quantities from both sun and rain for future use,—properly harvested, dried, and stored, it would keep good for years.

(3.) In preparing the fern-root for daily food, it was never used green. The dried root was slightly soaked in water, roasted a little on the embers, and beaten soft with a stone pestle, or short hard-wood club, or one made from the bone of a whale (each properly made for the purpose), on another large smooth waterworn stone; this beating of the root was constant and hard work. In the roasting and beating the black outer bark, or skin, peeled off. The better quality root so prepared was as soft as a bit of tough dough; it soon, however, became stiff and hard, when it snapped like glass or good biscuit. When it was prepared in large quantities, for taking with them to sea in their coasting voyages, and also for going to fight, then

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* See Appendix D.

it was made up into a kind of pounded mass. In the spring of the year the succulent young shoots *(monehu)*, which rose out of the ground like asparagus, were also eaten fresh ; they were very mucilaginous.

No doubt the fern-root was very nutritious ; the old Maoris thought highly of it, and always liked it, even preferring it in the summer with fresh fish, of which, in that season, they always had abundance. They also used it in the summer season soaked, after pounding, in the sweet luscious juice of the berry-like petals of the *tutu (Coriaria ruscifolia)*. Pigs fed on it, in their wild state, always yielded the finest and most delicious pork ; as *we* well knew and experienced before that we had either beef or mutton in the country.

Both by way of illustration and of proof, of how the fern-root was formerly prized, I here bring forward the following :—

(1.) It is stated of the New Zealand chief Kiinui—who had been basely kidnapped and carried violently away from his native home (Doubtless Bay) by M. de Surville, commander of the French ship *Saint Jean Baptiste*, in December, 1769, and who died of a broken heart at sea, on the 24th March, 1770, off the Isle of Juan Fernandez, on their passage to France—that "while he ate heartily of all the ship's provisions, he pined after the fern-root, and always regretted the want of his primitive food."—*(Rochon's Voyages aux Indes Orientales*, Tom. III., p. 389.) Curiously enough Captain Cook, on his *first* voyage, had only just left that bay on his voyage north, when De Surville entered it! They did not, however, see each other's ships.

(2.) The Fable of the Fern-root and the *Kumara*.—The fern-root and the *kumara* were one day bantering each other ; at last the *kumara* rudely said to the fern-root, "Thou art an unsightly thing! containing but small sustenance from long eating." Then the fern-root answered his antagonist triumphantly (for it has passed into a proverb with us), "Although I am but an unsightly thing to look at (as thou sayest), carry me to the water and soak and prepare me properly, and when the sea-breezes are blowing, then it will be nothing else but the joyful cry of 'prepare! prepare!' "*

Meaning, that in the summer season, when the sea-breezes blow daily, and the choicest fish in large shoals approach the coast and are caught, and

* I find that Taylor has given this fable, in incorrect Maori and worse translation (!) as usual ; not apprehending the real gem of the excellent retort, through which it had passed into a proverb. To which, and worse still, he has added this remark,—"Formerly fern-root was nearly the sole food of the Natives during the *winter* months. It was beaten indoors, on account of the constant rain, and their houses being always filled with smoke, the eyes were as constantly suffused with tears." *(Loc. cit.*, p. 302.) I copy this remark as being quite in keeping with the erroneous ones copied at pp. 4–5, footnote.

the cockles and other prized bivalves are in their season, (and when, too, there are no *kumara* to be had), then the cry continually will be—" Prepare the nice root as a delightful adjunct with our fresh fish."

(3.) Among the many diversions of the young folks in the olden time, were those of witty and laughable questions and answers, of course taught them by their seniors. Here is one, showing how greatly they prized the fern-root—it is the diversion of a party of young girls—it is called, " What is thy husband to be ?" And it runs thus :—

Question: What is thy husband to be ?

Answer: A man who well knows how to cultivate *kumaras.*

Rejoinder: Then thou must seek such, away, in a fine sheltered soil, and under a powerful chief to protect.

Again the question is put :

Q. What is thy husband to be ?

A. A man who is a good and lucky fisher.

Rej. Ah ! yes, at times, now and then, when the sea is smooth.

Again the question is put :

Q. What is thy husband to be ?

A. A man who is good at digging fern-root.

Rej. That is the choice one : always a pile of your own, stacked in store, ready at hand for the wife to pull from.

Much of the beauty and wit of this little piece is lost in a translation ; in the original it is exceedingly terse, full of meaning, and semi-poetical.

(4.) In a very old and quaint semi-genealogical song, the heavenly origin, or birth, of the fern-root is thus given (omitting the introduction) :

—This tradition (is) not from me,—
From ancient times (was) this tradition ;
Mine (is) merely an announcing,
A proclaiming to the habitable world.
Thus I speak forth, that thou mayest hear ;
Nevertheless, (it) has been repeatedly heard.
* * * From Rarotimu was born
The closely-woven-mat[1]-of-the-sky
Which verily formed[2] the Fern-root ;
There, upon the great broad back of the sky,
It was clinging closely.
But when Taane[3] uplifted his father on high,
(Separating him for ever from his wife, the earth),
Then the Fern-roots fell off rattling down below
To the earth beneath[4] who received them,

1 Or, Vegetable carpet.
2 Or bore ; or caused to grow.
3 One of the sons of the Sky (father) and Earth (mother.)
4 *Lit.* the Kicked below : *i. e.* Mother Earth.

Henceforth to stand in her fertile vales and sides.
In the times of deception[5] they were first thoughtlessly (collected),
But thoughtful-ability first selected them properly,
And planted them fittingly out into little holes
Sticking them in securely—
So as to become firmly-fixed roots of the Fern.[6]
At last, the succulent crosier-like shoots
Appeared, uprising among the habitations of men;
And (they were) named
(The) Young-lady-who-showed-how-to-dig-up-her-lord.[7]

A piece very difficult of translation, owing to its containing such a large amount of compressed allegory, referring to their ancient mythology and cosmogony. It is almost unique (as far as I know), and therefore I have given a free literal translation of it, with a few notes.

To the foregoing Maori testimony I would just add a few brief extracts from the writings of their first European visitors respecting the fern-root.

Captain Cook says: "Instead of bread they eat the root of a kind of fern. Of these roots, after roasting and beating, a soft substance remains, somewhat clammy and sweet, not unpleasing to the taste."—(*First Voyage*, Vol. II., p. 312.)

Mr. Parkinson (Sir Joseph Banks' draughtsman) says: "They have a kind of fern, the roots of which roasted make a good substitute for bread, especially when their *kumara* is young and unfit for use."—(*Journal*, p. 99.)

Dr. Anderson, who was Captain Cook's surgeon on his third voyage, says: "They use a fern root, which seems to be their substitute for bread, as it is dried and carried about with them in great quantities when they remove their families, or go far from home. This they beat with a stick till it becomes pretty soft, when they chew it, the edible part having a sweet mealy taste, not at all disagreeable."—(*Cook's Voyages, Third Voyage*, Vol. I., p. 158.)

Rutherford also, who had to subsist in part on it, *a-la-Maori*, during his long residence among them, speaks approvingly of it; and a Hindoo, whom Marsden and Nicholas found dwelling among the Maoris, and who refused to leave them, preferred the fern-root to rice.

Twenty-five years ago experiments were made at home in England on the root of the common fern of that country—the brake, or bracken (*Pteris*

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5 Or Deceit; or Imposition; or Carelessness.

6 *Lit.* Haumia; one of the sons of Sky and Earth; who, at the great separation, remained with his mother, and is called the Father, Former, or Precursor, of all vegetable food spontaneously growing—particularly of the common Fern.

7 Or, Superior, Master, or Forerunner. *Lit.* The name is, Miss- (or, Daughter-Lady) dig-up-thy-lord; *meaning*, that the young shoots of fern showed annually where the best (thickest, strongest) roots, which produced them, were to be found; and, also, in their being used as food by man, they enable him to persevere in digging them up.

aquilina), partly under the belief (which still obtains with some folks) that that common British species is identical with this of New Zealand; or, at all events, that both plants were but varieties of one species, which I, however, do not believe, for they differ in several important particulars, particularly in the root itself. The experiments signally failed, very likely owing to the roots having been dug up and used *fresh*, and that perhaps at the wrong season of the year; besides, they did not go about its preparation and cooking in the right way. This is what the celebrated cryptogamist, the Rev. Mr. Berkeley, says about it: "The long creeping rhizoma of a variety of *Pteris aquilina* was formerly much used in New Zealand for food; but, if the New Zealand variety is not more palatable than our own, it is a very undesirable food*. The rhizoma of our own form of *Pteris aquilina* when roasted has just the slimy consistence, taste, and odour of ill-ripened brinjals" [*Solanum melongena*.—W.C.] "when cooked, than which nothing can be a worse compliment. The great objection, however, to this as an article of food is the nauseous mucilage. If the rhizoma, after being washed and peeled, is scraped, so as to avoid including the hard-walled tissue, and then mixed with a sufficient quantity of water, the mucilage will be dissolved, and after a few hours may be decanted," etc.—(*Introduction to Cryptogamic Botany*, p. 519.)

2. The second is the succulent fruit of the *karaka* tree (*Corynocarpus lævigata*), a genus confined to New Zealand, of which, also, only this one species is known. This fruit, or, rather, in common language, its nut or seed, was of inestimable value to the Maori as a common and useful article of vegetable food, second only in place to their prized *kumara* tuber; and I should have placed it before the fern-root, only it is not so common, being confined to the vicinity of the sea. In its *raw* state, however, it is a deadly poison; a small quantity sufficing to throw into convulsions and great and permanent distortions of the limbs, and to kill; but prepared and cooked, it is perfectly innocent and wholesome. The Maoris ate both the flesh (*sarcocarp*) of the fruit (*a drupe*) when fresh and ripe; and its kernel (*embryo*) or large seeds; it was this latter only that was poisonous in its raw state.

Every autumn the Maoris removed in large numbers,—men, women, and children,—to the *karaka* woods and thickets on the sea-coast, to gather

* This statement has never failed to remind me of what the Maoris said and did when they *first* saw our mission wheat growing at the Bay of Islands, a vegetable production too, which they had long wished for, through having so often tasted bread, biscuit, and flour, of all which they were passionately fond. "What!" said they on seeing it in leaf, "Grass, it is only grass;" and then a little later, when early in ear, they hastily and eagerly tried some of its green half-filled grains, and spat them out with disgust and reproof to us.

up and prepare the *karaka* kernels for keeping; properly prepared and kept dry these would keep two or three years, or more. The fruits were collected in baskets full,—placed by bushels in very large heated ovens, generally made in the sea-beach above high-water-mark, and there baked and steamed a considerable time, then taken out, put into loosely-woven baskets and laid in running-water, and shaken and knocked about a little, to detach and to carry off all of their outer skin and pulp, leaving the large seed intact, within its own cartilaginous shell of fibrous network (*endocarp*). The baking and steeping completely removed all their poisonous qualities. Afterwards, they were spread out on mats and stages in the sun to dry, and when perfectly dried, stored away in baskets for future use. When used, the kernels, still in their thin yet tough inner skin or husk, were steamed in an earth oven, which softened them for eating. As an article of vegetable food they were greatly and universally esteemed by the Maoris; and were very wholesome.

3. The third was the fruit of the *hinau* tree (*Elæocarpus dentatus*); a tree generally common throughout the islands, in the forests in the interior, but not near the sea. Of this genus there are two, probably three, species in New Zealand. The fruit, which grows plentifully in small loose bunches (*racemes*), is a small drupe about the size of a large sloe, having a tolerably large and peculiarly shaped furrowed nut within; its skin is hardish, dry, brittle, and shining, and of a dull ash or grey olive colour, and its flesh (if such it may be termed) is also dryish, small in quantity, austere, and altogether uneatable in its fresh and raw state, reminding me of the taste of the acorn. Here, too, the ingenuity and patience of the Maoris were particularly displayed. These fruits were collected in large quantities when ripe from the ground under the *hinau* trees, and placed in water in the hull of a canoe, or some similar large wooden trough; there, after steeping, they were well rubbed in the hands, the nuts, stalks, and bits of broken skin strained out, the water carefully drained off, and the grey coarse meal left as a residuum made into a kind of huge cake, cooked and eaten. By some tribes, however, the fruits were not steeped in water at all, but merely gathered up and pounded in a rude wooden mortar with a pestle-like club, and the whole sifted through a cunningly-devised though coarse sieve, made of the long, straight mid-ribs obtained from the linear leaves of the tii-tree (*Cordyline australis*). To bake a big cake (20–30lbs) of it thoroughly, took two days. In colour the cake was a blackish-grey, darker than barley or rye bread; the rough unpalatable taste of the fruit in its raw state being wholly lost in the cooking. Although a troublesome and lengthy preparation, especially when the very small amount of floury meal obtained from each drupe is considered, this food was greatly esteemed, and

always made a first-rate dish, when in season, for visitors. The Maoris had even an old proverb as to its superior excellence—showing that it was well worth being roused up out of one's sound sleep to eat it freshly cooked—which, I suspect, arose in a great measure from its large, solid, heavy pudding-like mass—a kind of "cut-and-come-again" dish! of which they had not another such among all their vegetable messes. The rats, in the woods, were very fond of its seed or kernel. Often have I, in travelling through the forests, picked up the nuts, and have been astonished at the patient gnawing of the rats, always made at one end, to extract the kernel, which they also invariably did through a very small hole! the shell of the nut being excessively hard, and the kernel itself very small. I scarcely ever found a sound nut on the ground, all had been gnawed.

4. The next is the *puwha*, or common sow-thistle (*Sonchus oleraceus*, var., or two varieties, exclusive of the later introduced British one). This was only used fresh as a vegetable, and gathered daily, or twice a day, as required, and steamed with their other food in the earth-ovens. Only the tender young leaves and unexpanded flowering tops of the plant were used; and the succulent stems of these were sometimes roughly bruised and washed in running water to get rid of the bitter milky juice before cooking. This plant was largely eaten, especially with fresh fish in the spring and summer, and it was greatly liked. It is a very good and wholesome vegetable; often have I gathered it for my morning or evening meal. Though everywhere common, yet in some places, as in the woods and on the dry open plains in the interior, both myself and travelling party have not unfrequently, when hungry, sought for it in vain!

5. The roots of the *pohue*, the common convolvulus or bindweed (*Convolvulus sepium*), were also carefully dug up and cooked for food. These, however, were not greatly esteemed; partly, I am inclined to believe, from the trouble of digging their long thong-like roots, and the small quantity obtained for the amount of labour expended.

A great peculiarity here to be noticed, is, that the roots of this plant, said to be identically the same species as the British one, are here in New Zealand edible and wholesome; while in England and elsewhere they are highly purgative (a few grains being sufficient), and were formerly there used medicinally. [I early pointed this out to the late Sir W. Hooker.]

6. The fine frond-stems (*stipes*) and trunk of the *korau* or *mamaku*, the black tree-fern (*Cyathea medullaris*), were also baked and eaten, and were greatly liked. This excellent boiled sago-like substance was certainly one of their very best wild vegetable productions, so easily, too, obtained; but it could only be used occasionally from its comparative rarity, as the plant being slow of growth required several years to bring it to any size, and when

once cut died. The first European who discovered and named it, Dr. Forster, spoke very highly of it.

7. The blanched heart-shoot (*korito*) and bases of the youngest leaves of the *tii*, or *kouka*, or *whanake*, the cabbage-tree of the settlers (*Cordyline australis*), were also commonly eaten both raw and roasted in the embers or hot ashes; but more as a makeshift in travelling or fishing (eels), etc., than as a regular village article of food. Being common, and almost everywhere at hand, it was very useful at such times of hunger,—as I, myself, have proved; its taste is slightly bitter, but not unpalatable.

The large tap-root of this plant was also dug up and split and cooked for food; it was very fibrous, yet contained a large amount of both saccharine and farinaceous substance. It took very long in cooking, and was chiefly resorted to in times of great scarcity of vegetable food. Upwards of 30 years ago, at a time of severe want of vegetable food here in Hawke's Bay, through long drought and failure of their crops, the roots of this tree were extensively used in every village,—the modern Maoris being greatly benefited through having iron pots in which to boil them. Another species of this genus, *tii-koraha* (*Cordyline pumilio*), a very much smaller plant of low growth with narrow grass-like leaves, had much more fleshy and saccharine roots; these were sought and dug up, hung in the wind and dried in small bunches, and eaten sometimes in their raw state. This plant was more commonly found at the north, growing in the open fern lands.

8. A very capital article of food was the blanched heart (*korito*) of the southern palm-tree, *nikau* (*Areca sapida*); but as a fine tree only afforded a single dish, and the obtaining of it always killed the plant, it was not very commonly used. It, however, is excellent eating, even in a raw state, juicy, succulent, and nutty, with an agreeable taste, and is very wholesome. It proved of very great service to me once when I had both lost my way and my companions too, in travelling in a new country, and was starving.

9. Another highly curious article of vegetable food was the *pungapunga*, the yellow pollen of the *raupo* flowers—the common bulrush, or cat's-reed mace (*Typha angustifolia*). This was collected in the summer season, when the plant is in full flower, in the wet swamps and sides of lagoons, streams, and lakes. I have been astonished at the large quantities of pollen then obtained. On one occasion, more than thirty years ago, I had several buckets full brought me by the present chief, Tareha, in his canoe, some of which I sent both raw and cooked to the Kew Museum. In appearance in its raw state it exactly resembles the ground yellow mustard of commerce, and when put up into bottles would be mistaken for it. It is obtained by gently beating it out of the dense flowering spikes. To use it as food it is mixed up with water into cakes and baked. It is sweetish and light, and

reminds one strongly of London gingerbread. Dr. Sir. J. D. Hooker informed me that when he was in India he found the natives of Scinde making a precisely similar use of it.

10. The large, hard, stony seeds of the plum-like drupe of the *tawa* tree (*Nesodaphne tawa*) were also used as food by the natives of the interior. This tree grows tall and large, and is very common throughout New Zealand in the low-lying forests. The fruit is something like a common English dark-coloured plum, and the flesh or pulp, though eatable in its raw state, is scarcely palatable, and not relished. The seed or kernel is peculiar, resembling that of the date of the shops, and equally hard. Long steaming them, however, in their Maori earth-ovens does wonders, and makes them to become serviceable to man. For this purpose they were formerly collected in quantities.

11. Another magnificent fern *(Marattia salicina)*, *para* of the Maoris, was also an article of food, the large, scaly, bract-like pieces of its big tuberous root were used for this purpose. It inhabited damp, shady forests, and was very scarce. I never found it but once, in forests at the head of the Waikare River, Bay of Islands, when I took off my hat to it! Of those plants I sent specimens to my good friend, the botanist, Allan Cunningham; also to Sir W. Hooker, at Kew,* I believe that it only inhabited the northern parts of this North Island, and formerly was much more plentiful there (from Maori report). No doubt its being so eagerly sought for food caused it to become scarce, just as with the black tree-fern *(Cyathea medullaris)*. Its large arching fronds were ten to thirteen feet in length.

12. Another peculiar plant was the *karengo* (*Laminaria* sp.), a sea-weed, found growing in abundance on the flat clayey tidal rocks of the East Coast, and particularly about the East Cape;—a plant not readily forgotten by the traveller that way, should he have incautiously trodden on it when wet, from its extreme slipperiness, and flat prostrate paper-like form of growth. This plant was collected and dried in the sun, and closely packed away in baskets for use. I have known baskets of it dried, to be taken inland to Taupo and elsewhere, on the Maoris' backs, as a suitable present, in exchange for the delicacies of the interior forests, like the *karaka* kernels *(ante)*. Sometimes in the summer season it was steamed in the earth-oven, and together with two other species of sea-algæ, *rehia* and *rimurapa* (*Gigartina* and *Gracilaria* sp.), was mixed with the sweet juice of the *tutu*, as an excellent kind of blancmange-like summer food, eaten cold, and devoured with avidity.

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* See *London Journal of Botany*, 1842, Vol. I., p. 303; and *Tasmanian Journal of Science*, Vol. II., p. 305.

13. Several fungi were also eaten in the summer season, such as the two large terrestrial species called *pukurau (Lycoperdon fontanesei* and *L. giganteum)*; the *harore (Agaricus adiposus)*; the *hakekakeka (Hirneola auricula judæ)*; and the *paruwhatitiri (Ileodictyon cibarium)*. Of this last, only the thick gelatinous volva, or outer shell, was eaten, and that when young and *before* it burst. For—*after* it had burst and thrown out its curious pileus of globe-shaped white network, covered with dark and fetid slime—its stench was unendurable; hence, no doubt, and from noticing how readily they sprang up after thunder showers, arose its Maori name—thunder excrement!* The two species of *pukurau* grew commonly in the open fern and grass lands, and were often of large size, and when young are very good eating. One species, *L. giganteum*, is said to be identical with the well-known edible European species of that name. The *harore* and *hakekakeka* were found plentifully on trees, both living and dead, in the woods, but were not greatly esteemed; recourse would be made to them in times of want.

14. The thick, fleshy roots of the New Zealand lily, *rengarenga (Arthropodium cirrhatum)*, were also formerly eaten, cooked in the earth-oven. This plant grows to a very large size in suitable soil, and when cultivated in gardens. From this circumstance, and from having not unfrequently noticed it about old deserted residences and cultivations, I am inclined to believe that it was also cultivated.

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* Rev. Mr. Berkeley has a curious error, in his work already quoted, respecting this plant (similar to that about the fern-root). He says,—"In New Zealand the gelatinous volva of *Ileodictyon* affords an execrable article of food, which would indeed be used nowhere except under great scarcity of better sustenance." And again,—"The gelatinous volva of *Ileodictyon* is eaten in New Zealand, but it must be a very unpleasant kind of food; and the same part of *Lysurus mokusin* is eaten by the Chinese."—*Loc. cit.*, pp. 254 and 334. No doubt Mr Berkeley supposed that this fungus was used as an article of food *after* bursting. Just as if one was to write against the use of asparagus for food after it was in flower! A similar or worse error is also made, or enlarged, by Dr. Lindley, in writing on the mangrove tree (*Avicennia officinalis*, Lin.); he says,—"It exudes a kind of green aromatic resin, which furnishes a miserable food to the barbarous Natives of New Zealand, who call it *manawa*."—*Veg. Kingdom*, p. 665. Dr. Hooker, in his Handbook of the New Zealand Flora, attributes this error to Forster, who—certainly in two of his botanical works ("*Plant. Escul.*" and "*Prodromus*")—had named the New Zealand mangrove, *A. resinifera*; but, as Forster was never in the North Island of New Zealand, where alone the tree grows, he could not have even seen the living plant. Forster had obtained that information from Crozet (*Voyage de M. Marion*); and Crozet had jumped to that conclusion from seeing the Bay of Islands Maoris chewing the *kauri resin* (not to eat, but as a mere masticatory, an old practice of theirs), and from noticing the large lumps of that resin floating about and stranded on the sea-mud among the mangroves,—and so error grows and is perpetuated!

15. The inner part of the white succulent roots *(koreirei)* of the *raupo* or bulrush (already noticed), was also largely eaten raw, especially by children in the summer; it is mild, cooling, and refreshing, and not unpleasant.

16. In times of great scarcity of vegetable food, the globular nut-like roots of the *riiriiwaka*, tall sedge *(Scirpus maritimus)*, were collected and eaten,—that is, the kernel-like inner part. It was amusing to witness the half-wild pigs of the modern Maori in the summer season—before the arrival of the European settlers—when the littoral swamps were drying up, how they would go into them, and dig and crack and munch those roots, concealed in the sedges of the swamps; they were often detected by the sound of their cracking and munching!

17. Another fleshy root, and that a tolerably large one, of the Orchis family, often the size of a middling-sized *kumara* tuber, or of a stout, long-red radish root—the *perei (Gastrodia cunninghamii)*—was also eaten; but it was rather scarce, and only found in the dense forests.

18. Lastly, the leaves of several smaller plants were also used in their season as vegetables; as *raupeti (Solanum nigrum); toi (Barbara australis); tohetake (Taraxacum dens-leonis)*; and the very young succulent and mucilaginous shoots of two ferns, *Asplenium bulbiferum* and *Asplenium lucidum.* But the use of these in modern times, or during the last 40–50 years, was commonly superseded by that of the extremely useful and favourite plant—the "Maori cabbage," *(Brassica oleracea)*, introduced by Cook *(nanii*, of the Maoris at the north; and *rearea* at the south), of which they carefully sowed the seeds. I have, however, often partaken of *Solanum nigrum*, boiled as greens, at the table of a settler.*

Before, however, that I close this subject, a few words on their summer fruits may not be out of place. Foremost here (the *karaka* having been already mentioned) is the *tutu (Coriaria ruscifolia);* the rich and wholesome juice of the berry-like petals of this plant, common everywhere, was in large request and plentifully expressed into big calabashes, which were kept in a cool place for immediate use. Next is the *tawhara*, which can scarcely be called a *fruit*, being the large thick white fleshy and sugary bracts of the

* I mention this as being a similar instance to that I have given of *Convolvulus sepium (ante);* the *Solanum nigrum* of Europe being narcotic and poisonous. Lindley says of it,—"It is more active in its narcotic and dangerous symptoms than *Solanum dulcamara*,"—the English bittersweet, both also being British plants,—"a grain or two of the dried leaf has sometimes been given to promote various secretions, possibly by exciting a great and rather dangerous agitation in the viscera. It is a narcotic, and, according to Orfila, its extract possesses nearly the same power as lettuce opium."—*Vegetable Kingdom*, p. 620. I had both those plants, with others, and their common edible uses here, as vegetables, in my mind, when I wrote what I did in the "Essay on Botany, North Island of New Zealand."—"*Trans. N.Z. Inst.*," Vol. I., p. 3 of Essay.

climbing *kiekie* plant *(Freycinetia banksii)*, these were largely collected in the summer in big calabashes, being delicious eating when fresh;* curiously enough the real fruit of this plant (called *ureure*), which was also eaten, was only ripe in the winter season, thus being, as the Maoris say, the only New Zealand plant which yielded them its fruits *twice* in the year. The fruits of the larger timber trees, *totara (Podocarpus totara)*, *kahika* or *kahikatea (Podocarpus dacrydioides)*, *mataii (Podocarpus spicata)*, and *rimu (Dacrydium cupressinum)*, were also gathered in baskets full, and greedily devoured; these, however, were only obtained through difficulty and danger, in climbing those high trees and getting at the fruit on the very extremities of their branches, which the adventurous climber broke off and threw down; in doing so not a few accidents yearly happened, some being sadly maimed for life. The purple perfumed berry of the large fuchsia shrub, *kotukutuku* or *konini (Fuchsia excorticata)*, were abundant, easily obtained, and very nice when fully ripe, even to a European. So were the orange-coloured berries, though small, of the *rohutu (Myrtus pedunculata)*; these the natives obtained by spreading their larger garments, or floor-mats, on the ground, and shaking the trees, when the fruit fell in showers; the berry is about the size of a red currant, seeds large and very hard. The large berry of the *poroporo (Solanum aviculare)*, was also eaten; it is about the size of a small plum, and when fully ripe it is not unpleasant eating, before it is ripe it is very acrid. This fruit was commonly used by the early colonists in the neighbourhood of Wellington, in making jam. The *koropuku (Gaultheria antipoda*, var. γ.*)*, a curious small white fruit (though large for the size of the plant), growing on a very low shrub only two to four inches high, on the high plains in the interior, is also good eating. And so is the pulp of the rich orange-coloured fruit of the *kawakawa (Piper excelsum)*, when fully ripe, rejecting the numerous seeds.† The small fruits

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* See Proverb 19, "Trans. N.Z. Inst.," Vol. XII, p. 117.

† I should here quote a passage from Dr. Seemann's Botany of Fiji; where, in writing on an allied species of *Piper* (*P. methysticum*), he makes some strange remarks on the New Zealand plant, and on the Maoris themselves. (Like not a few others, before him and since,—hastily adopting, or jumping to, a conclusion—not yet warranted by any known soundly logical premises—to bolster-up a pet theory!) Dr. Seemann says:—"Drinking *kawa* being peculiar to all light-skinned Polynesian tribes, Dr. Thomson expresses surprise that the Maoris of New Zealand should have forgotten the art of extracting it, 'seeing that the plant (*P. methysticum*, Forst.) grows abundantly in the country.' But the *Piper* found wild in New Zealand is not, as Thomson supposes, the *Piper methysticum*, Forst., (the true *kawa* plant), but the *P. excelsum* of the same author. Hence it can form no surprise that a genuine Polynesian people should have forgotten the art alluded to during the long lapse of time intervening between their departure from Samoa (*sic*) and their discovery by Europeans. They have, however, preserved the name

of several species of *Coprosma (karamu, kakaramu, taupata, papaauma, tatarahake*, etc., of the Maoris) were also eaten; so were the fruits of several species of *Rubus (tataramoa)*, and of the *ngaio (Myoporum lætum)*, especially by children. While the liquid honey-like fluid abundantly supplied in the perianths of the *korari*, or New Zealand flax *(Phormium* sp.), was commonly used by all, both old and young, and was very wholesome eating.

Lastly, and in conclusion, I would briefly observe, that this estimable trait in the character of the Maori,—of passionate attachment to cultivation, descended and remained with him down to modern times,—to times long after the foundation of the Colony. For many years, however, prior to that event, the chief harbours of New Zealand (North Island) were thronged with ships—whalers and others—which called in to get supplies, mainly of vegetables,—potatoes, *kumara* (both small and large, the latter newly introduced), pumpkins, onions, maize, melons, cabbages, etc.; these were all raised by Maoris, who often received but a very small return in barter, especially if sold by them to the intermediate men, the storekeepers and ships' husbands on shore. A writer on New Zealand in 1834 (who for some years previous had been a resident in the Bay of Islands) says,— "Vast numbers of whaling vessels touch at the various harbours on the eastern coast, for supplies of potatoes and pork and other fresh provision, the produce of the country. In the Bay of Islands there have been at anchor, at one time, as many as twenty-seven vessels, most of them upwards of three hundred tons burthen, all of which have been supplied, by the industry of the inhabitants, with a sufficient stock of fresh provisions for a long whaling cruise." And a similar testimony I can also bear for the time (ten years) that I resided there. I have seen 400 seamen on shore at one time from those ships! and when the great and increasing number of the shore residents, including the several mission stations, the large number of their dependent natives at school, etc., and the sawyers in the neighbouring forests, are duly considered, the quantity of potatoes, etc., raised for all seems really astonishing! and all, too, done by manual labour, together with their bringing their produce many miles by land and by water—on their backs and in their canoes—to the market. And it must not be forgotten that the Maoris had now double labour in their cultivating,—in having to fence against the incursions of the pig, everywhere abounding; and, also, through their non-using of manure, as has been already shown. Such, indeed, was the strong, the passionate attachment of the young Maoris of

of *kawa*, which they have transferred to their indigenous pepper (!) (*kawakawa*), and also to a beverage (!!) (*kawa*) made of the fruits of the *Coriaria myrtifolia*, Linn.,—a plant by them termed *tupakihi*, *tutu*, or *puhou*. *Kawakawa*, according to Colenso's statement in J. D. Hooker's Flora Novæ-Zealandiæ, signifies 'piquant'" (*Flora Vitiensis*, p. 261).

those days to the cultivation of the soil, that we were *obliged* to allow the young men residing with us,—whether as servants, boatmen, or scholars,—to return to their several homes for that purpose every year in the planting season.

And just so it was here in Hawke's Bay for several years; in 1845 the Maoris (south side) first sowed and reaped wheat (the seed of which I had obtained from Auckland); and in succeeding years they raised enough of wheat and maize (exclusive of potatoes and scraped New Zealand flax), to load annually several small vessels; and all the produce of *hand* labour! Truly the Maoris of to-day, with all their civilization and riches, may take for a proper motto Fuimus!

Appendix A.

A List of the different Varieties of small Kumara formerly cultivated by the Maoris:—

1. Varieties in the northern districts, namely—Bay of Islands, Hokianga, and Kaitaia:—

(1.) White skin varieties, having white or whitish flesh—

* *Toroamahoe.*
Mapua.
* *Monenehu.*
Waniwani.
Kawakawa.
Maramawhiti.
Pauaataha.
Puurata.
Kanawa.
Maomao.
Mengerangi, with grooved sides.
Torowhenua, uniform small size, peculiar.
Pane, mealy dumpy sort.
Toitoi.

(2.) White skin varieties, having slightly reddish flesh—

Pohutukawa.
Kauto.
Hitara, a prized variety.

(3.) Red skin and flesh—

Whakakumu.
Toikahikatea.
Koreherehe, grooved sides, prized sort.
Taurapunga, a mealy sort.
* *Parakaraka.*

Awangarua.
Panahi.

(4.) Dark purple skin and flesh—

Makururangi.
Kauutowhau.
Kengo.
* *Pokerekaahu*, very dark throughout.
* *Anurangi.*
Matakauri.
Poranga, dark claret flesh.
Kaikaka, very dark throughout.

2. Varieties in Hawke's Bay and on the East Coast (exclusive of those, also cultivated by them, already entered in List No. 1, and marked with an *) :—

Tutaetara.
Tokouu.
Kawakawatawhiti.
Kairorowhare.
Hawere.
Paihaukaka.
Ngakomoa.
Raumataki.
Taputini.
Maori.
Pehu.
Kaawau.
Tutaanga.
Kurararangi.
Patea.
Kiokiorangi.

I do not consider the foregoing lists as being anything like exhaustive (indeed I have the names of a few others from the north which I purposely keep back); many of them I have both seen and eaten, 40 years ago and more. My two lists I have obtained from six sources, three north and three east coast, extending over 35 years, and I have been surprised at their great general uniformity. In all, the sort called *parakaraka* is said to be "the oldest variety"; the lists from the East Coast did not clearly specify the differences.

Appendix B.

"I suspected the cause," says Mr. Knight, "of the constant failure of the early potato to produce seeds, to be the preternaturally early formation of the tuberous root, which draws off for its support that portion of the sap which in other varieties of the same species affords nutriment to the blossoms and seeds, and experiment soon satisfied me that my conjectures were perfectly well founded. I took several methods of placing the plants to grow in such a situation as enabled me readily to prevent the formation of the tuberous roots, but the following appeared the best. Having fixed strong stakes in the ground I raised the mould in a heap round the bases of them, and in contact with the stakes: on their south sides I planted the potatoes from which I wished to obtain seeds. When the young plants were about four inches high, they were secured to the stakes with shreds and nails, and the mould was then washed away by a strong current of water from the bases of their stems, so that the fibrous roots only of the plants entered into the soil. The fibrous roots of this plant are perfectly distinct organs from the runners which give existence, and subsequently convey nutriment, to the tuberous roots; and as the runners spring from the stems only of the plants, which are, in the mode of culture I have described, placed wholly out of the soil, the formation of tuberous roots is easily prevented; and whenever this is done numerous blossoms will soon appear, and almost every blossom will afford fruit and seed."

Appendix C.

A List of the different Varieties of Taro *formerly cultivated by the Maoris.*

1. The varieties grown and used in the North, namely—Bay of Islands Hokianga, and Kaitaia Districts.

The best kinds were the three following:

*1. *Pongo,* } Varieties having a pleasing scent.
*2. *Turitaka.* }
3. *Potango,* a very superior sort, greatly prized.

Those three were eaten as *popoa*—sacred food used by the priests, (*tohungas*) on the death of chiefs; and also on the *Iriiringa*—the ceremonially naming of a newly-born chief's child ; pigeons were eaten with them as a relish.

4. *Awanga,* a very abundant grower and therefore prized.
*5. *Wairuaarangi,* a sweet, grateful kind, having a flesh of a peculiar pink tinge.
6. *Ngongoro,* a very large and prized sort.

Those three were used for noble or welcome visitors; one of this last variety, *ngongoro,* was said to have been sufficient for a man, but if a very great eater he might be able to manage two, hence, perhaps, its name, *ngongoro*—wonderful! from *Onomatopaeia,* that being the name of the strong nasal sound usually emitted on expressing great astonishment at anything.

7. *Mamaku,* } Good kinds, usually eaten at the *hahunga*—ex-
8. *Haukopa.* } huming and scraping the bones of a chief.
9. *Tokotokohau,* a large kind used at feasts.
*10. *Kinakina,* used by workmen when working together in large bodies.

2. The varieties formerly grown here at Hawke's Bay and on the East Coast, south of the East Cape, not included in the above list:—

11. *Paeangaanga.*
12. *Kohuorangi.*
13. *Patai.*
14. *Matatiti.*
15. *Takatakaapo.*
16. *Tautaumahei.*
17. *Koareare,* a white-fleshed sort.
18. *Kakatarahaere,* a dark-fleshed sort.
19. *Upokotiketike.*

Also Nos. 1, 2, 5, and 10, marked with a star.

Besides those they had here two others, which I have never seen; they were peculiar (if they really were *taros,* which, from their names, I doubt).

20. *Uhikoko* ("*he taro noa, otira he pai ano*"—a common *taro* of the usual kind, but a very good one).
21. *Uhiraurenga.*

Of this last it is said, "*he taro tapu tenei, he atua, whanatu rawa te ringa ki te hopu kia taona hei kai, rere atu ana.*" = This was a sacred *taro* (or one used only for tabooed purposes); it was a demon (or something extra-ordinary), when the hand of the taker was stretched forth to lay hold of it, that it might be baked for food, lo! it suddenly removed away.

Several of those *taros* I have both seen and eaten.

Appendix D.

The best kinds of *aruhe,* or fern-root, at the north were known by the general names of *maahunga* = mealy, and *motuhanga* = brittle, easily snapping. Here, however, on the East Coast, the best kinds were called *kaitaa* = gentlemen's food, and *renga* = mealy.

The *motuhanga* was really a splendid sort. I have seen it, a fine-looking black-skinned smooth root, eight to ten lines in diameter, with scarcely any woody fibres, and these were small, like a very fine rush, lustrous, hollow, and white. It would snap readily, like good biscuit, before being prepared or beaten.

Then the best was again separated, thus :—

1. *Kowhiti*=best selected ; for the chiefs.
2. *Huirau*=a hundred together in company ; for warriors. This was stored up in their hill-forts for sieges and fighting times*.
3. *Paka*=dried ; for general feasts.
4. *Ngapehapeha*=rinds, skins ; for common daily use.

There were also other names for the third best and inferior sorts, as *pakakohi*=dried and gathered scraps ; *pitopito*=ends ; and *pakupaku*=small in size (broken parts of the choicer kinds) ; *tuakau*, *pararaa*, etc., etc.—(See "Trans. N.Z. Inst.," Vol. XII., p. 122, *Proverb* 55.)

Art. II.—*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.* By W. Colenso, F.L.S.

[*Read before the Hawke's Bay Philosophical Institute*, 12th *July*, 1880.]

These Maori relations which I bring before you this evening, are selected from several other similar stories which I possess, and I have no doubt but that other parts and other tribes of this island have, or have had, many such ; so, also, those other unhappy tribes who preceded them—and of whom not a vestige remains !

From the earliest traditionary times this country seems to have been exposed to the rage and curse of desolating wars, which every now and then sprang up from very slight beginnings (as it appears now to us), and which were too often carried to fearful lengths. This sufficiently accounts for its great depopulation. Nearly all their wars seem to have been of that kind so pathetically and truly deplored by Lucan—"as leaving no cause for triumph." Nothing struck me more forcibly in travelling, (pretty extensively and always on foot, before the country became colonized and partly settled), than to find in all directions strong indications of a once heavy population, or a series (so to speak) of populations. And that those people

* This kind was what Cook, Crozet, and others of their early European visitors saw stored up largely in their forts and fighting places, which quantities excited their astonishment. Moreover, the Maoris would not sell them any.

who once dwelt together must have done so in very large numbers, the remains of their extensive earth-works (mostly on hill-tops and ridges), accomplished, too, without tools or the use of iron, plainly attest.

In these narrations we shall find not a few highly characteristic traits of the New Zealander, some of which I have already mentioned, or alluded to, in former papers,* as *Shame*—at detection of a fault, not unfrequently ending in suicide: *Revenge*,—deep, long meditated, obtained at any cost, and patiently waited and toiled for; on account of an insult, or a curse, never forgotten or forgiven! *Cunning schemes*,—laid and often well and fully carried out: *Vengeance*,—for bloodshed, which (as with the ancient Hebrews) was generally undertaken by the next of kin, and terrible in its effects! † *Strong belief*,—in the efficacy of spells and charms, and in the mere recital of words exceedingly simple in themselves, and rarely ever possessing the merest germ of a prayer to, or invocation of, any higher power; and, also, the highly peculiar custom of *personification*,—or the personifying of things, animate and inanimate,—together with their giving proper names to every single thing they possessed or manufactured; which names were, sometimes, well chosen and expressive, and sometimes highly ridiculous; yet, at the same time, were not seldom the cause or source of future trouble to them.

I would also further observe, that it is only in relations of this kind, as given by intelligent old Maoris, that we may expect to find accounts of, or allusions to, many things,—as works, doings, habits, manners, customs, beliefs, etc,—which have become quite obsolete and lost. Even the very meanings of the names of some are now scarcely known, save to the older men. Indeed, herein is a mine of ethnological wealth, if it could but be *expeditiously* worked, for in a very few years more there will be no remainders left! Even now, what is related by the *best* of the Maoris relating to the *olden* time will require *to be very cautiously received and examined, and that, too, by competent hands.*

Another thing which I may be allowed slightly to touch on here in passing, is, that these historical narrations will serve faithfully, though silently, to show to the settlers of to-day a portion of what the early

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* *Vide*—"Trans. N.Z. Inst.," Vol. I., "Essay on the Maori Races," § 28 and 35; also Papers on the Maoris, Vols. XI., XII., ditto.

† Like the "Goël haddâm" of the Hebrews, the next of kin was bound to avenge the murder of a kinsman; and too often here, like in those old and bloody times of the Jews (*e.g.*, Gen. XXXIV., 25, etc.; Joshua X., XI.; 2nd Samuel VIII., 2, and XII., 31), the Maoris carried their vengeance to a terrible length! Let those, however, who would freely censure the old Maori, fairly and honestly bear in mind what they may read pretty much of in the Old Testament.

missionaries in this country had to contend with; which, while scarcely any perceptible traces of them are now left, were, at first and for a long time, immensely powerful obstacles.

1. The Story of the Murder by Rangiwhakaoma.

The principal place of residence (*pa*) of this chief, of Rangiwhakaoma, was at Rakaupuhi; there he dwelt. One day he went to the entrance porch of his *kumara* store, and there he sat down. Now the name of that store was Raumatirua. While he was there a certain lad, named Tawakeariki, the son of a chief named Te Aotata, went up also to that spot, when Rangiwhakaoma said to him, "O, sir, whither art thou going?" The boy replied, "Just here, to this place, to look at the *kumara* in thy store." On hearing this Rangiwhakaoma said to him, "Stay a bit; it is not so very good to look about here (in the *kumara* store). Far better is it, O thou! below in the unseen world *(reinga)*, that the looking about may be both beautiful and pleasing." Then that boy went quickly below to the unseen world *(reinga)* to observe and look about at the steep cliff in Hawaiki. There he expressed his admiration at the beauty of the *kumara**; and, while he was thus admiring, lo! the whole piled-up-stack of *kumara* (in that store) was made to fall suddenly down upon him, so that he was immediately killed. His friends, on finding that he was dead, sent off a messenger to Uawa, to his father, Te Aotata. On hearing the sad news Te Aotata exclaimed, "By whom was my son slain?" The messenger replied, "By Rangiwhakaoma." The father, having mourned over his son, assembled a band of his followers. On their leaving to seek revenge the principal chief, Hauiti, called out to them, "O, friends, listen! If you should capture the daughter of Rangiwhakaoma, let her be kept alive, to become my wife." So the armed party of Te Aotata went to Rakaupuhi, the place where Rangiwhakaoma dwelt, invested the place, assaulted and took it, and killed the people, including Rangiwhakaoma. A remnant, however, escaped; and of those they caught alive they slew some as food for themselves, saving alive three women—namely, Rakauma-

* This is difficult to express clearly in a mere translation, although *to me* the original is clear enough. I have given it just literally; it may mean, either that the lad was *so* carried away in thought at that saying of the chief; or, that he *soon proved* the truth of what had been said (I incline to the latter). What the chief said was no mere bombast, but the common belief of the Maoris. To an *adult* that remark would have been sufficient, meaning *keep off*. But an adult would scarcely have gone thither, at all events not without a special invitation, as those barns or stores were rigidly tabooed, and could only be entered by tabooed persons, and then only at proper set times. And the lad, it seems, did not take the significant hint, but afterwards went inside. The *central* stack of *kumara* in the store, as formerly piled, might very easily be made to fall bodily on a little boy below; their *kumara* was always stored away rather loosely, to allow of the dry air circulating throughout, their great enemy being mould, caused by damp.

nawahe, the daughter of Rangiwhakaoma, and two others, young women of rank, named Rakaiparore and Hineparata. This business over the armed party returned to its own place—to Uawa; and Hauiti took Rakaumanawahe to wife. One day in the summer those two young captive women, Rakaiparore and Hineparata, were bathing as usual in the deep water, and there they amused themselves (as women do in bathing) with causing their armpits to make a great noise* while lashing the water with their arms. The noise was heard by some of the men at work, who cried out, "Those women are deeply affected!" and then the loud taunting song was raised respecting them, through which those two women felt greatly ashamed. So they both together arose and left that place, and travelled a very long distance by the sea-coast until they reached a place called Orerewa, where they stayed, and afterwards both took husbands there. In due course of time Rakaumanawahe, the wife of Hauiti, gave birth to two children; the first was named Karihimama, the second Ngatorotahatu. Being in want of seed *kumara*, Hauiti said to his wife, "Go to Ngatira to fetch some *kumara* for us." So she went thither, taking another woman (lady) named Tahipare for a companion. On those two women arriving at Pakaurangi, Ngatira's village, the people of the place rushed out and killed one of the women, Rakaumanawahe, but saved her companion; and, not content with killing Hauiti's wife, they cut her up and ate her. Then the woman that was saved returned to Hauiti, and related all that had taken place. On hearing this sad news the chief, Kahukuranui,† became exceedingly cast down, on account of the degrading outrage offered to his wife, and immediately began to assemble an armed band to go and take revenge. While this army was getting ready a woman came over from the people of Ngatira to see Kahukuranui, being incited thereto through her sympathy for him, and she showed him how Ngatira's place (*pa*) could well be taken by the army, saying, "By means of the crawfish the fort can be overcome," for Kahukuranui's army was not physically strong enough for that purpose. On hearing this, Kahukuranui commanded an immense taking of crawfish to be made, and they all went willingly about it. Crawfish were caught in great numbers and dried; they were brought from all the fishing stations on the rocky sea-coast—from Te Haha, from Taoparapara, from Te Ika-a-tauira, from Tatara, from Maitara, from Whangaiariki, from all the many creeks and seas the crawfish were

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* This is done while swimming, by rising and uplifting both arms, and bringing them down suddenly together with the air in the hollow of the armpits to the surface of the water. When well done by practised persons, it makes a loud hollow sound, and may be heard a great way off.

† Kahukuranui was the son of Hauiti, and the husband of Tahipare, the woman that was saved.

collected, and, when ready, were carried away for Ngatira.* Hence it was that Ngatira and his people afterwards suffered dreadfully in their fort when besieged through want of water, for the water of the place being outside of the village was soon in the possession of the besieging party, and the people of the fort could not get at it with their calabashes. But the friends and relatives of the foe living in that place took with them their heavy, thick flax-mat garments when they went down to see their relatives;† these they used instead of calabashes to carry up water to the besieged, soaking them in the water (although, after all, scarcely any water remained in the said garments), and when they returned to the fort they wrung the water out for the children and the women, while others desperately chewed and eagerly sucked the loose hanging flax-fringes of the wetted garments, just to moisten a little their parched throats. The water to drink was also the more required through their still eating the dried crawfish, being impelled thereto through hunger. For some time they managed miserably in this way; but at last, on trying it again, they found the armed party (who had become suspicious) watching the water, so that when the women and others went into it to wet their flax garments as before those watchers rushed in upon them, and they fled back to their fort with scarcely any water! Soon after this the final assault was made, and though the picked band of brave and fearless fighters, Koparakaitarewarewa and his friends, went boldly outside and withstood the besiegers, and that more than once, they were obliged to give way, being all faint and half-dead through want of water, for it was this alone that slew them. So Ngatira was killed, and Pakaurangi was taken. This battle was called "The death in the wet garments," or, "The death in the time of the wetted garments." The remnant who escaped of this people fled various ways, some went to Kaiora and dwelt there, building a fort *(pa)* for themselves; some fled further north; some haunted the neighbourhood of their

* The crawfish were preserved after this manner: they were taken alive, and in their shells were planted thickly in the bed of a running stream of fresh water, much like shingles are placed on the roof of a house; there they were kept down under water with stones placed on them. In a day or two they would be taken out, their shells slipped easily off, and the flesh hung up separately in the wind on light frame-work stages to dry. The flesh shrunk amazingly in the drying process, and when dried each one was very thin and light, all the legs, etc., having been packed on to the body of the fish in its damp state and there consolidated and compressed, were not now plain, so that each bore no resemblance to its original. When quite dry and hard they were put up in bundles and packed away in baskets, and kept in a dry store. They might well be called fish-cakes. They were greatly prized, especially by the Natives in the interior, to whom presents of them were sometimes sent, who gave potted forest birds in return.

† Their relations by marriage; a practice always allowed in their wars, though highly injurious to both sides, which they also well knew.

former homes, but away up on hills and mountains, and in cliffs, and in inaccessible sides of streams. Those who did make a stand and dwelt at Kaiora had a wretched life of it through constant dread. At last some of them fled south to Wairarapa, and even to Kaikoura (South Island), and thus were widely dispersed the refugees from Pakaurangi. This battle was known to our fathers by the name of "The death in the time of the wetted garments;" and this conquest was achieved by Kahukuranui. [This fight took place, according to several genealogical lists, thirteen generations back. —W.C.]

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2. The Story of the Chief Hauiti and his Two Elder Brothers.

The chief Hingangaroa had three sons; the first was Taua, the second was Mahaki, and the third was Hauiti; these all were grown up to manhood, and dwelt at Uawa. They all agreed to turn their attention to the making of large seine nets for themselves; those three chiefs were to have three nets, that is, one each; each chief having also his own immediate followers. Hauiti named his net Whakapaupakihi (*lit.* Taker of all [fish] in shallow tidal waters, *or*, in the ebbing tide); he gave it this name because of its immense size.* One day they all cast their nets into the sea, and had a large catch of fish; but Hauiti's net contained a great deal more than the others. Then his two elder brothers, with their followers, came and took away forcibly *(muru)* the prime fishes out of his net; and at every subsequent casting of his net his two elder brothers and their followers would come and take away by force his best fish out of his net. Then Hauiti began to think within himself, Whatever shall I do to circumvent or overcome my elder brothers? Not perceiving any means of doing it, he visited Tauranga, and went far inland to Makihoi, to see Marukakoa, a priest, or cunning man, of note; and to him he put this question, "How

* It may be useful to quote here what Cook says about their nets,—"We had plenty of fish, most of which, however, we purchased of the natives, for we could catch very little ourselves, either with net or line. When we showed the natives our seine, which is such as the King's ships are generally furnished with, they laughed at it, and in triumph produced their own, which was indeed of an enormous size, and made of a kind of grass [*Phormium*] which is very strong; it was five fathom deep, and by the room it took up could not be less than three or four hundred fathom long. Fishing seems indeed to be the chief business of life in this part of the country; we saw about all their towns a great number of nets, laid in heaps like haycocks, and covered with a thatch to keep them from the weather, and we scarcely entered a house where some of the people were not employed in making them." Cook's Voyages, Vol. II. (first voyage), p. 369-70. The very large nets, the heaps like haycocks, and the making in many houses, I have also seen, precisely as described by Cook. Curiously enough Cook had anchored and stayed some time at that very same place, Uawa, his Tolaga Bay. Cruise, and also Nicholas, 50 years after, relate the same of their nets.

can the killing (*or* discomfiture) of the relation be effected ?" And Marukakoa replied, " Shut close the eyes, and when thou openest them to see, (he is) killed, prostrate (on the ground): another plan (is by) fire." Then Marukakoa himself lit a fire in his talking-house—where these two were ; and when it was kindled he placed some cabbage-tree * upon it ; this tree in burning emits much smoke, which is also very smarting to the eyes. On seeing this, and smarting too from the smoke, Hauiti called out, " O, Marukakoa, what is this for ?" and Marukakoa replied, " This is the killing of the relation." Then Hauiti returned to his own place and people. Soon after his return he began to build his fort, which was named Ko te poti o Hauiti. He also said to his followers, " Be courageous, be brave and daring ; do not consider the relationship of the elder brother or of the younger brother or of the father ; let the eyes be firmly closed." Then he gave his orders, "Put the net into the canoe," which his people immediately did. All being ready, he sent a man up to the top of the hill to watch the motions of the fish, and when he saw the shoal of fish had come in pretty close to the land, he raised the signal for the casting of the net. They cast it, and a great number of fishes were enclosed ; then the elder brothers, with their followers, came forth again to take away, forcibly, the fish which had been caught from out of his net. On seeing this, Hauiti retaliated by falling upon them unexpectedly, and they were well beaten, suffering severely ! so that the fish marauders hastily retreated, letting drop from their hands the *kahawai* fish they had taken. Hence this fight was named, "The dropped *kahawai*" *(Arripis salar)*. Some time, however, after this event, Hauiti said to his people, " Come, let us cast again the net." And they did so. But before that the two ends of the big net were drawn on shore, the fish-robbing folks came down and turned again to the forcible taking of the fish out of the net ! On this the chief Hauiti suddenly called out, " Close up !" (His people knew well the meaning of that order !) So they brought together the ends and also the top of the net, thus enclosing, in one huge mass, both fish and men, and both died together. Hence the name of this destruction was, " The joined-top-of-the-net." His two brothers became greatly enraged at this, and said, " Verily, he has the best of it ! We must fight." *(Koia, kei a Papa !)* Then they despatched a herald to their own people to assemble and come to them, to destroy their younger brother with his people.† On Hauiti hearing of this, he said to his followers, by night, " Let us all leave and go and seek a good place, where we may dwell quietly, and live well." This he said, because his followers were but few in number (it is said, only 300) ; while those of his

* *Cordyline australis.*

† Very likely through being sons of their one father by *different* mothers.

elder brothers amounted to 2000 (*" e rua mano "*). So they deserted their place by night, and travelling steadily on they reached Whangaparaoa by nightfall. In the morning early he was surprised there by his two brothers and their people; then they fought, and several were killed on both sides, though by far the greater loss was that of the two elder brothers; Hauiti himself was wounded in the leg with a spear. The name given to this battle was, " *Werewere.*" After this, notwithstanding the many killed, they fought again; for whoever cares for loss of men in war when they are numerous? [The old world story!] By night Hauiti and his people left that place also, and reached another spot where they bivouacked. On the following morning he was again pursued by his two brothers, and when he had nearly reached the village (*pa*) of the chief Tamatauira (that is, Te Rangitawehikura), he was again overtaken by his two brothers. Again he turned with his people to fight them, and they were again defeated; many fell in this battle, which was named " *Kauneke.*" Then it was that his friends came forth to strengthen him, and they fought again, when his elder brothers were again beaten; this battle was named, " *Ko te ngaere-nuku, ko te ngaere-rangi.*" Now, however, Hauiti, being reinforced by his friends, followed after his two brothers and overtook them in their retreat; they again fought another battle, and his two brothers were again defeated; this fight was named, " *Ko te Rangihiwera, ko te Parawera-nui.*" And this was the last fight between them, for the two elder brothers were utterly routed. Afterwards, their bitter wrath and anger being over, they ceased fighting, and dwelt peaceably; but their descendants, in aftertimes, fought again,—as shall be now related.

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3. The Story of the Dreadful Falling-out between the Children of two of those Brothers.

TAUA, the eldest brother, had a son named Apanui; and Kahukuranui was the son of Hauiti. Now the very beginning of the deadly feud between their sons arose from Apanui's calling to Kahukuranui after the manner of calling to a dog; * and the inciting cause of his doing so was the whiteness of the hair of the head of Kahukuranui. However, though greatly displeased, Kahukuranui kept his deadly anger in his own bosom, brooding over the insult, and scheming how he should be amply revenged on Apanui. At last he hit upon a plan; he, Kahukuranui, determined to give his son as a husband for the daughter of Apanui, and when the two fathers had quite agreed, Kahukuranui proceeded to build a fine house for the occasion, which was also named " *Whakarei* "—beautiful, *or* highly ornamented. The

* " *Moimoi* "—a common term among the old Maoris for calling to a dog; but a great insult if applied to a man.

house being finished, Apanui was formally informed of it, and the day was also fixed for him to bring his daughter, whose name was Rongomaihuatahi, to become the wife of Kapi, the son of Kahukuranui. Apanui, therefore, came with his daughter and people; and they all entered into the new large house, which had been built for the occasion. Then Kahukuranui stirred up his people to bake plenty of food, and give a grand feast of good things prepared—of eels, and cod-fish *(hapuku)*, and *taro;* and so they feasted that day. On the morning after, the people of that place baked their morning's food for their visitors, namely, pieces of wood, bits of supplejacks, flowers and flowering stems of the New Zealand flax, and stones, and earth,—all kinds of rubbish! * and then, after having placed their dressed morning's meal properly before them in baskets, they suddenly fell upon Apanui and his people and killed them all. Hence that district of Uawa was taken from the elder son and became the land of the descendants of the younger son Hauiti.

[According to several genealogical lists which I have by me, and have examined and compared, this affair took place 12 generations back.—W.C.]

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4. The Tale of the Great Lady Ruataupare.

Here begins the story of Ruataupare. She was a woman of rank, and was the wife of Tuwhakairiora. In course of time she bore him six children, of whom four were girls and two were boys; and these were their names: the first, Mariu; the second, Te Aotiraroa; the third, Tukakahumai; the fourth, Te Atakura; the fifth, Tuterangikawhiu; and the sixth, Wehiwehi. † At the birth of this last, of Wehiwehi, the mother, Ruataupare, received serious internal injury, ‡ so that she dwelt apart in the sickhouse, on account of her severe pains. Some time after the birth of this last child her husband thought that she was getting well; but no, she continued very ill. On a certain day the husband went to the house where she was to see the mother of his children and to enquire after her, when, after some talk, she said to him, "O, sir, listen to me. Wilt thou not be willing to go and fetch the daughter of Te Aomania, to become a wife for thee?" The husband replied to her, "O, mother! O, mother! and what of her own husband?" The wife rejoined, "O, my lord, thou must also be saying that thou art a great chief." On this he assented to the talk of his wife, that he should go thither

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* This was done to insult first before killing (having got them completely in their power), and so to make death doubly bitter. In all such matters the New Zealanders excelled!

† *Lit.*, Fearing; Apprehension. Named, no doubt, like Ichabod and Benoni, of the Hebrews, from the circumstances attending his birth.

‡ *Vagina lacera.*

for that purpose, so he and his friends—a large party—went together. On arriving at the forest in the way they made a nice easy carriage for the woman, to carry her in on their shoulders. This they took along with them; and when at last they got near to the village to which they were going they left the shoulder-carriage there, and proceeded to the residence of the woman and her husband, whose name was Tuhauanu. On seeing the party of welcome strangers coming the man and his wife loudly welcomed them to their village with the common national cry of, "Come hither! come hither!" So the travelling party entered the big house and sat down, and all wept together through joy, which over they performed their usual nasal salutations. The woman then busied herself in preparing food for the strangers, and, when it was cooked, they ate. The repast over they rose to return to their own place, and the woman also went out in the usual way to give them the last parting words, "Go, go in peace," the travelling party replying, "Dwell, dwell in peace in thy own home." But when they were pretty near to the shoulder-carriage they caught up the woman and placed her in it to carry her off. Then they called loudly to her husband, "Thy wife is gone, being taken forcibly away." On hearing this he took up his own nice dog's-hair mat garment and went after the woman, crying out, "Go along, but go gently." He pursued and overtook the woman, and they wept and mourned together. When that was over he took his nice garment and spread it over her. Behold here two exceedingly excellent things performed by that man, Tuhauanu:—his yielding up his wife, and also his giving her his own choice chief's garment! The woman's name was Te Ihikooterangi, and she became the wife of Tuwhakairiora. She bore to him seven children, and these are their names: Te Aowehea, Mariuterangi, Te Rakaao, Te Rangitaupopoki, Tuhorouta, Tinatoka, and Kirianu. Of all that chief's family these following are the names of those who were highly spoken of, and became the common boast—namely, of the first wife, Tuterangikawhiu and Wehiwehi; of the second wife, Te Aowehea, Tuhorouta, and Tinatoka,—these being continually called and spoken of approvingly, day after day, as the noble offspring of Tuwhakairiora. Hence, too, the first wife, Ruataupare, became greatly displeased, and was filled with shame on hearing her children always spoken of as those of her husband, and bearing only his name, while her own name was never once uplifted, but utterly disregarded. So she commanded a canoe to be got ready, and she was paddled to Tokomaru, the place of her own tribe. Arriving there she was ridiculed and mocked by all the people, on account of her hurt (for which she also underwent severe surgical operation). All this made her very wretched, and she wept over her unhappy situation. Then she said to her brother, "Wilt thou not go to see our grandchild, that he may come hither to visit us?" So her brother went to him—to his place ; and, after some time spent with him, Te Rangitauki-waho, he came to Tokomaru to see his grandparents. The usual hearty welcomes and salutations over the old lady related to her grandson her situation. On hearing this he remained there, and commanded a fine large house to be erected, which was done, and when it was finished it was named "Te Koherearuhe." This done the summoning herald was formally sent to Waiapu, to Awatere, and to Wharekahika, to all the tribes, to the chief Kauwakatuakina, to the descendants of Hinerupe, to the offspring of Tu-whakairiora, and to the tribe Ngatiporou, to assemble themselves and to come and fight with all the various peoples who were dwelling upon the lands belonging to her—to the great lady Ruataupare. They accordingly came, and then the war began, which lasted a long time. The first battle was called "Te Koherearuhe;" the second, "Te Upokoparupuwha;" the third, "Taitimuroa;" the fourth, "Taiparipari;" and the fifth, "Waikoro-pupu." Those people living thereabouts were all killed, and this exterminating war was brought about by Ruataupare, and thus her own lands, which had descended to her from ancient times, were cleared of them, and the name of Ruataupare was now loudly proclaimed and feared throughout the whole district of Tokomaru. Hence her name rose very high, also those of her female children, who came to dwell with her on their old ancestral estates.

[According to their genealogies these circumstances happened ten generations back.—W.C.]

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5. *A Story of the Olden Time.*

The Fighting between Tuere and Tangihaere (of the one side) against Te Awariki.

A chief of old, whose name was Te Awariki, began this quarrel. This first fight is known to us in oral Maori history by the name of "The Bird, the flying Kite." On a certain fine day the chiefs of that village were all flying their kites, when the sons of Tuere and of Tangihaere were cursed by Te Awariki. He cursed them because the lines of their kites went above and over that of his own, which he was also flying. At this Tuere called out to his sons, saying, "Reply to him, that yonder is thy leg!"* So they all became very angry; ending in Te Awariki killing some of them. Not ceasing even then, he again arose in wrath with his followers against them, when they fought desperately, and seized and killed him. The distinguishing name by which this second battle between them is known is "Te Uirarapa" (*lit.* the lightning-flash). In that fight the people of Te Awariki

* Probably meaning the kite, or its string; this, of course, would be another bitter curse.

suffered greatly. Tuere, however, died at Te Waitotara, his own place, and was buried in a small wood called Kaniawhea. His sons and people continued to dwell for some time at that place; and by-and-by, at the proper time, they exhumed the body of their dead father Tuere, and manufactured his bones into fishing-hooks; and when all was done they carried them out to sea, and fished, and caught a large quantity of fine fish; then they paddled back to the shore, but on reaching it they did not take a single thing out of their canoe, leaving therein the fish, the hooks and lines, the paddles, and the balers,—all, everything; landing stark naked, and so going to their residence. Now all this was not of themselves, not of their own devising; for their dead father had planned all this, and bound them by his last words,—the performance only at this time being theirs; and thus they fulfilled his commands. They shoved off the canoe, and sent it adrift to go whither it would, being pretty sure that it would soon reach some other inhabited village on the coast, where the people would seize and eat the fish which was in the canoe, that by their so doing they might all die,—through the powerful malevolent influence of the bones of Tuere.* And so, at last, the wished-for slaughter was made, and the battle was gained by Tuere and his sons. And they (the sons) having done all this, left those parts, where they had long lived, migrating northwards to Maketu and Tauranga; where some of their descendants are to this day,—the offspring of Te Rangihouwhiri.

Two Tales, both historical and true, showing the Overwhelming Power of Shame.

6. THE STORY OF PUKOROAUAHI, HIS SISTER, AND HIS BROTHER-IN-LAW.

IN the olden time there was a chief named Taranuiomatenga; his wife's name was Puhaureroa, and her brother was called Pukoroauahi. These three lived together at one place. The wife's brother was very skilful at snaring birds for them to eat, which he continually did, while his sister and her husband remained quietly at home. The husband took good care daily to devour the choice fat birds, leaving for his brother-in-law the less prized and lean ones,—such as hawks and owls, parrots and crows;† these, too, the young man sat apart to eat by the smouldering brands of the cooking-fires, where his eyes were made sore with the smoke; nevertheless his sister very often managed, when cooking, to hide a nice tit-bit for her brother. One day the brother went to his usual occupation in the woods; on this day to catch, by imitation of their cries, small singing birds—as *kotihes* ‡ and

* The words are, "*Kei nga iwi o Tuere te mana te atua.*"

† *Callæas cinerea.*

‡ *Pogonornis cincta.*

*koparas** and *kookoos*.† While he was thus engaged he saw a bird, a pigeon *(kereru)* drinking water; then he went and got some New Zealand flax leaves, and made snares, and laid them cunningly, and soon caught a large number of pigeons, insomuch that he had them in heaps! He then returned to their place of abode, and told his sister to get proper baskets woven to bring home the spoils; saying that he had caught a great number of fine birds. On hearing this his sister was delighted, and when the proper baskets were finished, they went together to the place to gather up the birds. On arriving at the spot, there were the dead birds lying in heaps, looking so nice and tempting, that his sister was again delighted, and danced for joy, singing in her dance this new song,—"Even so, hanging out is thy tongue; snared securely upon his very perch, set for killing! Good, good, very good!" They turned to and collected all the birds which had been killed, and which lay in heaps before her, until they had filled 170 baskets with them. These were all caught by that one stream, and the name of that stream was Pouturu. And their death was cunningly effected thus: the food of the pigeon is the red *toromiro*‡ drupe, and there, just above the water, on a cliffy spot, were plenty of red pebbles; now the birds thought that those red pebbles were *toromiro* fruits, and so they came together at that spot in great numbers to eat those red pebbles, and when their throats got subsequently dry, through swallowing so many of those pebbles, they rushed to drink and were caught in the snares set by Pukoroauahi. (The names of that peculiar kind of snare are *parekauae*, and also *te whakoau*.) Having gathered up their birds they proceeded to carry them off on their backs to their residence, and worked hard all that day until evening; at which time the husband, returning from the woods to his home, saw the big pile of baskets of birds. Immediately he began to be angry with his wife, deeming those birds had been stolen, or surreptitiously killed, by his brother-in-law. At length his wife said to her husband, "Now, if thou wilt not believe me, come along and let us go together, and see the place where they were snared." So, in the early morning, they went thither together, and reached the water, and there he saw the red pebbles, and the snares, and all the rest of it. Then he knew well that they were not stolen birds from any preserves, and he became overwhelmed with shame. They went back to their home, and the young man said to his sister, "Kindle a separate *(tapu*=tabooed) fire to roast the birds for my brother-in-law; also, another common cooking fire to roast some for thyself." So she did so, she roasted the birds for her husband, and when

* *Anthornis melanura.* † *Prosthemadera novæ-seelandiæ.*

‡ *Podocarpus ferruginea.*

they were fully done she carried them to the place, outside of the house, where her husband was, that he might eat them; and entering she said to him, "O, Sir, arise and sit up; here are the choice birds nicely cooked; rise, and sit up." But he never moved. When she returned to the side of the fires, she said to her brother, "O, dear Pukoro, he never arose nor moved at all; he must be sleeping soundly." Now his manner of acting towards her was mostly in an unkind, rough way. Then the sister said to her brother, "Let us two eat our meal." The brother replied, "Let the preparatory ceremony be first performed." And these were the words of that ceremony:—"The ceremonial performance of Taranuiomatenga, the ceremonial performance of Pukoroauahi, the ceremonial performance of Puhaureroa, the ceremonial performance is fully done, the ceremonial performance is excellent (or approved); excellent (is the) food first ceremonially prepared, excellent the birds first ceremonially prepared."* This being fully done they took their meal, and when they had finished, the woman went again to see how it was with her husband; and, finding him in the same position, she cried out to him, "O, Sir, arise, and sit up." Then she looked more closely, and saw blood running down on his bed-mat! At this she went up to him to arouse him, and on pulling down the coverings (his loose garments), lo! he was quite dead, having been some time so. She left him in haste, and went out and called to her brother, "Alas! O, Pukoro, the evil thing is dead!" "Of what did he die?" replied the brother. "Of strangulation," she rejoined; "the troublesome grumbling creature is quite dead." Then they both took up fire, and set fire to the house in which the body was; and they heard the bursting of his belly in the flames. After this they proceeded to roast and pot in their own fat their birds, filling no less than 70 big calabashes with them. Thenceforth that young man took his sister to be his wife, and in course of time their child was born, and it was named Taporariiroi.

[I should here remark, that although only two or three persons are here spoken of by name—as, also, in most of these stories—there were many others concerned; for, according to New Zealand custom, the slaves and inferior working-men were never mentioned.—W.C.]

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7. The Story of a Thief, and of his Sad End.

The thief's name was Hotungakau; he went by night to the *taro (Caladium esculentum)* plantation of Tamateatitaka, and stole some *taros*; he baked

* This ceremonial was always performed over "first fruits," of birds (as here), of *kumara*, etc.; and, like most other of their semi-religious ceremonies, was very simple. Insomuch that the principal noun used, being neither a prayer nor a thanksgiving,—I could only translate thus,

them and ate them all up that same night, and so, having fully satiated his appetite, he went to his house to sleep. In the morning the man to whom belonged the *taro* plantation went thither, and lo! he saw what had been done by a thief, so he said to his friend, "My good fellow, our *taro* is being stolen by some thief and will soon be all consumed, I must go to-night and keep watch." So when it was evening he went thither, and sat down concealed. It was not very long after when the same thief returned, and was busy uprooting the *taro*; on this the man in ambush let fly his spear, which struck the thief in his side breast; he feeling the pain from the wound ran off and escaped to his own house. On reaching it he bound his girdle tightly around the wound and lay down to sleep, the pain being excessive and the blood though confined flowing inwardly. By-and-by the man who had thrown the spear went to the house of the wounded man. Arriving there he found the fire had gone out, so he called out, "Oh dear! kindle the fire, make it to blaze, that it may be light." So the fire was kindled and it soon burnt well; and Hotungakau was awaked out of his sleep and sat up. Then the man who had thrown the spear related his story, ending with saying to Hotungakau, "It seems to me that thou art the very man who was wounded by me with my spear?" On which Hotungakau replied, "It was not me, for here have I been sleeping ever since the setting-in of the evening." (Although at this very time he was suffering dreadful internal pain.) The spear-thrower rejoined, "The appearance of that man was exactly similar to thine." Hotungakau retorted, "I tell thee it was not me: thou art indeed beginning an evil altercation with me." On hearing this the visitor returned to his own place; but Hotungakau died just at daylight. His sudden and violent and shameful death was greatly lamented by the people of the village. His father, Rongomaikohina, being completely overwhelmed with shame at the doings of his son, came quietly, and wrapping the body in a garment, put it into his canoe and paddled off. Before, however, he went away, he laid a heavy and deadly spell upon the place. He paddled far away, even unto Waikawa, here he was pursued overland by some of the people he had left behind, because so many had died through his powerful spell, by which also the death of his son was fully avenged. At last a herald came to him, to Rongomaikohina, saying, "There are scarcely any people left alive owing to thy deadly spell, whatever shall we do that the remainder may be spared?" To which Rongomaikohina replied, "Kindle ceremonially a fresh fire by friction with the rubbing-sticks, letting a woman tread on the lowermost stick (to keep it steady), through that the power of my man-destroying spell shall be dissolved." Rongomaikohina never afterwards returned to his former place of residence.

8. THE STORY OF A BRAVE BOY, NAMED TAUTINIAWHITIA.

Once there was a chief, named Porouanoano, whose wife was called Hurumaangiangi. They dwelt together for some time; the woman becoming pregnant hungered after a bird, and said to her husband, "I am very desirous of having a bird to eat." On hearing this he took up his bird-spear and went away to the forest; but he was unsuccessful in spearing any of the birds commonly eaten; notwithstanding, he brought back with him two living birds, one was a *huia* (*Heteralocha gouldi*), and one was a *kotuku* (*Ardea flavirostris*); these, however, the woman would not eat, but kept as pets. After some time the man went away to his own (other) place of residence, while the woman remained. By-and-by, at the proper moon, she was delivered of a child, a boy, whom she fed and nourished and brought up. When he became a big boy he played at the sailing of canoes, at the whipping of tops, at the running of races on the sandy beach, and at the catching of small birds, with the other boys of the place. Then those other boys, who had fathers, would say,—"Those (doings, actions) of the fatherless brat are the only ones which go ahead!" On hearing this, Tautiniawhitia was swallowed up with shame, through his having no father; and he went crying and complaining to his mother, saying, "O mother dear, mother dear, wherever is my father?" She replied, "Thy father is not here, he is a long way off, at a very great distance; look towards the sun-rising, there away in that direction is thy father." Then the boy went into the forest, and sought about, and brought back with him a seed-pod of the *rewarewa* tree (*Knightia excelsa*), this he took to the water and tried it, and found that it remained upright very well, and did not upset. Then he returned to their dwelling place to his mother, and said, "My dear mother, I am going to the residence of my father;" saying also to her, "on no account will I remain here in this place, I am so greatly overwhelmed with shame." The mother said to him, "My dear child, at all events stay awhile until some food is cooked (and prepared to take with you), that you may be strong and able to endure for your journey." He said unto her, "Indeed I will not eat; 'a wooden spear-thrust can be parried, but a spoken spear-thrust cannot be warded off.' "* And so saying, he went his way to his canoe (made like) a pod of the *rewarewa* tree;† this he dragged into the water, and entering on board of his canoe paddled away. The mother cried affectionately after him, and he also cried back lovingly to his mother; he gave her his last words (to be remembered), and she did the

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* See "Trans. N.Z. Inst.," Vol. XII., p. 123; proverbs 58, 59.

† *Ka tae kei tona waka hua rewarewa*":—probably the meaning is,—after the model of; made like, in form and shape.

same to him. He went away out on the sea; then his mother chaunted the following charm—

From whom (is this) canoe?
From whom (is this) canoe?
From me, mine;
From Urumaangiangi,*
From Taramaangiangi.
The cunning snares of Rei†
(Are) as nothing at all!
The canoe glides fleetly.
Let the scowling winds coming hither‡
Be all stayed.
Pass through space;
Pass through weather;
Pass through billows:
Lo! the earth glides by!
Sail on to the nice landing;
Now beached nicely—so!
A canoe lightly passing over waves;
The doing—away, there,
(I am) beholding here with satisfaction.

Onwards the lad sped in his canoe, away, away, until at last he reached the very place where his father dwelt. Jumping ashore he dragged up his canoe, and hid it under the gravel of the beach. Then it was that the young folks of the village came running down to where he was, each exclaiming, "My slave! My slave!" and so he was seized and led up to the village, each boy and girl, and also each one of the adults, claiming him with much clamour and gestures. In the end, however, he became the property of a very small boy (who also was the son of Tautini's father), who ran off with great glee to his father, shouting as he went, "O, sir, behold! Here is my new slave!" The father was greatly pleased at the good luck of his little son, and said to him, "Take him away to the little bush (or wood) to dwell." One day, soon after this, the boys of the place went as usual to their play, some for the catching of small birds, some to the sailing of little canoes, and others to the many various games and sports of children. Tautini, however, went away into the forest, whence he brought back two birds exactly similar to those very two which he was made to hunger after when in the womb of

* Observe the change of her name by dropping the *h* (poetical usage), of which there is more in the way of elision in this chaunt, showing, though we cannot perceive it, that the retention of the letter *h*, even in a proper name, was offensive to the nice discriminating ear and cadenced rhythm of the Maori. Bearing in mind the literal meaning of the woman's name, White-and-thin-locks (*or* hair), these two lines—four and five—may well and literally mean from (her possessing) white and thin locks above; from (her possessing) white and thin locks below.

† A name of one of the malevolent superhuman ones of old

‡ Those raised by adverse malevolent beings.

his mother. Then he said to the *huia*, "This is the cry for thee to utter, 'The fire does not burn brightly; dark, dark, darkness prevails;'" and to the *kotuku* he also said, "This is thy cry, 'The fire does not blaze; it is very dark all around.'" And thus the lad taught those two birds in the little bush where he dwelt. On a certain night when it was dark the lad went to the place where the big house of the chief was, to reconnoitre, and when he got there he found all the inmates were fast asleep and snoring loudly. Then he returned to the little bush, and, taking his two birds, carried them off to the big house. Arriving there in the porch he opened the closed door, sliding it back carefully. Then he entered the house, and took inside also his birds and set them down, placing their supplejack cages among the ashes of the fireplace. Suddenly the *huia* cried out, "The fire does not burn; dark, dark, darkness prevails;" and then the *kotuku* cried, "(There is) no blazing of this fire; smouldering, dark!" The sleepers were all now well aroused at those shrill cries and human words, and, sitting up, looked on with feelings of wonder and admiration, which they expressed. Then it was that Tautini's father arose and stood, and, after observing closely for some time, exclaimed, "Verily, this lad is my own son, for those were the very birds which his mother longed for!" and, embracing his son, he wept over him rejoicing; and when it was daylight he took him away to the water, and there performed the usual and proper lustration and ceremonial service fitting for a chief's son.

[Highly curious, as showing, among other things, the general vulgar European belief in the powers of the moral affections of the mother over her unborn offspring, extending to New Zealand.—W.C.]

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9. A Story of Old, of a certain Drowned Boy, whose Spirit returned to trouble the Living.

This lad went with the water-calabash to fetch water to drink, being sent by his parents. He went, he got to the place where the water was, and on his pressing down his big light calabash under the water in the deep pool to fill it, it slipped suddenly away out of his hands. He then (as it was supposed), went into the water after his calabash, which was being carried away floating before him, and in doing so he sunk, and his belly was filled with water. After some time his parents went to look for him, but though they found the calabash floating they did not readily find him, because all over the surface of that water was overspread with spiders' webs; at last, however, they found the body and dragged it to the shore, and carried it to their village and mourned over it, and when the usual funeral lamentations were over they buried it in the earth. Then the spirit *(wairua)* of that boy appeared here in this habitable sphere, bewildering the living, and (it) dwelt in Ihurahirahi to be a medium for it, who came to Tokomaru that is now, his principal place of residence being at Orangikupa, and there he dwelt. That village *(pa)* was on a high steep cliff, from which he went right off into the sea, and thus it came to pass; the poor bewildered one was walking, when the evil demon *(atua)* said to him: "It is all solid land there below, that he would not get bogged* in that water." The people of the place were on the look out and saw him walk right away from the top of the cliff, when he was lost to their eyes. On his sinking down, however, he was at the depths of the sea following his great chief (or leader),† near the mouth of the codfish *(hapuku)* who was being snapped at continually by the *hapuku*, so he followed his great chief; there he saw the multitude of fishes, food for man, scuttling about in all directions. His big chief was very courageous, and so was he through him, and he at last re-appeared above on the surface of the sea. Then he looked about, fastening his eyes on the land, its mountains, and hills, and cliffs, and he knew that shore and that land, and at length reached the strand at a place called Te Poroporo. There he told what he had seen in the sea to the people of that place, who were all highly delighted at his relation to them. In the morning they embarked in their fishing canoes, and paddled away out to sea to the spot rich in fishes which had been described to them, which they also found by its bearing signs on the land. There they fished with hook and line, and soon filled their canoes with fish. They named that rock "Kapuarangi." Their fishing over they paddled back to the shore, landing at Te Poroporo. The chief, Te Haratau, who lived near by, hearing of this, went also out to sea, to that very rock, to Kapuarangi, but he took with him to sea his weapons for fighting. The other chief, Ruatona, being informed of this, went also out to sea in his canoes, taking also with him his fighting weapons, to show his anger against Te Haratau. On Te Haratau looking up from his fishing towards the land, he saw the canoes of Ruatona paddling out towards him, so he left off fishing and came to meet him. They met full drive! They fought at sea, and then they all paddled to shore. On landing they recommenced their warfare, and behold! Te Haratau was killed by Ruatona. Then it was that Ruatona's friends and helpers said, "Let the body be

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* "Bogged"=*powharuwharu*,—This term, which is commonly and properly used with reference to swamps and deep muddy places, seems strangely out of place here. I never heard, never met with it so used before, especially with reference to the *deep sea*—clear water. I have a suspicion that, like some of the noted Delphic Oracles,—and like that of the juggling fiend in Shakespeare, ("The duke yet lives that Henry shall depose."—King Henry IV., part ii., act 2, sc. 4), it was "said" with a double meaning.

† Translation here is difficult; I have given it nearly literally. I suppose the great chief, or leader *(heruiwi)*, to be the *atua* or demon, who had deceived him.

buried." When Ruatona replied, "What, wilfully throw away the bit of (food obtained by extra exertion in) the scarce summer season?" And so that hand-to-hand fight ended in favour of Ruatona, who kept possession of Kapuarangi.

Art. III.—*Contributions towards a better Knowledge of the Maori Race.*

By W. Colenso, F.L.S.

[continued.*]

[*Read before the Hawke's Bay Philosophical Institnte, 8th November*, 1880.]

——"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 III.—On their Poetical Genius.

It may truly be said that with the New Zealander poetry is, or was, part of their daily life. Whatever differences in taste may have existed among the various ancient tribes *(iwi)* composing the Maori people, in this matter they were pre-eminently as one,—all used it, all were moved by it, all enjoyed it. Indeed, I have very good reasons for believing that poetry—in one shape or other—was much more commonly used than even their proverbs were,—which formed the subject of my last paper read before you under this head. Is it not true, that under much of poetry, as well as of proverbs, there lies a philosophy? With nursery ditties and jingles they strove to amuse and quiet their young children, and with longer legendary and historical rhythmical recitals the old informed their youth, and dissipated the *ennui* of wet days and long nights. With smart songs of encouragement, sung alternately and in full chorus, they eased the heavy labour of their most laborious works,—such as dragging the hulls of their large canoes from the forests—often over many miles of the roughest country, without any road—to the sea, and also the large totara timber for their chiefs' houses; and often whole trunks of trees to form the outer wall of fortification around their town *(pa)*. They paddled their war-canoes to suitable inspiring songs, which were regularly chaunted by their chiefs, or fit men,† often two, if not three, in each large canoe, to which song the paddlers kept time, both in paddling and in occasionally slapping the blades

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

† Called *kai-tuki, hau-tu, etc.*,—a kind of vocal marine fuglemen, encouragers, chaunters; who, standing on the thwarts (more like birds than men!) directed, and kept, and gave time, both by voice and gesture, to the paddlers.

of their paddles against the sides of the canoe, accompanying the same, at regular intervals, with their united voices, which arose together more like the voice of *one* man !*

They broke up and prepared their extensive tribal *kumara* plantations, working regularly together in a compact body, chief and slave, keeping time with their songs, which they also sang in chorus. When visitors arrived, the open talk was invariably commenced with a suitable song, which was responded to by the visitors in a like manner; which, indeed—and especially whenever the meeting was an important one—often indicated both their feelings and determination. They took up arms and went to war with songs; they sung them before engaging with the enemy; the watchers within a besieged fort kept on announcing the passing hours, and the movements of the stars and planets, with short suitable songs. They taunted and sorely galled their foes with songs; they gave loud utterance to their most deadly and revengeful feelings in songs; they closed their battles and feuds, and made peace with songs; they bitterly mourned over and bewailed, and finally deposited their dead, with parting songs and dirges. Their many and varied spells, charms, counter-charms, invocations, ceremonial calls and demands, and propitiations, mostly took the poetical form. On entering a forest for the first time to fell a tree, they invariably prefaced their operation with a pleasing song of deprecation to the presiding deity, *genius loci*, or guardian of the place; † on their finishing (or opening for reception) of a chief's large or tribal house, that was done always with a poem or song *(kawa)*; so, also, on their first casting of one of their immense seine nets—originally made in separate pieces (or nets) by each family, and now put together—they used the proper chaunts or songs. Sufferers by calamity,—as by floods, by drought, or by fire,—the sea, and war,—through theft and slander,—each and all expressed their griefs, and consoled them-

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* "Their war-dance is always accompanied by a song; it is wild indeed, but not disagreeable; and every strain ends in a loud and deep sigh, which they utter in concert. * * * In their song they keep time with such exactness, that I have often heard above 100 paddles struck against the sides of their boats at once, so as to produce but a single sound at the divisions of their music."—*Cook, First Voyage*, Vol. III., p. 468.

† Among their ancient myths and legends are some pleasing and warning stories of some daringly thoughtless persons, who had ventured to hew down trees for canoes without first paying the usual apologetic and deprecatory ceremonies; which have always served to remind me of the story of Erysicthon, who impiously "rushed without shame into the grove of Ceres, and hewed down the trees," and paid a fearful penalty for his transgression (as told by Callimachus in his hymn to Demeter). But those thoughtless Maoris, in all instances, eventually escaped far better than Erysicthon did; although, in some cases, they often repeated their crime. Was this owing to the *milder* nature of the Maori wood-nymphs—as conceived by the old Maoris?

selves, with songs. While the young men and women were undergoing the painful and protracted operation of tattooing, the females sang a suitable song of encouragement and hope. The females, also, courted and covertly indicated their tender feelings in songs; the disconsolate lover sought to assuage his melancholy with songs;* and not unfrequently the suicide (especially when a female, and about to throw herself from a precipice) sang her last words, like a dying swan,—or after the example of Sappho—in a song!

Their handsome forest pet, the *tuii*, or parson-bird, *(Prosthemadera novæ-zealandiæ)*, was taught with much pains a very long song, though they might have more easily taught him to whistle.† Children sang or trolled songs in summer to lessen the power of the sun's rays, also to cause the rain to cease, and to lull the fierce winds, etc. The chiefs sang suitable songs to their pretty paper kites while flying them, and the young women did the same to their light stuffed and ornamented hand-ball while engaged at their pleasing and dexterous game of *poi;* the women also extemporized their joyous songs over a plentiful haul of fish, or an abundant snaring of birds, and, also, had their semi-humorous songs for their big gourds or pumpkins, in cutting or breaking them up for cooking. The old Maoris even professed to have heard songs, of a highly curious character, sung by the spirits of the dead! and by fancied *atuas*, supernatural beings, while engaged in fishing far out at sea.‡ These latter they responded to and sang their replies.

* "I think," observes Burns, "it is one of the greatest pleasures attending a poetic genius, that we can give our woes, cares, joys, and loves, an embodied form in verse, which, to me, is ever immediate ease." It is said of Fuseli, the painter, that seeing his wife in a passion one day, he said, "Swear, my love, swear heartily; you know not how much it will ease you!"

† Vocal whistling, however, was almost wholly unknown, and never practised, being quite foreign to the natural musical genius of this people; indeed they often showed a dislike to it when made by a European (as I have proved). Probably this aversion to vocal whistling was owing to their superstitious views, as (they said) their familiar spirits or demons *(atuas)* thus made their presence known. Yet they had a peculiar kind of loud whistle in use by their chiefs, made out of hollowed hardwood, though not very common, when Cook visited them.

‡ There is a singularity here which has frequently reminded me of what is recorded of the Greenlanders, who, however, did not meet their supernatural visitants so bravely as the Maoris. It is said "that their times were often made painful by fancied terrors; sad sounds were often abroad in the air, and there were noises also on the deep and the shore, for which they could not account. In the sublime description in the Apocrypha, 'they heard the sound of fearful things rushing by, but saw not the form thereof.'" And again, "Of spectres they stand greatly in dread. The loneliness of their lives, where the sense of hearing is often invaded with the most appalling sounds, conduces to this belief. The spirits of the lost at sea are heard to come on shore in the dead of night,

When the New Zealanders were first taught to read and write by the missionaries, and for (at least) twenty to thirty years after, they almost invariably in writing a letter or note, began it, after the introduction, with a few words from a song, which also served to indicate (especially to themselves) what was about to follow, or what was particularly meant. As this peculiarity had not been in any wise taught them by Europeans, it is highly characteristic of their strong abiding national taste.

No doubt their common practice of using songs when at their various works and labours, especially the very heavy and continuous ones, originated with them as a means of beguiling their length and wearisomeness, and was wisely and politically used and encouraged by their chiefs.

During the first ten years of my residence in New Zealand I resided in the Bay of Islands, where almost every visit from home had to be made by sea in a boat; and not unfrequently either in going or returning up or down the long tidal arms or rivers (as Waikare, Kawakawa, and Kerikeri), or in visiting the shores of the outer bay (Paroa), I should be many hours at a time in my boat,—sometimes nearly all night,—owing to head wind, or strong adverse tide. At such times, and when my faithful Maori rowers were nearly exhausted, for one of them to strike up a simple canoe- (or boat-) song, would act as a charm upon their spirits, and give them fresh vigour.* I am sure that by such means—the wonderful powers of simple song—we have sometimes overcome, or passed through, no small difficulties and even dangers.

Having already in a former paper† written on their various kinds, or classes, of poetry, I shall not again repeat the same. Such, however, may be easily inferred from what I have just mentioned; as, of course, their poetry and its music ever varied with the subject:—

"From grave to gay, from lively to severe."

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and utter a mournful wailing." A singular effect of the imagination is also given:—"A Greenlander came from a distant and quite healthy place to visit his sister in the Mission Station; they were deeply attached to each other. Before the boat came to land, he thought he saw her apparition flitting along the shore and beckoning him to come. The Greenlander paused on his oar, and gazed intently on the spot; his companions saw nothing but the rocks and the ice-hills. But there, he said, she was standing, like the dead, and he refused to go near her. They rowed back directly. Overcome with the fright, he fell sick the very day of his return, and infected the people where he dwelt."—*Life of Hans Egede.*

* If I recollect aright, Captain Sir James Ross, Dr. Hooker, and the other officers of the Antarctic Expedition, informed me, in 1841, that when they had to raise the deep-sea lead (in this case made up to 75lbs.) from their deepest soundings of 4,600 fathoms, the labour was so great that they were obliged to have recourse to the aid of music! A sailor perched on the capstan played on the violin.

† In "Essay on the Maori Races," § 46.—"Trans. N.Z. Inst.," Vol. I., p. 47 of Essay.

Nevertheless, I may here observe that their rude poetry, while mostly dithyrambic and generally destitute of what a European would term rhyme and metre, wonderfully abounded in strong natural sentiment,—in pleasing and suitable utterances,—and in fit, and often beautiful, imagery; proving again, even here at the Antipodes, that mere rhyme is not poetry. Indeed, some of its imagery would compare with that used by the best poets of the Old World. But while it was natural and simple, it was all rough, forcible, telling, convincing, gushing, impassioned, affecting,—highly suited to the Maori character. Very much of it was ancient, handed down orally from the olden times, and often ingeniously altered and extemporized *(improvised)* to suit the present occasion; a knack in which the Maoris greatly excelled.

Some few pieces, however, have tolerably regular strophes, and many possess both solo and refrain, or chorus. Often one meets with a startling abruptness of transition; very natural in lyric poetry, especially among a rude and warlike people; by the slightest modification the author's skill fixes the strongest contrasts. Sometimes the maker or singer of the song is both subject and object; again, comparison would be implied with the omission of the particle of comparison; while pronouns, apparently pleonastic, and not unfrequently omitted, would be used emphatically. Inanimate objects, as well as abstract subjects, are very commonly and naturally personified in bold and highly figurative language. Many common things also possess mythological names, as in their myths and legends, this alone being a sign of antiquity.

A few of the more striking peculiarities of the composition of their poetry may also be briefly mentioned, as I think them highly characteristic, if not unique: (1) They sometimes have several consecutive lines* (three or more), each line beginning with the same few words; and this may occur three, four, or five times throughout the piece. This reminds one of the alphabetical form of some of the ancient Hebrew poetry. (2) Sometimes they have a single word (often an imperative or a passive verb) forming a line, which is followed by two or three other such words, making so many lines, agreeing in syllables and in emphasis, and almost in measure. (3) Not unfrequently the first two or three sentences, or lines of the piece, are again taken up at the end to form the conclusion. (4) Sometimes each line (distich or hemistich) of the whole song or piece ends with the same word or particle. (5) And sometimes, though not frequently, the short concluding

* Although I have used the words *line* and *lines*, yet I should also state that the Maoris, in writing poetry, never confine themselves to the use of artificially written poetical lines, but continue on as if writing prose; seldom, indeed, using either stops or capitals.

and terse ending of every alternate line, containing three to five words, is repeated,* so making that line long and the next one very short.

The Maori bards, in their natural imagery, occupied but a short time in description ; often transitional it was generally done too rapidly to allow of any detail. More frequently the particular and suitable natural simile was merely seized, mentioned, or alluded to, together with one or two of its more striking points, to be followed in quick succession by moving, natural appearances in preference to stationary ones : *e.g.*, the setting of the sun, the red evening sky, the twinkling of a star, the rising of the moon, the breaking of the dawn, the glistening of the sunbeams, the sudden darkness, the rising of the evening star, the passing of the night hours, the flashing lightning, the hooting of the owl, the blowing of the summer breezes, the light flying clouds, the flowing and the ebbing tides, the billowy sea, the noisy surges, the falling rain, the flowing tears, the joyous seasons *past*, the various flying birds, the gliding canoe, the moving branches of the forest, the waving of the long leaves of the *kowharawhara*,† and of the shining plumy heads of the graceful *Arundo* reeds, the thistle-down borne away by the winds, the raging fire consuming the forests, the sulphur-burning crater at White Island, the running brooks, the swift currents both of river and of ocean, etc., etc. And I think that it is in their proper and skilful use of those two great poetical means—namely, simile and living moving nature—that they not only excel, but show their fair claim to IDEALITY, and to rank as poets, for it is to their excelling in those two particulars that our own great British poets owe their justly-earned fame.

We also often meet with this love of familiar natural imagery, and the use of it as similes, in the oldest poets of various nations—as in Homer, Hesiod, and Callimachus ; in Virgil and in Ovid ; in the Hebrew bards, and also in their prose writers ; and, particularly, in the Scotch bard, Ossian. Much of the common natural imagery embraced and used by Ossian is just exactly what an old Maori loved to use, and used in his way too ! and some of it we shall yet find in our few examples (*infra*). It was owing to this in great measure, that the early translation (A.D. 1837–8) into Maori of the Hebrew Psalms, and other Old Testament poetical pieces, found such universal acceptance among the Maoris. There is a beautiful ancient passage by the Son of Sirach, (though, perhaps, but little known,)—*Ecclus.* 50, 1-21,—abounding in such natural and pleasing metaphors as the Maori poets commonly used, and all, too, applied to one man ! as, the morning star,—

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* Some old Scotch songs that I have formerly seen are somewhat after this fashion, as, for instance, in Burns'—" Ye Jacobites by name."

† *Astelia banksii.*

the sun shining,—the moon at the full,—the rainbow giving light,—the bright clouds,—the flowers,—the branches of trees,—the time of summer, etc.

In the volume of Maori poetry printed and published several years ago by Sir George Grey, while Governor here, there are collected between 500 and 600 songs and other poetical pieces; to which, I suppose, I could add nearly an equal number,—or (say) about 1,000 in all; and there are, or were, many more, unknown to or uncollected by Europeans. Now, all these were only retained by the old Maoris in memory, and from memory dictated to others, or (in a few instances) written down by themselves. Here, of course, as in the case with their proverbs, there could not be much room for variation; and the oldest and best songs, etc., are much the same, whether rehearsed among the northern or the southern tribes. This, together with the collateral fact of their many ancient myths and legends and fables, and their numerous semi-religious and ceremonial chaunts and recitations, also agreeing in the main, as well as their long ancestral genealogies, is a most wonderful instance of the prodigious memory of uncultivated unlettered man! and certainly to the philosophic mind must ever speak strongly in favour of the ancient Maori. This high faculty, together with those of sight and hearing, which they also eminently possessed, always, when prominently exhibited (as I have known striking instances of) struck me with astonishment.*

Their poetry (as far as it is known under the various names of *waiata*, *tangi*, *haka*, *ngeri*, *umere*, *tau*, *keka*, *pana*, *peruperu*, *apakura*, *oriori*, *to*, *tuki*, *whakaaraara*, *tukeka*, *pihe*, *karakia*, *mata*, *hari*, *whakamohio*, *whakatapatapa*, *whakaoriori*, *kawa*, etc., etc.) may be conveniently and briefly classified as follows:—(1) lyrical: (2) historical and legendary: (3) ceremonial, or semi-religious. 1. Their lyrical poetry contains martial, vengeful, taunting, satirical, melancholy, wailing, dirge-like, love, humourous, nursery, and inciting songs. 2. Their historical and legendary—though, with them, it was all alike historical, all equally believed!—included much of the prowess and doings of their forefathers; which they also recited in their traditions

* That the Maoris possessed, in an eminent degree, the faculties of both distant and quick sight and hearing has long been known; these natural qualities being generally highly improved and developed among all savage and uncivilized nations. I have often proved their fine and clear sight, in getting them to point out to me the position of Jupiter's satellites by their unaided vision, while I used my telescope. From captains of ships I have often heard of the very great superiority of the Maori seaman in this respect,—in discerning ships, whales, icebergs, etc., at a long distance. Then 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.

and legends. 3. Their ceremonial comprised a large and varied amount of strange and yet often simple utterances and recitations (mostly spoken in a whisper or undertone), which we almost want a new English word fully to express; such being neither charm, spell, nor invocation, neither prayer, request, nor supplication; but, as it were, a little of each, with not unfrequently more or less of a command, and sometimes even a threat.

Some slight—yet it may be painful—attempts have been from time to time spasmodically made to render a few of their songs into English; but those who have attempted it, as far as I know, have greatly failed; and that, among others, for two chief reasons:—(1.) They have attempted to do so in the fetters of both rhyme and metre, such too, above all, as the C. M., L. M., etc., of English hymns! or in the equally unsuitable cadenced jingle of Longfellow's "Hiawatha." (2.) They have thought more of themselves as "poets," than of their subjects—if indeed they in every case clearly understood them, which I greatly doubt; for in some instances they do not seem to me to have comprehended the Maori, or, at all events, to have caught the leading ideas in the piece before them; for some (and that not a little) of the Maori poetry is as difficult to be understood by a foreigner—even if he be a tolerably good linguist at common colloquial Maori—as parts of the English translations of Homer and of Dante, of Milton and of Shakespeare would be to an uneducated Englishman; while in the Maori language they would also have the very great disadvantage of not having any good lexicon, or historical work of reference, to aid them. Foreign languages may be usually translated in three ways:—(1.) By a literal version; (2.) By a free translation; and (3.) By a paraphrase. But in the poetry of the New Zealanders, in order to give the true *meaning* of the original, something more than a mere verbal rendering is often absolutely required; for their whole style is exceedingly elliptical, and often abounds in allusions and aposiopesis, and the gaps need to be filled up. Then there is the common want of distinction in gender, both in nouns (proper names) and pronouns, which, where there is so much of personification, often including inanimate things, creates another difficulty; while not unfrequently the song begins and ends with a bold emphatic denial of its true and pregnant meaning. Besides, to translate clearly into English one Maori song or poetical piece, might require a large amount of knowledge of their legendary lore and of historical facts and events, and of their general natural history. Indeed to perform this work well, a person should bring to it not knowledge merely, but sympathetic imagination, and there are few, if any, among us who possess those highly necessary requisites. Moreover the idioms and the whole structure of the two languages are so very dissimilar. But on this head I shall not now dwell, concluding this part of my subject by observing—that those great difficulties should ever fairly be borne in mind whenever we meet with any of those so-called translations of Maori poetry into English metre; far better it would be to translate it into good English prose, accompanied with notes.

I will now proceed to give a translation of a few examples from their poetry, in support of what I have already stated. The first will be a portion of a justly-celebrated Lament, alluded to by me in my last paper.*

(1.)

The Lamentation of Te Ikaherengutu for his dead Children; some of whom were killed by the foe, and some died through wasting sickness.

Sitting idly here in misery, the chord of my heart continually throbbing concerning my own dear children. ——— Behold, how great! Here am I, O, my friends, just like the offspring of the forests inland, bowed down towards the ground; aye, bending low down, even as the long lithe fronds of the black fern-tree, without ever once rising upwards, concerning my own dear children. Where, indeed (is he)? O, the dear child, who was formerly cheerfully welcomed with "Come hither, O my son." Ah! he is indeed gone, carried off by the strong ebbing tide.

I continue still in one place, sitting idly, O friends, upon the same plot of ground where my dear chlldren formerly assembled in play—where we dwelt together lovingly! Now (it is become) a slippery plot (on which there is no standing for the foot)—a plot clean denuded and desolated, wholly and entirely despoiled, nothing pleasing left! so that I care not to look up at the sun standing above me, neither to the once fondly-remembered home-mountain standing near! nor even think of the sweet native breeze blowing from (our) home! which one is ever wont to dwell on with affection when the bitter blasts of sorrow are blowing and felt, which are verily as keen as the sharp-cutting icy wind from the south.

Here, indeed, I must mope owl-like in the hut, through the work of that evil-minded friend *Whiro!* My heart is even becoming forgetful of the doings of the many around about me. Was it, indeed, owing to the attempt of my children to steal the moon that they died, or was it, indeed, through (their) attempt to steal on the edge of some cliff that my offspring fell down suddenly, like *debris*, and perished miserably? If it had been so (then) the hateful demons would have banded together in anger against us all, and we should all have been exterminated, never more to be seen; extinct for ever, as the *Moa!*†

This fine poem ends with—

Enough! I will not sigh, nor show affection any longer unto you!‡

There are several similes herein used that require both explanation and attention.

"The offspring of the forests:" *lit.*, the begetting of *Taane*—*Taane* being considered, in their mythology, as the special maker or begetter of all the vegetable kingdom.

"The fronds of the black fern-tree:" *lit.*, *mamaku* (*Cyathea medullaris*).

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* See "Trans. N.Z. Inst.," Vol. XII., p. 88.

† See "Trans. N.Z. Inst.," Vol. XII., p. 88, etc.

‡ A version of this poem will be found in Grey's collection of "Poetry of the New Zealanders," p. 9.

This beautiful figure, taken from the long palm-like fronds of this fine fern (twelve to twenty feet), gracefully curved and drooping towards the earth, is not unlike that used by us in funereal subjects, our own "weeping willow." Further, this was the solemn attitude always assumed by the old Maoris in weeping and lamenting over their dead, with body and head bowed forwards, and arms extended together and curved downwards towards the corpse or remains.

"Where indeed is he," etc. Here one is strongly reminded of those pathetic and striking lines by Byron, in the "Bride of Abydos:"—

> "Hark to the hurried question of Despair!—
> 'Where is my child?' and Echo answers 'Where?'"—(*Canto* II.)

A note appended thereto is also worthy of notice—"I came to the place of my birth and cried,—'The friends of my youth where are they?' and an echo answered, 'Where are they?'" (*Arab.* MS.)

"Upon the same plot of ground," etc., *lit. kahuipapa;—i.e.* the flats, or small islets and shoals, in or near salt-water lagoons and estuaries, where the small sea-birds, etc., flock and preen and dress themselves in the sun; another beautiful figure.

"The mountain standing near my home," and "the air, or breezes, of my native place." These two beautiful similes have ever been in great esteem among the Maoris, and are still very commonly used by them in letters when away from home and writing thither, not unfrequently causing affectionate tears when read. Those tender and natural familiar expressions closely resemble some of our own esteemed European ones—*e.g.*, the song of "Home, sweet home;" the proverbs, "Home is home, be it ever so homely" (*Eng.*); "East and west, at home the best" (*Germ.*); "The reek of my own house is better than the fire of another's" (*Span.*); "Home, my own dear home, tiny though thou be, to me thou seemest an abbey" (*Ital.*) And so our British poets—Burns, Scott, Byron, and Wordsworth, and particularly Goldsmith. Cotton, who preceded most of them, has a beautiful hemistich, which I cannot help quoting:—

> "The world has nothing to bestow;
> From our ownselves our joys must flow,
> And that dear hut,—our home."

Not, however, forgetting Burns' beautiful song,—

> "Of a' the airts the wind can blaw."

"That evil-minded fiend *Whiro*."—Whiro was, possibly, the worst of all the demon-gods, or supernaturals, of the Maoris; to whose malevolence, death and disaster *on land* were always attributed.

(2.)

The Lament for Te Heuheu, a principal Chief of Taupo; who, together with about 60 of his followers, was suddenly swallowed up by a terrible land-slip near the south end of the lake Taupo in 1846. (A portion only, less than half.)

Behold! there is the red streak of early morning dawn! appearing on the far-off horizon, over the craggy peaks of the mountain Tauhara. That, perhaps, is my dear friend returning hither? Alas! no; alone am I, uttering vain laments among the dwellings of men.

Thou art, indeed, gone for ever! O precious treasure! Go on, then (in thy way, thou) great one; go on, (thou) who wast feared (by the foe); go on (thou who wast as) the fine big *raataa* trees, protecting those smaller trees behind them from the stormy winds. Let me ask, who was the demon who so evilly overwhelmed you all with sudden death?

Sleep on (with thy face turned) towards us, O (our) father, within the cold miserable house. The string of the prized ear-drop (by which it once hung) is now firmly knotted; that ancient prized heir-loom of greenstone; left behind, among us, to become a loved memento for ever of thee.

* * * *

In vain the stars of the heavens plan (their) schemes: the great star *Atutahi* is gone, carried off a prey for the cannibal star *Rehua*. But the fine star shining by the side of the Milky Way, is verily thou thyself! Alas! Alas!

* * * *

(End.) Thou hast fallen! thou art lying dead within the bowels of the earth! Alas! Alas! Still thy fame shall resound (as thunder) far off to the other side of the heavens.*

"*Tauhara*:"—a conspicuous craggy isolated mountain, 3,000 feet high, about 30 miles north-east from the place where the calamity occurred.

"Fine big *raataa*-trees" (*Metrosideros robusta*):—among the monarchs of the forests.

"The prized ear-drop:"—*lit.* "*Kaukau-te-ika-a-Ngahue.*" This was the name of a famous prized ancient ear-pendant; fabulously reported to have been brought from "Hawaiki." [Of this "*ika-a-Ngahue*," more anon.] "The string" by which it was suspended to the chief's ear, when alive and worn, being now "knotted," indicates that it never would be worn again.

"*Atutahi*" and "*Rehua*," two noted stars; see "Trans. N.Z. Inst., Vol. XII., pp. 145, 146.

(3.)

The Spell, or Invocation, used by the Hero Whakatau, on his going forth to fight.

"Then the brave warrior, Whakatau, arose, and seized his fighting-belt, and, while girding it on, uttered the following charm, that he and his companions in arms might become bold in battle." (MS., *ined.*)

If Tangaroa should enquire,
"Who is that young warrior
So daringly girding-on my war-belt?"
(I reply) Nobody at all; nothing, only me,
Whakatau!

* Grey's "Poetry of the New Zealanders," p. 28.

A man of no rank,
A man of no notice,
A demon, a despised thing,
A poor young fellow, (an) eater of servants' scraps!
But,—concerning my war-belt, ha!
My war-belt which was dreaded,
Behold it now!
Fittingly and securely fixed.
(It was) carefully and fitly woven in the house,
Over which was sung (while weaving)
The mournful lament of sisters!
Lo! the favourable wind arises;
I hear it; I feel it.
The strong north wind blows,
I feel it encircling.
My foes are already hiding through fear!
Enclose me around, O Space!
O Space and Air encircle me!
O Sky encircle me!
Who am now here, engaged
In girding-on the war-belt of the warrior
I shall stand—as a rainbow,
Girt with the war-belt of the warrior.
Lo! the lightning flashes—it flashes!
The war-belt is rough as the sharp spines of the sea hedgehog;—
Dreadfully hated it is!
This war-belt, whose fame carries fear and hiding;
Whose great fame is everywhere known.
Do you still ask, "What is this war-belt?"
A war-belt of wrath!
A war-belt of flaming rage!
A war-belt that destroys and eats up its foes!
Now you know. Hurrah!

(MS., *ined.*)

"If *Tangaroa* should enquire, etc." The great fight in which Whakatau was engaged, and so valiantly slew his foes, was commenced at sea and finished on the sea-side; hence the name of "Tangaroa,"—who was the Maori "god" (=maker and master) of the sea and of fishes; one of the great Polynesian "gods."

"Space" (or the clear open expanses, or Air,) and "Sky," are here invoked, as being the most ancient of all their many personifications.

"I shall stand—as a rainbow,"—see *Proverbs*, "Trans. N.Z. Inst.," Vol. XII., p. 139, proverb 167. See, also, the closing hemistich of song 13, *infra*.

"Do you still ask, 'What is this war-belt?'"—meaning, What the consequences of putting it on?

The ancient Maoris went naked into the fight, the principal chiefs only wearing the war-belt; which was first girt on when actually entering into the battle, and was curiously and very firmly fixed. So that the girding it on, was, to them, quite an event; and, in reality, was just as Hector, or Mars, in Homer, putting on their armour.

This poetical piece is most stirring and spirited in the Maori original; and its effect on Whakatau's followers, when properly chaunted by him, to, doubtless, a most inspiriting and bold tune,* may be guessed. Especially, too, as they had ventured to say to him,—"Don't attempt it; they are many; thou wilt be killed." The whole prose legend in its entirety is a capital one. A portion of it, much abbreviated and altered, may be found in Grey's "Polynesian Mythology," p. 102.

(4.)

A ceremonial Charm, used in divorcing the man from the woman and the woman from the man:—

A pulling off by Space,
A pulling out by Sky,
A great drawing-out from within;
A letting fall,
Of [*or* by†] this great priest,
Of [*or* by†] this knowing teacher;
Go on.—
There the post stands—the post stands,
The very post of the separation.
It is the Sky that unties;
If untied above here, then untie
That you two may be untied,
Separated here be the bed of you two,
Where you two were intimate,‡
Where you two slept,
That you two may be untied.
The Sky itself separates;
The Earth itself separates.
Be separate in this evening,
Be separate in this night.
Turn away, proceed;
To the full tide,
To the tide flowing by night,
To the tide that resounds in its ebbing.
Henceforth I turn upwards
To the untrodden forests,
Do not thou sigh lovingly;

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* *Vide infra*, near end of this paper.

† *By*—here in a secondary sense; passive, or politely lessening.

‡ *Lit.*, embraced closely.

Do not thou lament.
Untie the string of the garments;
Be rough, be strong, the string of the garments of you two.
Embrace the *rimu* pine tree,
Embrace the *totara* pine tree,
Embrace the tangled fern.
There the post stands;
The post indeed of the separation;
The post of the Sky above:—
Be thou made all aglow.

For a version of this see Grey's "Poetry," p. 296.

(1.) According to the Maori cosmogony the Sky and the Earth were anciently man and wife, and lived conjoined; but they were forcibly separated, and that for ever, for the good of man.

(2.) The *last* line here (as in that of the first poetical piece, *ante*) must be taken to mean its direct opposite.

(5.)

A soothing Charm, to be recited when the young women are having their lips and chins tattooed,—punctured and stained with black figures.

(Part only, as a specimen; the whole containing 13 stanzas.)

Lay thyself quietly down, O daughter!
 (Soon it is done!)
That thy lips may be well tattooed;
 ('Tis quickly performed!)
For thy going to visit the young men's houses;—
 Lest it should be said,—
"Whither, indeed, is this ugly woman going?
 Now coming hitherward."
Keep thyself still, lying down, O young lady!
 (Round the tap goes!)
That thy lips may be well tattooed,
 Also thy chin;
That thou mayest be beautiful!
 (Thus it goes fast!)
For thy going to visit the houses of courtship;—
 Lest it should be said of thee,—
"Whither does this woman think of going with her red lips,
 Who is walking this way?"
 (Still it is revolving!)
Give thyself willingly here to be tattooed
 (Briefly 'tis over!)
For thy going to the houses of amusement;
 (Or) thou wilt be spoken of,—
"Whither goes this woman with her bare* lips;
 Hastening hither indeed (in that state)."

* *Lit.*—plain, unadorned, without ornament or covering; applied sneeringly.

(Round it revolves !)
It is done ! it is tattooed !
(Soon it is ended !)
Give hither quietly thy chin to be imprinted ;
(Nimbly the hand moves !)
For thy going to the houses of the single men ;
Lest these ill words should be said ;—
" Whither goes this woman with her red chin ;
Who is coming this way ? "*

NOTE.—All those separate lines within parentheses, run thus in the original, "*Pirori e!*" and the great difficulty is, to know what was really *meant* by that word or phrase. *Pirori* (as I showed in a recent paper)† is the name of the curious wimble or drill, of the old Maoris, with which they perforated the hard greenstone ; and is used, as a verb, of the making of the drill revolve quickly ; also, of the setting a hoop, or a ball, rolling, with a quick jumping or hopping motion ; and also (formerly by old Maoris), of a European writing quickly, or shading with black-lead pencil, as in drawing. I am inclined to believe that the word was used here partly in a semi-humourous and partly in a cheering sense ; to divert their attention, and to assure them the puncturing operation, always painful, would be soon over. And in this view of it I am also borne out by several old Maoris with whom I have conversed on this subject. Nevertheless I cannot help thinking there is still something more (after their fashion) concealed in the short pithy phrase. In their beautiful and expressive language, so full of natural and truthful metaphor, especially in all matters referring to a young female,‡—there is a proverbial comparison for a woman's lips when well tattooed ; such are said to resemble a *rori (Parmophorus australis);* the plump black smooth and glossy mantle of this shell-fish appearing, when living, its whole length on both sides from under its narrow back shell, and turning up and enveloping its sides, no doubt originated the proverb ; and *pi* being the general name for the young of birds and small animals,—the whole sentence may have been intended to remind the person operated on of that (in their estimation) pleasing natural simile—"*Pirori e!*"=Beautiful as the black young *rori!* (by keeping quiet).

(6.)

The Cry of the little green Parrot.

G. P. " O, thou big brown parrot, flying away there !
Give me back here my own red feathers !"

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* See Grey's "Poetry," p. 58.

† "Trans. N.Z. Inst.," Vol. XII., p. 93.

‡ See "Trans. N.Z. Inst.," Vol. XII., p. 142, for a few terse proverbs of this kind, referring to females.

B. P.—"My red feathers are my own indeed; I fetched them from the sacred isle, *Tinirau** gave them to me."

G. P.—"*Torete, kaureke; torete, kaureke.*"
"O, thou big brown parrot, still flying away there!
Tell me whither art thou flying?
Art thou flying away to *Poutahi?*
Art thou flying to *Puke whanake?*
To carry tidings away to *Te Iripa?*"

B. P.—"Verily, I will not reply (do, or say anything) to thee."

G. P.—"Here am I standing in the preserve, causing
Aching-legs, made by *Tokoahu!*
Here am I both listless and tired out. Alas!
The weary doings of the hot summer days!
Torete, kaureke; torete, kaureke!"

(See Grey's "Poetry," p. 74.)

NOTES.—*Torete*, etc. This is the common cry of the green parrot, according to the Southern Maoris of the North Island, (especially when engaged in quietly talking to itself, as in confinement), hence, too, in some parts it has obtained the name of *Torete.*

Poutahi, etc. Those proper names may be all figurative, and used by the little bird tauntingly: *Poutahi*=one pole, or perch, of the big parrot, on which it too will soon be fastened.

Puke whanake=hill, or grove, of cabbage trees, (*Cordyline* sp.), on the fruit of which it feeds.

Te Iripa=the (one bird) hanging in a village—may mean, the mate or companion bird of the big parrot already caught and made a prisoner, and there being fettered with a cord by its leg to a pole or stick, it sometimes hangs head downwards from its perch in its useless strivings and flutterings.

I suspect this green parrot is itself a prisoner, its own last words facetiously imply as much. Its cage, "made by *Tokoahu,*"=*lit.* hot vapour:—*scil.*, a long fellow reaching out or forth, (who hangs me up here in the hot sun), is another figurative play on words. The whole, especially when sung to its own proper tune, is very facetious, especially to a Maori.

(7.)

A joyous revelling Song, Duet, or Glee, sung by the Wood Rats.

First Rat.—O, Rat, O! let us two descend (the tree).
Second Rat.—Why should we two go down below?
First Rat.—To gather up nice baits for us to eat.
Second Rat.—What are those nice baits?
First Rat.—The sweet ripe fruits of the pine trees.
Second, or Third, Rat.—Fudge! I am just come up from below, O my friends!
And down there is the fear and trembling, my friends;
The springbolt of the set snare resounds with a click!

* For *Tinirau*, see Grey's "Polynesian Mythology," p. 90, etc.

My neck is caught and held fast;
I can only then squeak, *Torete! torete!*
Be assured that I will not go down below,
Seeking those nice baits; alas! no, no!

A version of this song is to be found in Grey's "Poetry of New Zealanders," p. 234.

"The fruits of the pine trees:"—the names are given in the Maori—"*miro*" and "*kahikatea;*" *Podocarpus ferruginea* and *Podocarpus dacrydioides;* the fruits grow at the extremities of the long, lithe branchlets, so that the rats could not well get at them on the trees.

"*Torete!*"—the same word is here used in mimicry as before by the green parrot.

(8.)

A Chaunt used by Children for fine Weather.

Fly, fly away, O thou kingfisher,
To the thick long-leaved plants* on the tree;
There snugly shelter thy wings,
Or thou wilt suffer much from the rain.
The clouds are breaking—from inland;
The clouds are breaking—from sea;
Behold a clear sky! the rain is ceasing!
The rain is all over! quite cleared is the rain!

(See Grey's "Poetry of New Zealanders," p. 29.)

Much longer ones for the same purpose were also used by adults, but were just as simple.

(9.)

A Charm, causing Healing of Wounds, to be recited for the fresh green gourds when about to be broken-up and baked in the earth-oven. Then the woman who is baking them must say:—

The children, like them! are crying
For their nice food of green summer gourds:
The gourds are plentiful:
The seeds of the gourds are sown;
The gourds grow;
The running branches stretch out,
They grow abundantly.
Grow on, abundantly!
Be ye many:
Grow away fast;
Be ye numerous:
Grow on, become good gourds;
Be ye flourishing!

(A version of this is at p. 388, Grey's "Poetry of New Zealanders.")

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* *Lit.*, "*Puwharawhara*" (*Astelia banksii*).

(10.)

A Sentinel's Cry, or Watch-song, at night, within the besieged fortress.

Here is the owl hooting away bravely !
He is not moving up and down on his perch ;
Not he !
No, not even once uplifting his head to look about,
The thumping big head of the owl !
Not gliding away on his wings,
But staying and hooting !
Now,—It is night ! it is night !
Anon,—It is day ! it is day !
Open broad daylight,—Hurrah !

(Grey, *loc. cit.*, p. 62.)

The inference from the natural actions of the undisturbed owl on the neighbouring forest-trees is,—that there is no enemy prowling near ; so, sleep on ; *we* (the owl and I) are watching.

(11.)

Another Watch-song.

It is night : it is night :—
It is day : it is day :—
The moon it is breaking ;
The bird it is singing ;
Broad day-light is coming !
It is day ! it is day !
It is broad day-light !

(Grey, *loc. cit.*, p. 40.)

In their watch-songs, used *within* the fort (of which there are several, as may be supposed), there is always more or less of the coming dawn, and of its harbingers ;—the wished for morning dawn,—the stars heralding the approach of the dawn ;—expressed in various natural ways. Reminding one of the many not dissimilar bold and beautiful expressions in the Psalms, and in other parts of the Old Testament, *re* " the waking up of the morning,"—" the dawning of the morning,"—" those that wearily watch for the morning," etc., etc.—(*Psalms* 30–5 ; 57–8 ; 130–6, etc.) ; and, also, in *Ovid*,—" Evocat auroram."—*Met.* XI., 597.

(12.)

Another Watch-song.

The moon shines brightly !
The moon shines brightly !
What is to be seen ?
(Here) the spears strong and ready !
(There) the spears weak and fearful !
Mine were not quite true to aim ;
Yet they shall be.
Thine were not true to aim,

For thine fell to ground
  A long way off! oh!
With us is the god of war—*Tu*,
Who approves of close fighting.
Ye will not come on!
  Ye dare not! Ye say,—
"Just leave the assault till they fear."
  Ha! ha! But know ye,—
The eye of the leaders of war
  Never sleeps;* never winks! oh! oh!

A truly fine spirited song in the original. (MS., *ined.*)

(13.)

A Love-song. By a widow, or a widower, for the partner deceased.

(Part only.)

Go on setting, O thou sun!
Descend into thy cave,
To carry tidings thither!
  Alas! alas!
The tears fall plentifully from my eyelids,
Gushing like a flowing tide;—
But thou repliest not!
  Alas! alas!
*   *   *   *
Truly grey hairs are showing
On my dear friends;—
But with me especially,
  Alas! alas!
The flowering plume of the *Arundo* reed,
Shows prettily, glancing in the sun
In the seventh (moon),—
  Alas! alas!
In the eighth (moon) it is blown away!
  Alas! alas!
The rainbow shows brightly in the dark cloud,
But the lightning is flashing!—
All is over!—
  Alas! alas!

(MS., *ined.*)

An altered version of this beautiful song is on p. 261, Grey's "Poetry."

(14.)

A Love-chaunt. (Part only.)

Rain on, O thou rain! Continue to rain down without, there; here am I, within the hut, deploring my distress, and comparing (this with that), for my eyes are as if supplied with water from a flowing spring. It is the great love I bear to the fond one of my affection that causes these fierce convulsive pains: the dear one who is so greatly desired and hoped for! Now, alas! thou art separated, far off to a distance; who will return thee

* See "Trans. N.Z. Inst." Vol. XII., p. 139, for this proverb.

hither to me? And you, my hundred friends, who are strenuous to aid me, leave it for a while; just merely for a little (time), while I am sitting-up a bit. Be assured, I shall not wait long, only until the moon rises; then I, also, will go forth, to look at the fleecy clouds sailing hither, coming this way over the mountain.

Alas! the boundary that parts us, dear young lady! is as a great ocean-depth to thee. Notwithstanding, in that one direction towards thee, my eyes are dim with steady gazing. For thou alone art the only one of my deepest affection, etc., etc.

Note.—The great beauty of this song, in its commencement, arises from the poet's making it to rain heavily and unceasingly *without*, while he is lamenting *within* a miserable hut, and comparing the flood of waters flowing from his eyes with the falling rain! The imagery is so natural, plaintive and affecting, that it is worked up into many of their love-songs. So, again, where he says—" wait a while,—*while I am sitting up a bit;*"—meaning, just as a sick person, who is weak when roused to get up. (A version of a part of this song is at p. 396 of " Grey's Poetry.")

(15.)

A Love-song. By a Widow for her Dead Husband.

(Part only.)

After the evening hours,
I recline upon my bed,
Thy own spirit-like form
Comes towards me,
Creeping stealthily along!
Alas! I mistake!
Thinking thou art here with me
Enjoying the light of day!
Then the affectionate remembrances
Of the many days of old
Keep on rising within my heart!
This, however, loved one; this
Thou must do,—
Recite the potent call to Rakahua
And the strong cry to Rikiriki,—
That thou mayest return (to me).
For thou wast ever more than a common husband,—
Thou wast my best-beloved,—my chosen;
My treasured possession! alas!

(MS., *ined.*)

(This, in part, worked up with another song, will be found in Grey's "Poetry of the New Zealanders," p. 352.)

Note.—The cries, or invocations, to Rakahua, and to Rikiriki, often mentioned in their poetry, etc., were said to be to those beings who had power to restore from the dead.

(16.)

A Love-song.

Rise up quickly, O thou Moon! make haste to get above me, that I may give vent to my sighing, and utter my laments! Now, indeed, for the first time, do I feel the pangs of love; it is as if a demon, or a lizard, were within me gnawing. If, indeed, my people, you are not willing to dwell with me, and bear me company in my distress,—you had better separate yourselves to a distance; for the love within me is very great; far, indeed, beyond expression.

O ye light, fleecy clouds, flitting above; fly on, fly away, and carry tidings, that my beloved one may hear of me in her anxiety. Here, also, am I, in very great perplexity. I must hide my strong affection for the one I love. Alas! alas! my very eye-sight is fast failing me; when I look at the distant headlands, they quiver and are dim!

If the burning sulphur-crater at White Island were near me,—gladly thither would I go; turning away from all my friends,—never more to return hither; but for ever remain absent in the dreary cold South.—(MS., *ined.)*

(17.)

A Love-song, or Lament. By a Wife for her Absent Husband.

The eye is strained and wearied with the long looking-out;
Thou art, to me, the peaks of firmly-fixed affection!
If I were but a bird, then I could fly away,
Then, indeed, my wings would quickly become extended.

My own very heart is no longer faithful to me,
Hanging, far away, suspended! I see the fine white clouds
Above me, flying hither, over the far-off mountain tops,
Beyond which is the husband so dearly loved by me.

In the house I am being eaten up with anxiety;
The husband was unwilling to dwell here with me!
But now thou art separated, a long way off from me,
And my remembrances come crowding in hundreds,
Causing the flowing tears to trickle down from my eyelids.

(Grey, *loc. cit.*, p. 62.)

Those few examples of striking natural imagery herein brought forward, are both varied and brief. Among them are,—melancholy, warlike, ceremonial, humourous, and love pieces; some whole, some only in part;—having purposely excepted the long historical, legendary, martial, revengeful, and ceremonial ones (as such would require much explanation for a European reader); also, all of a licentious character,—of which there are many, as might be supposed, among a people where all and everything was open and naked. Yet, no doubt, in the martial and revengeful pieces, so truly characteristic of the people, the Maori poets more fully rise with the occasion; there the poet shows himself as absolutely "dowered with the hate of hate, and scorn of scorn!" I might, also, have shown much more of their numerous natural beauties, had I confined myself to a line or two, here and there, containing a single beautiful image or expression, and so have picked them out from a large number of poetical pieces; and such would also have been easier for me,—but I considered, that in following the plan I had adopted, I have given both longer and more continuous (unbroken) specimens, and done the Maori poets justice. I have mostly preferred to take them from Sir G. Grey's published collection, or, at all events, to refer to such when found therein (although, in several instances a different version, having been altered, as is frequently the case) as, in my so doing, the published Maori originals could be referred to by those possessing that book.

In conclusion, I would make a few remarks on their musical talent, this being a natural and necessary part of the subject, seeing that the old Maoris either sung or chaunted all their poetry. And I am the more inclined to do so from the fact of so very little being known about it for this—the music (unlike the words) of their poetry—has nearly become wholly lost both to them (their descendants) and to us.

This I purpose considering briefly under two heads—I., Instrumental; and II., Vocal.

I. *Of their Instrumental Music.*—Here, however, little can be said, save that they did possess such ; and that, rude as it was, they sought to vary it in many ways, showing (1) their musical faculty, and (2) their endeavours after its improvements. But to do them justice, we must never lose sight of this one great fundamental fact, already mentioned by me*, *their utter ignorance and want of all and every kind of metal!* How, then, it might well be asked could they possibly manufacture a musical instrument? Still they strove to do it, and, to a certain rude extent, succeeded. Their attempts in this direction have always served to remind me strongly of what the ancient Greeks related concerning the early endeavours of Apollo himself in constructing his first lyre, or harp, from the castaway shell of a tortoise and a few strings drawn across it!

First I would observe that their instruments were nearly all wind instruments, which they played or sounded with both mouth and nose, having, however, separate instruments for each service. Of these, fortunately, we have a few accurately drawn and described by their first European visitors; also a few deposited in museums at home. Yet, while the proper names of several of them still remain (though some are for ever lost) an accurate description of all of them is not now to be obtained from the Maoris. I myself, in all my researches during a lengthened residence, have seen but a few —a poor remnant! They were all made of wood, bone, or shell, and may be conveniently classed under three familiar names: (1) trumpets, (2) flutes, and (3) whistles.

(1.) The *trumpets* were made of wood or shell; for this latter purpose the shell of the large *Triton (T. australis)* was used, its apex was neatly cut off, its mouth scraped, and the whole shell polished, and a mouth-piece of hard wood, suitably hollowed and carved, was ingeniously and firmly fixed

* See "Trans. N.Z. Inst.," Vol. XI., p. 80.

on. Here I must notice a most curious plan which the old Maoris seem to have had for increasing, or altering, the power of the sound of their conch shell. An ancient trumpet of this kind (formerly belonging to the old patriotic chief of Table Cape, Ihaka Whanga, but now the property of Mr. Samuel Locke, of Napier,) has a thin piece of dark hard wood, of a broadly elliptic form, and measuring 5 × 3 inches, most dexterously fitted in to fill up a hole in the upper part of the body or large whorl of the shell; which piece of wood is also curved, and ribbed, or scraped to resemble and closely match the transverse ridges of the shell; and additionally carved, of course, with one of their national devices; besides being ornamented with strips of birds' skin and feathers;—the plumage of the *kaakaapo* or ground parrot, *(Strigops habroptilus)*. At first I had supposed that the said shell, having been somehow broken, had been repaired by having this piece of wood set in; but on further examination, and also comparing it with the figure of a similar New Zealand shell trumpet in Cook's Voyages *(Second Voyage*, Vol. I., plate 19,) which has, apparently, a precisely similar piece of dark wood let into it! I have concluded as above, that, in both instances, such was done purposely. The old Maoris informed Mr. Locke that only one sort of wood was used by them for such purposes, it being very sonorous, *viz. kaiwhiria* (also, *koporokaiwhiri*, and *porokaiwhiri*) = *Hedycarya dentata.* Of this wood they anciently made their best loud-sounding drums, or gongs *(pahu)*, which were suspended in their principal forts. They also manufactured several other musical instruments from this wood, for the producing of delicate sounds to accompany their singing; some of which processes being highly curious (and all but wholly lost) may be here briefly described.—1. Two small smooth sticks, each about 18 inches long, were made, one of them was held in the mouth, while the other was used to strike that one at the end; the performer at the same time humming the tune. 2. Another manner of musical performance was by two persons standing about 4 feet apart, each holding a prepared rod of *kaiwhiria* wood, of the length and size of a walking-stick; these sticks were thrown to and fro alternately, and gently and dexterously caught, but so that they should while passing in the air touch each other, and give out the exact note required; the two performers at the same time chaunting their song. Might this wood not be advantageously used for stethoscopes, etc., etc. Their wooden trumpets were also very peculiar, made of pieces of hard wood, scraped and hollowed and jointed, and very compactly put together, after a highly curious fashion, so that the joinings are scarcely seen! Some long ones have a large hole in the middle of the instrument, whence the sound issued, which was there modified by the hand; and others, four feet in length, have a singular (if not unique) central piece, larynx, or diaphragm, set a long way (12-14 inches) within its mouth,—the sound of this kind was emitted from its larger aperture at the big dilated end;* to me, this instrument seems a really wonderful work and contrivance! The noise they made with some of their trumpets was very loud and powerful, and must, I think, be justly termed discordant, if not absolutely hideous, to an European ear; yet by their different sounds their several chiefs in travelling were known. And not only so, for those loud-sounding instruments were also used as speaking-trumpets to carry words to a distance.†

(2.) The *flutes* were made of wood and of bone—when of the latter it was human bone. They were of various lengths, generally six to eight inches long, open at both ends, and having three holes on one side and one on the other. The wooden ones were ornamented with a great amount of carving and inlaying, each being an example of skill, industry and patience, and of the time necessarily taken in its construction. Those for the mouth were differently formed from those for the nose. One of the smaller ones (often made of bone) was not unfrequently worn suspended from the neck of a chief. On these the old Maoris managed to play simple Maori tunes and airs.

(3.) Their *whistles* were very large; that is, thick, obtuse, peculiarly

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* One of these peculiar trumpets (and, as far as I know, the only one remaining in New Zealand) is also in the possession of Mr. Samuel Locke, of Napier, who kindly lent them both to me, to exhibit on my reading of this paper.

† Of this we have two notable instances in the historical traditions of the Taupo tribes, which, as they are very rare, I may give here.

(1.) When the tribe of Ngatituwharetoa were returning from the battle and slaughter of the Marangaranga people, and had reached the beaches of Taupo lake, they sounded their big trumpet as a sign by which their approach should be known. On hearing it, a lady named Hinekahuroa, one of the Ngatikurapoto tribe, then living at Rotongaio, deeming it to be an insult, bawled out a bitter curse upon them (*Pokokohua ma!*—mummified heads); which they hearing immediately retaliated with another fell curse, making their trumpet to say "*To roro, To roro*,"—thy brains, thy brains. This so irritated that chieftainess, that she followed it up with another, still longer and worse, which, of course, was as promptly repaid back by them in kind, through their trumpet; and the end of this was that two towns (*pas*) were besieged and taken, and the inhabitants ruthlessly slaughtered, within a month.

(2.) Another instance was that of a chief named Ruawehea, a grandson of Tuwharetoa, who had managed to inveigle Maoris of another tribe (Ngatitama) to become his dependants, and, afterwards, whenever he should visit them in his canoe, he caused his trumpet to proclaim his approach, ordering food to be got ready for him, and ending with insulting language and curses, all spoken through his trumpet. The people of that village bore it for a considerable time, but one day on his landing at their place as usual, he was decoyed into their house of reception and killed—for the insulting words spoken through his trumpet. Of course, that also quickly ended with a fearful revenge and full slaughter.—(Historical Incidents of the Ancient Tribes of Taupo:—*MSS. ined.*, *W. C.*)

shaped, and something like a short thick tongue, some being a little curved. They were made of hard wood, scraped, polished, and profusely carved, and inlaid with mother-of-pearl; these, also, were worn by the chiefs, hung to their necks. Parkinson (Sir Joseph Banks' draughtsman) has given a drawing of one in plate 26 of his interesting "Journal," figure 24;—in describing it he says,—"A whistle made of wood having the outside curiously carved; besides the mouth-hole they have several for the fingers to play upon. These, which are worn about the neck, are 3½ inches in length, and yield a shrill sound." I suspect that these, like their trumpets, were not used for obtaining any proper tune, but only for the purpose of making a loud call,—as from a chief to his followers.

Captain Cook, in his first voyage, when on this subject, briefly says,—"They have sonorous instruments, but they can scarcely be called instruments of music; one is the shell, called the *Triton's* trumpet, with which they make a noise not unlike that which our boys sometimes make with a cow's horn: the other is a small wooden pipe, resembling a child's nine-pin, only much smaller, and in this there is no more music than in a pea-whistle."—(Vol. III., p. 468.) Either Cook, then, had not seen them all, or Dr. Hawksworth, in compiling that history of the *first* voyage, had overlooked it;—I think this latter the more probable.

Forster, who accompanied Cook in his *second* voyage remarks,—"They also brought some musical instruments, among which was a trumpet, or tube, of wood, about four feet long, and pretty straight; its small mouth was not above two inches, and the other not above five inches in diameter; it made a very uncouth kind of braying, for they always sounded the same note, though a performer on the French horn might perhaps be able to bring some better music out of it. Another trumpet was made of a large whelk *(Murex tritonis)* mounted with wood curiously carved, and pierced at the point where the mouth was applied; a hideous bellowing was all the sound that could be produced out of this instrument. The third went by the name of a flute among our people, and was a hollow tube, widest about the middle, where it had a large opening, as well as another at each end. This and the first trumpet were both made of two hollow semi-cylinders of wood, exactly fitted and moulded together, so as to form a perfect tube."—*(Forster's Voyage,* Vol. I., p. 227.) I think Forster could not have seen their small flute (which is a very differently-formed instrument, and without "a large opening in the middle"), on which alone they played their plaintive airs;—at all events, such is not included in the above.

Second, we have the proof recorded by competent early visitors, of the abilities of the New Zealanders in playing tunes on their *flutes;* which they could only have attained to through long and persevering practice. And this, to me, is indicative of both a high musical ear and a love for music,—to find that they could patiently succeed in extracting even a short series of pleasing notes from such wretched instruments.

Captain Cruise (84th Regiment), who was in New Zealand in H.M.S. "Dromedary," in 1820, and who spent nearly a year here, and therefore had far better opportunities for observation, remarks in his "Journal,"—when in the Thames, and not far from the site of the present town of Auckland,—"Two chiefs came on board; one of them, a very tall handsome man, wore a carved flute or pipe round his neck, upon which he played the simple but plaintive airs of this part of the island, with much correctness."—(*Loc. cit.*, p. 212.)

I may here mention a few incidents which have in past years come under my own special notice, as further showing their natural ear for music—or melody.

(1.) It is well known that at an early date, say forty years ago, the Maoris showed a great desire to obtain jews-harps, this was common. But to see them—one at a time being quite enough!—critically examine and try a whole score, or more, of those little instruments, before one was found that was "soft" enough (or suitably melodious) in its twang to please their ear! I have known them to leave the store where jews-harps were sold without purchasing one after trying many, though sadly in want of one at the time, rather than bring away a "hard" or unsuitable one. They also often spent much time in endeavouring to alter its tone, by trying all manner of schemes and plans with its tongue. Again: in later years, I have known them to improve on the sound of the jews-harp (for their ear), by fixing a small lump of sealingwax, or *kauri*-resin, on the projecting end of the tongue of the instrument, for the purpose of playing the same *within their mouth and with their tongue*, instead of with their finger! This certainly rendered the sounds much softer than when played in the usual way. Young men would sometimes be thus occupied for one or two hours, evidently delighting themselves with the dulcet sounds. Another little-known item in connection with jews-harp playing, or its musical sounds, I may also mention, as it is very peculiar, namely, I have known the Maoris anxiously to beg for old dessert knives when worn out by constant use and scouring, to make with them (the worn thin remnant of a blade) a small instrument resembling a jews-harp, its sound, they said, being so much sweeter.

(2.) A little Maori lad, named Itama, whom I was training, and who lived with me some time, showed at a very early age a most refined ear for music. Seeing that he was always endeavouring to elicit pleasing sounds from threads and twine strained over a bit of board, or a shell, I procured him some catgut of different sizes, which highly delighted him. He then sought (in his own quiet persevering way) pieces of wood of various sorts and shapes, and cut them and fixed his chords to please himself, making, at length, sweet sounding instruments; and often have I known him to spend hours in quietly listening to those soothing sounds, especially during one long dreary and painful season, when he was in the doctor's hands for his eyes, which ended in his totally losing the sight of one of them. At such times I have been led to think upon Wordsworth's beautiful and appropriate lines:

> —— "And she *shall lean her ear*
> In many a secret place,
> Where rivulets dance their wayward round,
> And *beauty born of murmuring sound*
> *Shall pass into her face.*"—(LUCY).

But there is much throughout the whole of that poem strictly applicable to the subject of this paper.

Another lad, whom I had residing with me at a much earlier period, also showed a fine natural ear for music. I bought him a piccolo flute, and he early taught himself to play on it. I have known him after hearing a tune a few times (at church, or elsewhere), to come home, and in a very short time to play it correctly and harmoniously on his little flute. This, too, he did with several of our tunes, of course, all without notes or previously knowing them.

II. *Of their Vocal Music.*—Under this branch I have very little additional to say; the true old Maori singing differing so widely from our own; although some of it approached pretty nearly to a few of our more simple chaunts. The vocal Maori music, as a whole, has, like their own instrumental, almost become extinct. One remarkable feature, however, concerning their vocal music I would relate, as I am sure it is but little known;—namely, that almost every song or poetical piece had its own proper tune,—and must not be sung or recited to another! Indeed, the words alone of any newly-heard song, however spirited or approved of, were not valued without its tune. When I first discovered this I was astonished, and could hardly believe it, until I had repeatedly proved it. For, in my extensive yearly travelling, some 30–40 years ago, throughout the North Island, always having Maoris travelling with me, I found, in getting to a strange place or people, that my companions could do nothing with a new song they had brought with them, unless they also knew its proper tune. And I myself, when sometimes quoting a line or two from an unknown song, should soon be teased about its tune—"*He aha tona rangi?*" would be frequently asked. Here, then, is another addition to their amazing powers of memory, already alluded to by me in this paper.

I will conclude with two quotations from their earliest visitors, containing their remarks on this subject. Captain Cook says,—" A song, not altogether unlike their war-song, they sometimes sing without the dance, and as a peaceable amusement. They have also other songs which are sung by the women, whose voices are remarkably mellow and soft, and have a pleasing and tender effect; the time is slow, and the cadence mournful, but it is conducted with more taste than could be expected among the poor ignorant savages of this half-desolate country; especially as it appeared to us, who were none of us much acquainted with music as a science, to be sung in parts; it was at least sung by many voices at the same time." (*First Voyage*, Vol. III., p. 468). And Mr. Anderson, who was the surgeon in Cook's ship on his third voyage to New Zealand, thus writes:—" The children are initiated at a very early age into the keeping the strictest time in their song. They likewise sing, with some degree of melody, the traditions of their forefathers, their actions in war, and other indifferent subjects, of all which they are immoderately fond, and spend much of their time in these amusements, and in playing on a sort of flute. Their language is far from being harsh or disagreeable, though the pronunciation is frequently guttural; and whatever qualities are requisite in any other language to make it musical, certainly obtain to a considerable degree here, if we may judge from the melody of some sorts of their songs." (*Anderson, in Cook's Third Voyage*, Vol. I., p. 163.) But far beyond all, as I take it, is the scientific testimony of Dr. Forster, who was with Cook in his second voyage to New Zealand,—already, however, given by me in a former paper, with some interesting additions from Sir G. Grey's work.*

Art. IV.—*Notes on the best Method of meeting the Sanitary Requirements of Colonial Towns.* By Edward Dobson, C.E., President of the Philosophical Institute of Canterbury.

[*Read before the Philosophical Institute of Canterbury, 5th August*, 1880.]

In the following notes I propose to lay down certain propositions, which may be termed sanitary axioms, applicable alike to all towns, whether built on hill-sides, on table-lands, or on low-lying plains; and which may serve as standards, by which to test how far the sanitary arrangements, which are being carried out in our Colonial towns, fulfil, or fall short of, the conditions necessary for the due maintenance of the public health.

I refer especially to *Colonial* towns, because the conditions of sanitary work are very different in the irregularly laid out and closely built cities of

* See "Trans, N.Z. Inst.," Vol. XI., pp. 103–106.

the Old World, and the regularly planned and sparsely built towns of a new country. Not only does the fact of the denser population, on a given area, bring within the means of the inhabitants, works, the cost of which would be prohibitive in thinly peopled districts; but, in planning new towns, favourable conditions may be secured by legislative enactment, which are unattainable where the ground has been closely built over with an utter disregard of sanitary requirements.

And first, as to the Requirements of a Town House.

Access.—Every house should have access to a public thoroughfare, both from the front and rear; so that no rubbish, nor offensive matter, need be carried through the dwelling.

This is also an important point in case of fire; both as regards the escape of the inmates, and the facilities thus offered for checking the progress of the flames.

Surface drainage.—Every town property should be formed to such levels that the surface-water will drain, by gravitation, into the street channels; unless there is a fall to a natural water-course along which a right of drainage has been reserved.

This involves a careful consideration of the levels in the first laying out of the streets, so that the desired end may be attained without having either unnecessarily to raise the level of the sections, or to cut down the gutters to an inconvenient depth. As a general rule, the original levels of the streets of a town should be *lowered* by cutting down the lumps and ridges, rather than *raised* by filling in the hollows; the principle being the opposite of that to be followed in laying out a road through rural lands.

House Drainage.—Every house should have a paved channel, either open or covered, for the removal of the house-slops; communicating with either the street channels or underground drains, and provided with a sufficient supply of water to keep it constantly flushed.

No drain should be allowed to pass under or through any dwelling; but, should there be cases in which this is unavoidable, the drains should be perfectly isolated by being laid in concrete, and no communications should be made inside the dwelling with sinks or cisterns, the overflow from which should pass into the open air before being led into the house-drains.

Water Supply.—Each dwelling should have a supply of water for domestic use at a daily rate of not less than twenty gallons per inmate, exclusive of what is required for flushing the closets.

If rainwater has to be stored, the tanks should be protected against filtration from sources of impurity, and should be covered over to exclude the sun's rays, the light and heat from which have a powerful effect in promoting vegetable growth.

If the system is one of intermittent supply and cisterns are used, there should be separate cisterns for domestic use and for flushing the closets, and there should be no communication between them.

If there is a constant supply delivered at stand-pipes, there should be paved channels to take the overflow to the house-drains, and care should be taken to prevent the saturation of the ground by the waste water.

Dust-bins.—Every dwelling should have a properly constructed receptacle for ashes and kitchen refuse, the periodical removal of which at short intervals should be compulsory under municipal regulations.

The gratings to the house-drains should be provided with moveable strainers to collect the solid refuse, for which the dust-bin is the proper receptacle, and which would otherwise be carried into the house-drains.

Closets.—The closets should if possible be isolated from the dwellings, but, where they are unavoidably connected with them, the communication should be through a lobby freely open to the external air.

The introduction of sunk cesspools for the storage of excreta should be strictly prohibited within the boundaries of every township, no matter what the nature of their construction.

Closets may be of three kinds, namely :—

1st. The ash-midden, in common use throughout the Midland Counties of England.

2nd. The pan-closet, which, in many English towns, is superseding both the cesspool and the ash-midden.

3rd. The water-closet.

The ash-midden is a combination of the dust-bin and privy, and may be considered as a form of earth-closet. When this form of closet is adopted, the floor should be paved and slightly raised above the general surface of the ground, and provided with a drain to carry off any liquid not absorbed by the ashes.

If the pan-closet is used, the floor should be paved so that any droppings can be readily removed, and there should be a free circulation of air under the seat, and a ventilating shaft carried up into the open air.

The pans should be of ample size, and should be fitted with stout handles and with air-tight lids for use during removal, and they should be thoroughly cleansed and disinfected after emptying, before they are replaced.

Both ash-middens and closet-pans should be compulsorily emptied at short intervals, under municipal regulations.

The introduction of water-closets involves a considerable amount of municipal organization for the double purpose of providing a water-supply for flushing them, and a system of underground drains for the removal of the excreta.

The geological conditions existing in Christchurch, under which every householder can, at small expense, obtain a stream of artesian water rising to the height of several feet above the ground, are very rarely to be met with, and, as a general rule, water-closets cannot be introduced into towns unless in connection with public waterworks, by which the water can be supplied to the houses under sufficient pressure to rise into the cisterns supplying the closets.

In the construction of the closets themselves, the two principal points to be attended to are:—simplicity in the mechanism employed, and such cistern arrangements as will, on the one hand, ensure the complete flushing of the pan after use, and, on the other, prevent needless waste, as it must be borne in mind that every additional gallon used diminishes the economic value of the excreta, and adds to the cost of pumping at the outfall.

In the second place, passing from the individual to the community, or from the house to the town, What are the Requirements of Town Drainage?

The requirements under this head may be thus summed up :—

1. Surface and subsoil drainage.
2. Discharge of storm-water.
3. Discharge of local rainfall.
4. House-drainage ; and, lastly—
5. Removal of excreta.

The main point of our enquiry is—to what extent can the same channels be used for the several purposes ?

Surface and subsoil drainage are two distinct things. The first is the removal of water which comes from a higher level, and lies on the ground simply because there is no outlet for its discharge. The second implies the lowering of the water-level below the surface of ground which is either water-logged by filtration from above or by springs rising from below. Christchurch, thirty years back, afforded ample illustration of my meaning. The south-east portion of the town, between Jackson's Creek and what is now the Caversham Hotel, was a pond covered with *raupo* growing in water about a foot deep, on a tolerably firm bottom; whilst at the south-west corner of the town, near the South Belt, and along what is now the Windmill Road, was a district of treacherous peat swamp, tolerably free from surface-water, but full of springs, and so soft that cattle could not cross it. You will now look in vain for any trace of this early state of things : the Ferry Road ditch, the Windmill Road drain, and the south drain, having effectually done their work of reclamation, and having, in their turn, disappeared, to be superseded by brick sewers ; but if you will only call to mind the hundreds of pounds which have been paid as compensation for the right of cutting these necessary outfalls, the thousands of pounds which have been spent in abortive attempts to supersede them by the construction of drains on even less suitable lines, the litigation and heart-burning which have been always connected with them, and the danger to the public and the injury to the adjacent properties, arising from the construction of deep open drains alongside the public roads—I think it will be unnecessary for me to bring any further argument in favour of my next proposition, which is—that before laying out the streets of a new town the lines of surface and subsoil drainage should be decided on, and reserved for drainage purposes.

Next in order comes the question of the storm-water outfalls.

In almost every district, however level the ground, there will be found depressions, which, although not fed by springs, and therefore not coming under the designation of water-courses, are the channels by which, in heavy rainfalls, the storm-water passes from the upper to the lower levels. Instead of blocking up these natural channels, as is too often done in the formation of streets, they should be utilized, straightened, deepened, and connected with suitable outfalls to the rivers, so that the storm-water shall not unnecessarily be thrown on the street gutters; but that, on the contrary, the latter shall have such freedom of escape into the storm-water channels as to avoid all chance of the streets themselves being flooded.

And when the lines of surface and subsoil-drainage have been marked out, the storm-water channels reserved, and the position and levels of the outfalls defined, *and not before*, we may proceed to lay out the streets of our town; taking care, in doing so, to grade the streets in such a manner that, with a minimum of earthwork, the surface-water on every property may drain, by gravitation, into the street gutters, and the latter into the outfalls.

There is nothing quixotic, or unreasonable, in these propositions, which simply aim at defining the sequence of steps to be taken in laying out a new township; but they involve a great principle, which underlies the whole question of sanitary reform, viz.,—that, in a new country, the work of the engineer should precede, and not follow, that of the settlement surveyor;—and until this principle is recognized and acted upon by Colonial Governments, not only in the planning of townships, but in many other matters connected with the preparation of a new country for successful settlement, the history of colonial progress will always be a record of costly struggles to regain facilities of communication, drainage, and water-supply, which have been heedlessly sacrificed by handing over the Crown lands to private ownership, without the one reservation of conditions essential to the general welfare of the community.

Now, let us suppose our town to have been judiciously laid out as above described, and provided, in every part, with an efficient surface, subsoil, and storm-water drainage.

What are we going to do with our house-slops? Bearing in mind that the surface-drainage of the streets themselves unavoidably communicates a considerable amount of impurity to the rivers, into which it ultimately flows, even with the most efficient system of street cleansing—it appears, to me, idle to object to passing the house-drainage to the outfalls through the street gutters, provided that the excreta and all solid refuse are kept out of the house-drains, as previously suggested; and that they are kept constantly flushed by an efficient water-supply.

If, however, the closets discharge into the house-drains, a distinct system of sewers must be provided, leading to a pumping-station, at which the sewage is lifted for disposal upon the land, as the cases in which this can be effected by simple gravitation are quite exceptional. And this involves,—1st, that the rainfall must be kept out of the house-drains, to avoid the risk of the pumps being overpowered, and the sewage thrown back upon the houses in heavy storms; and, 2nd, that there must be special means provided for flushing the street gutters, as the domestic water-supply is no longer available for this purpose.

Lastly, let us take into consideration the different methods of disposing of the excreta, to which I have previously briefly referred.

The ash-closet is a great advance upon the cesspool system. There is no risk from sewer-gas, and no pollution of the soil from leaking or overflowing cesspools. The ashes act as absorbents and deodorizers, and there is but little smell or inconvenience experienced at the emptying of the closets; and as their contents are ready to be placed on the land without undergoing any intermediate process, the sale of the manure goes a long way to recoup the cost of collection.

The system is, however, less adapted for use in closely-built cities than in villages and small country towns, where there is ample garden-space round the houses, combined with an absence of municipal machinery for the periodical cleansing of the closets.

The system of closet-pans has the great advantage of giving facilities for disinfecting the excreta of persons suffering from infectious disease, an advantage which cannot be too highly estimated. With properly constructed pans, their removal may be effected in the day-time with no more annoyance to sight and smell than is occasioned by the visit of the brewer's dray, whilst the freedom from sewer-gas and the absence of complicated and expensive machinery, which is constantly liable to become deranged in unskilful hands, are great inducements for the adoption of this style of closet.

The water-closet is, probably, of all three systems the most luxurious, and, in theory, the most perfect method of disposing of the excreta. Its successful introduction demands three conditions—

1st. An ample water supply, with sufficient head for flushing the closets.

2nd. The cutting-off the sewer gas from entering into the closets from the sewers.

3rd. The satisfactory disposal of the sewage without the pollution of the water-courses.

The first condition is readily fulfilled wherever public waterworks have been established and the streets reticulated.

The second condition does not involve serious engineering difficulties, but the habits of plumbers and sanitary experts are so fixed, that it would be idle to expect its fulfilment except under compulsory legislation.

The third condition is one which is full of difficulty, as it involves the construction of a distinct system of sewers, separate from those required for storm-water outfalls, and the maintenance, in perpetuity, of a pumping station to lift the sewage to the surface at the outfall, whatever may be the means adopted for its ultimate disposal.

For the cost of these works there is no financial return.

The liquid sewage pumped up at the outfall has no commercial value, and the cost of the processes required to bring it into a saleable form are too costly to be undertaken with profit.

If on the other hand the sewage is used for irrigating the land adjoining the outfall, the results may be considered very satisfactory if the increased productiveness of the land so irrigated recoups the cost of the maintenance of the pumping station, leaving the interest of the constructive cost of the sewage works as a permanent charge on the municipality by which they have been undertaken.

The cost of sewage works must not, however, be adduced as an argument against the principle of water-carriage for excreta, although it may be a good reason for not introducing the system where the population is so small that its cost would become a burden upon the ratepayers.

It is easy to conceive that, in the crowded cities of the Old World, it may be the most economical that could be devised.

The real, and (as I consider) the fatal, objection to the water-closet system, consists in the danger arising from the gas generated in the sewers, which, if impregnated by the emanations from the excreta of diseased persons, becomes a fertile and wide-spreading source of disease.

It is true that with proper precautions we may cut off the direct entrance of sewer-gas into our dwellings from the house-drains, but we cannot prevent it from polluting the air of the streets, nor is it possible to say to what extent the germs of disease may not be carried in this manner.

I need scarcely remind you that typhoid fever is pertinently called "the water-closet disease;" and, if you will take even a cursory glance at the sanitary literature of the day, you will see that it is chiefly devoted to the discussion of this special subject.

Sewer-gas is the modern Frankenstein monster, which has been created and turned loose upon the world by sanitary experts, who are now vainly struggling to control and repair its ravages.

And I would ask, Whether it is not our solemn duty to ourselves, to our children, and to the rising generation, steadfastly to resist the introduction into our midst of this most insidious evil; and to stamp out, as we would the plague, any system which is likely to conduce to the spreading of infectious disease, and the consequent lowering of the physical standard of the future population of New Zealand.

In conclusion, I would submit for your consideration three propositions, which embrace the practical deductions to be drawn from my previous remarks:—

1st. That under a proper system of surface, subsoil, and storm-water drainage, it will be found advantageous to discharge the house-drains into the storm-water channels through the street gutters.

2nd. That of the systems of closet at present in general use, that with moveable pans is the one best adapted for colonial towns, on the grounds of safety to public health, simplicity, and efficiency, and economy in cost both of construction and maintenance.

3rd. That it is desirable to prohibit, by legislation, the storage of excreta in sunk cesspools, and the placing of night-soil in any drain, public or private, in any township in New Zealand.

ART. V.—*On periodic vertical Oscillations in the Sun's Atmosphere, and their Connection with the Appearance and Disappearance of the Solar Spots.*

By H. SKEY.

[*Read before the Otago Institute, 24th August,* 1880.]

IN a former paper* I endeavoured to show a tendency to periodicity in the vertical oscillations of the earth's atmosphere, and to connect the pressure of the barometer and the state of the weather therewith. And, in opposition to the generally received opinion, the downward oscillation of the barometer was shown to correspond to the greatest elevation or crest of the atmosphere, while the upward and greatest reading of the barometer would correspond to the lowest elevation or trough of an aerial wave; the vibration

* See "Trans. N.Z. Inst.," Vol. III., p. 306.

from maximum to minimum taking about three and a half days. The lapse of a certain time always occurring between the time of the lowest reading of the barometer and the actual occasion of rain may be thus accounted for. The desirability was also suggested of a simultaneous set of barometric observations being made at the same place, but at different altitudes, in order to determine the action of these vertical oscillations by direct experiment.

It is gratifying to learn that Professor Loomis has lately made valuable experiments in this direction. He states, "that from observations on Mount Washington, Pike's Peak, etc., both the maxima and minima of atmospheric pressure generally occur later on as we rise above the surface, the retardation amounting to one hour for an elevation of from 900 feet to 1,300 feet." Now, assuming that the retardation is uniform, then an oscillation of three and a half days would correspond to an altitude of about seventeen miles, and the great bulk of the earth's atmosphere is proved to be below seventeen miles.

Similar oscillations can be clearly traced on the diagrams of the Sydney meteorological observations.

Doubtless the original impulses, or first swings, were through the agency of heat which caused the first uplifting of a portion of the atmosphere far above the mean line of elevation. When the descending oscillation occurs it will not stop at a point corresponding to mean height and pressure, but will by its momentum descend considerably below it, so that a barometer at the earth's surface will stand at a pressure far above the mean. The lower portions of the atmosphere are therefore compressed, and must necessarily by their increased elasticity have stored up a force sufficient to cause another ascending oscillation, which will again influence the barometer and the weather. Generally after a few such oscillations they become lost or masked by others.

Their range is about one-thirtieth of the whole pressure of the terrestrial atmosphere in medium latitudes, and they must I think, to a considerable extent, lead to the formation of clouds in the upward oscillation, and to the solution and disappearance of clouds in the downward one. These vertical oscillations are, however, only local as far as our terrestrial atmosphere is concerned; at least it is not proved that general ones, embracing the whole atmosphere, have been yet observed, though doubtless such have occurred in earlier times.

We will now consider if similar movements, not only local but general, cannot be traced in the sun's atmosphere and surroundings.

Modern observations tend more and more to extend the height of the solar atmosphere and surroundings; some astronomers even approaching the conclusion that there is no upper limit; still it may be inferred that the great bulk of the sun's atmosphere is below a certain fixed limit. Now if a range of temperature of say 100° Fah., can account for the movements which at times take place in the earth's atmosphere, how much more readily must it be acknowledged that the commotions which have occurred on the solar globe in the remote past would be fully competent to produce an oscillatory motion in the sun's atmosphere.

But it may be asked what proof have we of these hypothetical oscillations, for we cannot take a barometer to the solar orb? It is not, however, improbable that the sun-spots may prove to be a solar barometer, so nicely adjusted, that we may, though at a distance of more than ninety-two millions of miles, study the meteorology of the sun. And it is to be hoped that this subject will not be thought uninteresting, when we consider that our own terrestrial meteorology is not only connected therewith, but absolutely dependent thereon. Many solar discoveries have been made during the last few years, but they appear to shroud the sun and its surroundings in still more numerous mysteries; no wonder, therefore, that various theories have been developed to attempt their explanation.

Amongst these mysteries may be mentioned:

1. The periodicity of the solar spots.

2. Their first appearance in each cycle along two belts more than 20° distant from the equator, and their gradual appearance nearer to the equatorial regions as the epoch of minimum is approached.

3. The acceleration of their rotation in proportion to their vicinity to the sun's equator.

4. Their greater prevalence north of the sun's equator.

Such are some of the greatest difficulties which beset every theory relating to the solar spots. As present theories do not I think explain these, I have ventured upon another, which, be it ever so plausible, will still require to be submitted to all possible tests, and if found untenable must be dismissed from our minds without further ceremony.

In attempting to explain such solar phenomena, we must bear in mind that a rhythmic motion characterizes not only the ponderous planets, but also the most attenuated comets. These bodies are so amenable to the laws of gravity, that their periods from aphelia to perihelia are calculable with wonderful exactness.

Now the law of gravitation comes into operation, not only when a comet is attracted by a sun into a very elongated orbit—having its perihelion passage very close to the sun, and its aphelion immensely distant—but it must also act on any other gaseous, or vapourous mass in his neighbourhood, which can be attracted sufficiently near a direct line to the sun, so that it can act, by pressure, on the immediate atmosphere of the sun; and, after compression, it can then, by its increased elasticity, be rebounded off again.

It is important to distinguish between those parts of the sun's surroundings which are influenced and carried round by his rotation on his axis, and those other portions above the reach of his diurnal motion.

If the sun can draw a comet from the confines of the solar system, can he not also drag after him a large mass of atmosphere, even though it be at too great a distance to partake of his rotation? We know that comets have passed at times very near to the sun; and what is the difference between the regular return of such a comet—moving in a narrow ellipse, and, therefore, appoximating to a line perpendicular to the solar surface—and a mass of matter, in gaseous and other states, moving to and fro, but exactly perpendicular to the surface?

Micrometrical measurements fail to detect any appreciable polar compression in the sun's disc; it is, therefore, probable that the photosphere, or luminous part of the sun, is nearly uniform in thickness or depth. Both the umbra and penumbra of the solar spots are now acknowledged to be below the surface of this photosphere. Now it can scarcely be admitted that solar storms are sufficient alone to account for the periodic formation of spots. Their general figure is more consonant with the idea that their production is assisted by the comparatively thin photosphere being squeezed yet thinner, and pushed away in certain places.

It appears also to be an established fact that when the spot frequency has passed rapidly or slowly from a minimum to the next maximum, it descends with a corresponding (relative) rapidity or slowness to the next minimum. This I think a certain characteristic of oscillations.

What, however, is the shape of the elastic medium hereby supposed to be in a state of oscillation? Even if the true atmosphere, or that portion of the sun's surroundings which actually revolves with the sun, is spherical, we can scarçely suppose the other portion to partake of that figure.

Circumstances appear strongly in favour of the idea of a flattened nebulous mass extending from the sun to the distant planets; for the planets moving for ages in one direction must flatten and draw out the more distant portions of the sun's atmosphere, and also those portions which we have good reasons for assuming are ejected in solar eruptions with such a velocity as to carry them too far from the sun to enable them to rotate diurnally around him.

We know how a light body like a comet is perturbed even by a satellite, and we know that the attenuated matter of a comet can generally hold together by gravity; it is therefore not unreasonable to assume that this lenticular-shaped nebulous mass would in its central portions (or that which is in the same plane as the sun's motion) be dense compared with its other portions, not only from the pull which the planets generally exert, but also from its own gravity. Such central portions have a tendency to disturb the more equatorial regions of the sun's photosphere, especially if a downward oscillation of the lenticular mass is ever exerted.

That this lenticular mass is not however equidistant all round the sun, but exhibits an elongation in certain directions, has already been attempted to be shown.*

The barometric pressure of the earth's atmosphere is greatest in latitudes 20° to 35° both sides of its equator, and certainly the greater prevalence of sun-spots about the limiting parallels of 35° on both sides of the sun's equator is a curious coincidence. Moreover, storms or hurricanes do not occur often at the earth's equator, but 10° or 20° distant therefrom; this may possibly arise from the fact that no great difference of speed of the atmosphere in miles per hour can occur from the earth's rotation until we reach 10° or 20° of latitude; the earth's rotation appears to be an important element in their formation. In the earth's case, however, its equatorial parts receive an excess of heat, and from an *external* source, while in the case of the sun we do not know that a diversity of temperature exists in its different zones.

We can scarcely suppose, therefore, that heat or any other of the forces of nature could be exerted periodically so as to effect the thinning of the photosphere, except that of gravity exerted on an elastic medium.

We have thus dealt with the first of the theoretical difficulties of the solar spots, namely their periodicity; in the second difficulty, or their first appearing in each cycle along two belts more than 20° distant from his equator, we must take into consideration that a gradually increasing pressure, arising from a downward oscillation of a lenticular mass of matter near the plane of the sun's equator would not first affect those parts of the sun quite on the equator (although the greatest pressure might be there) but those parts a few degrees distant therefrom where the photospheric stratum could be pushed away as well as squeezed.

The first breaks in the continuity of the photosphere from solar storms would therefore show themselves in north and south latitudes, but later in the cycle the more equatorial parts of the photosphere would get pushed away towards both sides until it became in its turn more compressed and pushed away; spots would therefore gradually be formed nearer and nearer to the equator until those parts in the higher latitudes where they first appeared would be gaining in their thickness of photospheric matter, not

* "Trans. N.Z. Inst.," Vol. VII., Art. 15.

only from the equatorial side, but also from the polar sides, by the gradual back rush of photosphere. This would prevent the formation of spots in those parts.

Moreover, as the equatorial parts of the photosphere become gradually forced into a latitude having a slower motion of rotation, a certain gyratory commotion must ensue tending to break its continuity. These breaks would also, from this reason, be more likely to occur at the beginning of the cycle in the higher latitudes, where there would be greater difference in the comparative speed of the parallels.

The third difficulty, namely, the acceleration of their rotation in proportion to their vicinity to the equator, may be explained under the assumption of the flattened nebulous mass before alluded to, when we consider that all the parts of the sun's atmosphere, which rotate with him, must tend to travel at greater velocities the higher they are above the sun's surface. When, therefore, the higher parts, directly over the sun's equator, are caused to descend to the sun's surface, by either a general or local oscillation, they must travel faster than the sun's equator, and act like a constant wind blowing in the direction of the sun's motion. The same result will happen, though in a gradually reduced degree, as we depart from the equator ; the solar spots will therefore travel at greater speed the nearer they are to the equatorial regions. After the downward oscillation is terminated, the upward one commences ; but by this time the solar spots have mostly disappeared for the photosphere resumes its ordinary thickness.

This variation in the speed of different parallels of the photosphere, arising from the downward oscillation, must, I think, produce those agitations in the photosphere so apparent just before the appearance of spots, and most likely conspires to their formation. The general drift of the spots in lines of parallel, together with the common arrangement of a number of spots in lines parallel to the equator, appear hereby explained.

The very fact of the solar spots being proved, by observation, to travel faster in the equatorial parts, appears to prove the existence of a lenticular-shaped mass surrounding the sun ; for a merely spherical atmosphere could not, by its downward oscillation, effect a change in their rotation.

Regarding the fourth difficulty, of the greater prevalence and size of sun-spots in northern latitudes, it is pretty certain that, owing to the intense heat of the sun's mass, a certain amount of adjustment must be already attained in its photosphere. If then gravity, at the sun's surface, is balanced by the expansive force of heat, any slight alteration in the pressure of his atmosphere must modify the equilibrium of all other forces there exerted. Can it be that the sun's own proper motion in space, in impinging on the interstellar medium, gives an additional pressure upon the sun's photosphere? If so, the northern parts of the sun would be more affected than the southern, for his proper motion has been concluded by various methods to be in north polar declination.

Should the existence of periodic vertical oscillations in the atmospheres of the earth and sun be demonstrated, then we may be enabled to account for the spots which occur on the planet Jupiter, and the periodicity lately attributed to them; also, the periodic variability of many of the stars, and even of certain nebulæ, H. II 278, and H. I–h 882, for instance, together with the curious alternation of visibility of a star and a connected nebula, as for example 80 "Messier's Catalogue of Nebulæ." There have also been cases in which nebulæ have only lately made their appearance, and instances of previously well-known nebulæ having entirely disappeared, the physical processes of which may be explained by vertical oscillations in elastic masses, which appear to be as universal in elastic media as gravity itself.

Art. VI.—*On the Permanency of Solar and Stellar Heat.*

By Martin Chapman.

[*Read before the Wellington Philosophical Society*, 10*th October*, 1880.]

A favourite subject of speculation with physicists is the question of the manner in which the heat of the sun and other heavenly bodies of high temperature is maintained.

Various hypotheses are from time to time put forward, supported by speculations of more or less probability.

Some of these—as, for instance, the ingenious speculations of Mathew Williams ("Fuel of the Sun")—do not appeal to any processes of nature which we can see going on or put to any kind of test.

Professor Croll assumes the existence of dark, cold masses, whose velocity in space is vastly greater than that of any lucid orb. The collision of these generates heat by the conversion of molar motion. It is to be remarked of this hypothesis that the assumed velocities are such as we can never see on any lucid body; but Mr. Croll points out that this is only to be expected, as it is only by the destruction of this motion that the bodies can become visible. Such a source of heat would result in this:—that the heat generated would be gradually dissipated, so that the body would gradually cool down and become invisible.

Most of the received hypotheses assume molar collision of some kind, whether of large bodies or of meteoric rain on large bodies, the motion of translation being converted into heat.

The last-mentioned kind is by far the most favoured. The eminent astronomer, Secchi, expresses an opinion that only a very small portion of the heat of the sun can be derived from this source; but the reasoning on this point does not seem conclusive, and is not, so far as I am aware, acquiesced in by other physicists.

We see this process constantly occurring on our earth, small bodies constantly plunging into our atmosphere, becoming incandescent by the conversion of their motion, and showing their course by a more or less vivid streak of light. Following the opinion of more than one astronomer, I assume that the process indicated is not confined to the earth, but is common to the latter with all other heavenly bodies.

We have considerable reason for supposing that meteoric matter is distributed throughout space, being perhaps sparse in some parts, and moderately closely aggregated in other parts, more condensed in the neighbourhood of large centres of attraction than at a distance from such centres. Assuming this, it will follow that every body in its progress through space will be continually bombarded with meteoric particles.

The quantity each body will receive at any time will be proportioned—firstly to the richness of the meteoric field; secondly, to the transverse section of the body, and thirdly, to the attractive energy of the body, in other words to the mass.

The amount of heat generated by the impact of a given mass will be proportional to the mass of the attracting body.

It will thus be seen that the impact of say one pound on say Jupiter, will generate more than three hundred times more heat in that planet than a similar impact will generate on the earth, the masses of those planets being as more than 300 to 1.

It is true, that as there is more than three hundred times as much matter in Jupiter to be heated, the absolute rise in temperature of the whole mass will be the same in both instances; but a larger proportion of the heat generated will escape by radiation from the smaller body in a given time than from the larger—this is readily seen.

Taking approximate figures, the diameter of the earth being 1, the surface 1, and the mass 1; the diameter of Jupiter is 11, the surface 121, and the mass 300:—the amount of heat generated by the impact of a given mass will be on the earth 1, on Jupiter 300.

The amount of heat radiated away is proportional to the surfaces from which radiation takes place. In the case of the earth 1, in the case of Jupiter 121. So that while Jupiter receives three hundred times the amount of heat energy received by the earth, it loses in a given time one hundred and twenty-one times, leaving a residue of one hundred and seventy-nine times that amount. So that only in the time that the whole heat would be radiated from the earth, Jupiter would only lose $\frac{121}{300}$.

It is manifest from these considerations that even if the collisions on the earth are so infrequent that the heat generated is all radiated away, and would be so if the collisions were hundreds of times more frequent; still, even assuming collisions still less frequent on Jupiter, a residue of heat might be retained and continually accumulated.

Taking, however, probabilities into account, we should be inclined to infer that, considering the enormously greater bulk and mass of Jupiter, collisions are vastly more frequent on Jupiter, as well as being three hundred times more energetic than on the earth. We should, therefore, be led to suppose that, assuming that in the case of such bodies as the earth, moon, etc., all the heat generated is again dissipated, yet there is some magnitude at which we should find the generation and dissipation of heat balance, the planet being permanently maintained at the same temperature as the surrounding space.

All bodies larger than this, if started at zero, would have their temperature gradually rise to a point where, in consequence of increased radiation from increased heat, the temperature would be maintained uniform so long as the mass remained uniform; but the mass would, in fact, not remain uniform, but would continually grow by the addition of meteoric matter; the temperature would consequently also rise. Hence we see that all bodies will constantly increase in magnitude, and all bodies over a certain critical mass will constantly rise in temperature to a certain point beyond which the only fluctuations will be due to the body increasing in mass and periodically passing into relatively rich or poor meteoric fields, such as the August and November meteor streams, etc.

If we apply the foregoing considerations to those bodies which we know best, we find that some of the bodies, as the satellites of the primary planets—the Earth, Mars, the Asteroids, etc., appear all to be below the critical point of mass, and we find them to be cold bodies.

The larger bodies of the system—Jupiter, Saturn, Uranus, and Neptune, certainly the two former, and probably the two latter—are in a state of intense heat, and are, therefore, above the critical point of mass.

The largest body of all in our system, viz., the Sun, is maintained at a temperature estimated by Secchi at not less than 10,000 degrees cent., and perhaps many times that.

It would be interesting to ascertain if the fixed stars, which are regarded as the largest, are also the hottest, as they would be on the present hypothesis.

So far as I can judge from a somewhat cursory examination of works on the spectroscope, it would appear that, when a variable or periodic star is at its maximum of brightness, its spectrum is the ordinary spectrum of the star with certain bright lines, those of hydrogen, added. Now in the stars placed by Secchi in his first class, such as Sirius, the spectrum consists also of a certain assemblage of bright and dark lines, with the characteristic lines of hydrogen superposed.

Art VII.—*Notes upon Mr. Frankland's paper, "On the Simplest Continuous Manifoldness of two Dimensions and of Finite Extent."**

By William Skey, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 26th June,* 1880.]

It may be still in your mind that, some time ago, one of our members, Mr. F. W. Frankland, read a paper to us embodying a great deal of very remarkable matter, and entitled, "On the simplest continuous manifoldness of two dimensions and of finite extent."* Now, there is much in this paper which I took great exception to at the time, and still do; but I have hitherto refrained from informing you of this, as I had always the hope that a subject in itself so startling and profound, though possibly not new to you, would, as presented to us, and championed in this way, have elicited something more than a mere verbal discussion thereon; something more comprehensive and connected than such a discussion can well be; something commensurate with the importance of the matter treated, and which would possibly represent my ideas thereupon better than I may ever attempt to do.

My hope not being realized I can wait no longer, and I therefore beg your kind attention for a short time, so that I may, as best I can, acquaint you with the particulars of my dissent from the views in question, and my reasons for it; and if, in its turn, this paper should fortunately induce Mr. Frankland to answer the objections which he will here find stated, or to explain those parts of his paper which must appear somewhat obscure to others besides myself, I am sure that, for such a boon, you will cheerfully accord me the time and attention I ask for, and excuse all my shortcomings.

Ere I proceed with this, I will refresh your memory by a synopsis of Mr. Frankland's paper.

It commences by a statement of the well-known fact that some geometricians maintain that the axioms of geometry may be only approximately

* See "Trans. N.Z. Inst.," Vol. IX., p. 272.

true (whatever this may mean), and that, of these geometricians, Lobatchewsky has, by assuming the twelfth axiom of Euclid to be untrue, "worked out the conception of a space in which the ordinary laws of geometry do not hold good." From this and other assumptions at variance with the axioms of Euclid respecting distance relations, it is assumed, as a fact, that geometry is only a particular branch of a more general science, and that "the conception of space is a particular variety of a wider and more general conception." To this wider conception is applied the term "manifoldness," and the full meaning of this term is very lucidly explained.

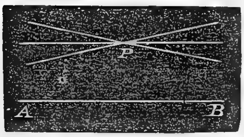
The author then adverts to "the existence" of a particular manifoldness, which has been treated by Professor Clifford in a lecture on the postulates of space; then he describes how this space is analytically conceived, with the object of putting us in a position to apprehend certain discoveries of his own, which relate to its very singular properties; these discoveries communicated to us, he closes his paper with a quotation from Professor Clifford imputing finiteness to the Universe as a result of certain conclusions he has arrived at, which pertain to, or are deducible from, this wider conception, and indicate, on his part, a belief therein, a belief which we may fairly infer is shared in by Mr. Frankland himself.

Such is a fair synopsis of Mr. Frankland's paper, and no one who considers it as a whole, can avoid the conclusion that its prime object is to spread and support the views of the metaphysical school; *i. e.*, it is working for the absorption of science in metaphysics by endeavouring to show that for one of its sections—geometry—there is a transcendental geometry, which not only stultifies it, but swallows it whole, and ultimately assimilates it to itself. This view is supported by the fact, that just recently this gentleman has read before us a very able and profound paper entitled "Mind Stuff," and which is evidently of a highly metaphysical character.

This, however, by the way, has nothing to do with the objections which I here restrict myself to detail and support, and I therefore proceed by premising, that these objections do not extend, at least in a direct manner, to the results of the original researches which are embodied in this paper. Whether these are valid or not is a matter to be only properly tested by examining, as I have, what they rest upon; but this I will say now, (so that the position I take in respect to this matter, may be apprehended at the outset)—that all which this paper treats of, which is distinctly antagonistic to geometry (as understood by geometers of the Euclidian school, or intended to be *conveyed by them*), I take exception to, and now I proceed to show cause. For this I shall, in order to keep myself within due limits, adhere as much as possible to the text of Mr. Frankland's paper, conceiving as I do, and as I have every reason to do, from my knowledge of his mathematical attainments, that the arguments of the geometers he cites therein are correctly rendered and are their best.

To commence then, as to the Euclidian axiom, which Lobatchewsky assumes should be incorrect—namely, the twelfth—that relating to parallel straight lines, an equivalent form of which the author gives as being the one "now generally employed in works on geometry"—it runs thus: "It is impossible to draw more than one straight line parallel to a given straight line through a given point outside it." But, observe, that it is not this equivalent which Lobatchewsky is supposed to use in his attempt at demonstrating the truth of his assumption, but an equivalent of the above-given equivalent; and so, as we have to deal with an equivalent thus twice removed, we must be doubly careful to see whether or not equivalence is here maintained.

As given by Mr. Frankland, this supposed equivalent is as follows: "If we take a fixed straight line, *A B*, prolonged infinitely in both directions,



and a fixed point, *P*, outside it; then, if a second straight line"—(say, *C D*)—"also infinitely prolonged in both directions be made to rotate about *P*, there is *only one* position in which it will not intersect the line *A B*."

Now, I contend that this is not what it purports to be—an equivalent of the Euclidian axiom set before us; and, I think it can plainly be seen that parallelism, as a quality of such lines to be sought for or maintained, is given up; for, allowing the reverse of the proposition to be true—allowing that the second straight line may be made to occupy more than one position relative to the line *A B* without intersecting it, still it will be parallel to it in *one position only*.

In reality the substituted proposition which we have here, does not even touch the original in its essential part; it is, in fact, an independent one, excluding the idea of parallelism as either a necessity or even a desideratum, and merely affirming something which, whether true or otherwise, has nothing to do with the matter now before us.

To any one who will examine the subject, all this must, I think, appear so palpable, that I may leave it now and turn to the discussion of what Lobatchewsky would make of this pseudo-equivalent.

Taking up Mr. Frankland at this point, we have him rendering the master thus: "Now Lobatchewsky made the supposition that this axiom" (meaning, of course, the equivalent in question) "should be untrue, and that there should be a finite angle through which the rotating line might be turned without ever intersecting the fixed straight line *A B*."

Here, then, are two propositions: first, that the lines *A B*, *C D*, though infinitely long, may lay angularly to each other without making an intersection; and, second, that this angularity may be such as to be of a finite value. Now as much is made to turn upon the supposed truth of these propositions it may be expedient (notwithstanding what I have already said) that I should make a few remarks upon this matter also.

You will hardly fail to note the very easy manner in which lines infinitely long are spoken of by the proposition; in effect it says:—Take two such lines, manipulate them in the manner described, and a certain result follows,—just as if this were as sure and tangible an operation, and one not so very dissimilar besides, as that of preparing puddings by a recipe out of some standard cookery book. Surely the mere taking of any line stamps that line as a line of but finite length. However this is, one of these lines is to pass through a point outside the other line, but nothing is said as to the distance away from this line at which the point is to be placed. As we have been started into infinities, it is open to us to place it at an infinite distance away or not; but if, in a friendly spirit towards Lobatchewsky, we place it where his result seems the more likely to be secured, that is at an infinite distance away from *A B*, the proposition becomes simply a truism, and by its wide significance defeats the end desired; for in this way any number of lines may strike through the point *P*, and at all angles to *A B*—each of which may be infinitely extended without intersecting this line. It is seen then that this proposition, as it stands, requires amending by an addition thereto which shall restrict us to the placing of the point *P* at a finite distance away from *A B*. Thus checked, we have only now to ascertain whether or no any line inclining to *A B* may be extended infinitely through *P* as now placed, without intersecting this companion line.

It is very difficult for me to work, or even suppose I am working, with lines of such unwieldy length as these we are set to improvise for our geometrical constructions, but it appears to me that even if the angle of convergence is infinitely small the lines would intersect, but not, of course, at any determinable or conceivable distance. It seems that the completion of the ideal construction begun demands this intersection; and yet, on the other hand, I cannot but allow that to realize an intersection at all is to reduce the lines themselves to finite proportions. Clearly, then, dealing in this way with infinities places us on the "horns of a dilemma."

But that the attempt at operating in this way with infinitely long lines is clearly futile if not absurd, is perhaps better manifested by conceiving, or rather trying to conceive, of the exact converse of the proposition in question.

Suppose then, two straight lines infinitely long, joining each other at an angle infinitely small, and the remarkable consequence follows, that at no conceivable length along these lines would they be apart any conceivable distance; and still the "analytical conception" (to use Mr. Frankland's term) is a valid one, that at some point they widen out to such an extent that a line joining their free ends is infinitely long. But then to our further embarrassment we have in this way upon our hands, or rather upon our minds, a triangle infinitely large, knowing full well the while, that aught which has a shape, must ever finite be.

Thus are we again led to conclusions which are self-contradictory, and we learn thereby that geometry is not likely to be advanced or served by us when we go out of our proper beat to soar in the regions of the infinite.

But whatever may be your views in regard to this aspect of the question, which I have thus so superficially and hastily treated, it is perhaps a fortunate thing for my continued sanity, that for his contention Lobatchewsky does not use arguments based upon the properties of lines which converge at angles infinitely small; possibly seeing, as I think we have, that this gives him nothing, he takes us on to the more solid if less extensive ground of the finite. He enlarges the angle which two non-intersecting infinitely extended straight lines in the same plane may make with each other, to a finite one. None of the evidence of Lobatchewsky in favour of this is given by Mr. Frankland, but simply the bare supposition itself. We cannot, therefore, examine the position fairly to Lobatchewsky, but being unaided by his arguments, I feel it impossible to conceive otherwise than that he is in very palpable error.

It appears to me that at any finite angle of convergence of $C\ D$ to $A\ B$ they will intersect at some determinable part of the line $A\ B$, for a finite angle can only mean an angle of such a size that it can be measured or conceived of, or its value numerically assigned. To hold it to be otherwise is really to hold that an angle finitely large is infinitely small, which either is a contradiction, or these qualifying terms are divested of all meaning. This granted, it then follows as a necessary corollary that there is a point along $A\ B$ which the line P will pass through, and a point, too, capable of being exactly determined.

It appears, then, that here Lobatchewsky, in trying to secure something tangible in support of his idea, has overshot the mark, and so entangled himself and his disciples in a fallacy.

If this is so, can we wonder that, starting in this way, Lobatchewsky gets, as Mr. Frankland says, "very curious results." Triangles, the sum of whose internal angles is less than 180°; triangles which get out at their elbows as they grow, and of the same fraternity as introduced to us further on by their patron ; straight lines of such potency that any two of them can bind a space ; and lastly, as we shall see, a pseudo-spherical surface combining in itself the utmost simplicity with inconceivable complexity ;—all these again, wonderful as they are, sinking to insignificance compared with the grand culminating idea (as more recently developed by this new order of geometricians),—a space of four, five, or even seven dimensions—a space which, to us, I suppose like the seventh heaven of Paul, will ever be both inconceivable and impervious.

And, now, proceeding with our observations on Mr. Frankland's paper, we find an Euclidian axiom thus disproved, and such tremendous conceptions as these projected. Mr. Frankland, under the impression that his enthusiastic belief in this has infected us, or that the arguments given are convincing, essays thus to speak in our behalf: "We see, therefore, that geometry is only a particular branch of a more general science, and that the conception of space is a particular variety of a wider and more general conception." Well, geometry may ultimately be thus subordinated. However, I cannot see that its time has come yet.

But a science so capacious—a science which, to us, is transcendental, at least to the less intellectually advanced of us, requires some mark to distinguish it from that which it has developed from, a mark which shall, if possible, indicate some salient or distinguishing feature of it; consequently this is done. Mr. Frankland says: "This wider conception, of which space and time are particular varieties, it has been proposed to denote by the term manifoldness."

To me this is like "giving to airy nothings a local habitation and a name." But we naturally ask, How comes time to be here conjoined with space under the term *manifoldness?* The idea of time is, to say the least, brought in here very abruptly. The explanation of this term in its application to space and time separately I thank him for, but the infinitely harder task of explaining its application to the two conjointly is left to us.

And now, the overthrow of Euclidian geometry being accomplished, a new kind of geometrical science instituted, and a specific feature of it defined and named, Mr. Frankland introduces us to a surface, which, as he says, Professor Clifford has treated as a surface which is taken by him to be "the simplest continuous manifoldness of two dimensions and of finite extent," or, in plainer and shorter English, the simplest surface of limited extent; and as it is upon a surface of this kind that those discoveries are made which it is a purpose of his paper to disclose, he explains how this surface is got, so that we may place ourselves in a position to intelligently follow him.

The conception of this surface is, in the author's own words, arrived at as follows:—"To obtain the simplest case of such manifoldness [*i.e.*, surface] we must suppose that the point towards which two geodesic lines converge is separated from their starting point not by *half* but by the *entire* length of a geodesic line, or what amounts to the same thing, that it *coincides* with the starting point."* Now it appears to me that Mr. Frankland is unduly cautious here, in stating as a supposition that which is a fact; for it is certain that any point which is describing a geodesic line, has for its ultimate converging point that identical position whence it started; indeed, as it travels along, it may properly be considered to converge every part of its road in succession, this, however, in a *subordinate* manner; but that part of a geodesic line which happens to be intersected by another geodesic line, is no more a point of convergence for that line than any other part along it. The idea of two principal converging points to every such line seems a false one. On extending a single line of this kind we are not at all impressed with the idea that it converges to a sort of half-way house on its route; the idea of a convergence there, is only got by simultaneously producing two such lines or more. That a geodesic line, then, converges to its own starting point, admits of no supposition, being a fact; but this is not all that is wanted. Two such lines, as heretofore known, enclose two spaces or surfaces; and, for the purpose these latter-day geometricians have in view, it is necessary that they shall enclose but one. This idea, or rather proposition, is conveyed to us in rather a queer manner, considering what it involves and clashes with, viz., (in the retrospective sentence which follows thus),—"It is true that we are utterly unable to figure to ourselves a surface in which two geodesic lines shall only have one point of intersection, and yet shall enclose space." Geodesic lines, then, proceeding from some common point of a surface, are to diverge somehow from the polar of that point; but, at this part, Mr. Frankland, otherwise so full, lucid, and connected, is singularly curt and, to me at least, hardly intelligible, so that it was not until I got nearly through his paper that I found what he omits to inform us of here,—that he is assuming a uniformly curved surface of immense size.† With this knowledge it is manifest that the analytical conception of two geodesic lines refusing to intersect each other more than

* Surely Mr. Frankland must take a positive delight in tormenting us with paradoxes. He gravely informs us here that the finishing point or goal for a geodesic line in process of construction is to be the length of such line away from the starting point of that line. The two points are to be apart, yet *coincide!*

† "And on this ground it has been argued that the Universe may in reality be of finite extent, and that each of its geodesic lines may return into itself, provided only that its *total magnitude be very great as compared with any magnitude which we can bring under our observation.*"—(Frankland, *l. c.*, p. 278.)

once, and so enclosing but one space, is founded upon Lobatchewsky's conception of what parallel straight lines are capable of. The application of this conception to the case in point is not explained by the author, but, if I understand him here aright, a figure is by this means "analytically constructed"—a cross between an ellipsoid and a sphere, with a strain of something undeterminable; a figure so large that its geodesic lines stand clear of each other at one pole; a figure, in fact, of the same rare genus as the burstable triangles of Lobatchewsky. If this *is* the interpretation of the author, and Lobatchewsky's conception is the groundwork of the structure in question, all I need do, in answer to it, is to refer you back to my criticism on the ingenious method employed by this geometrician to raise this very fertile conception.

But, in doing so, I must insist upon Mr. Frankland adhering to the limitation which Lobatchewsky has imposed or submitted to in respect to the angle at which his geodesic lines are to incline unto each other, that is, it is to be of a finite value; not that this is necessary to insist upon for my argument, but that in a way which is authorized by this geometrician it excludes from consideration here geodesic lines which incline to each other at angles which are infinitely small, a labour which I feel fully persuaded would result in nothing, although it has a promising appearance.

Summing up these results of mine upon the subject of Mr. Frankland's paper, it is now, I think abundantly evident that the analytical conception of a surface such as the one which has been worked upon for the discoveries therein communicated, is not in reality valid, and that though possibly not self-contradictory, as Mr. Frankland urges, it requires premises which *are* of this nature; that, in fine, this conception, and the whole of the assumptions which have been formed upon it, are based upon fallacious reasoning. As a consequence of this, therefore, it remains to us that the simplest surface of finite extent which is even analytically conceivable only, (or as Mr. Frankland puts it, "the simplest continuous manifoldness of two dimensions and of finite extent"), is that of a sphere.

All now which I desire to do further in this matter is to make a few remarks upon the quotation from Professor Clifford's "Postulates of Space," with which Mr. Frankland closes his paper, as not to do this would be to leave unchallenged (that is in a direct manner), the very remarkable conception which it is evident Mr. Frankland has all along been preparing us for—a conception, indeed, which I am fain to consider has a value, but this only in showing to what lengths theories of the kind described lead us when indulged in without stint. Magnificently suggestive as the Professor is here, he is only so by stultifying the Universe to us—defaming it as it were—levelling it down to our own plane. Evidently referring to the idea that the Universe is of finite extent, because, (as Mr. Frankland in effect puts it), the properties of any small area of a sphere do not "sensibly differ" from those of a plane, he argues that "in this case the Universe is again* a valid conception," (by the way a curious sort of equivalence this) "for the extent of space is a finite number of cubic miles."

Observe here the very important qualifying term *sensibly*, which forms a part of the proposition but is omitted in the *deductions.* To make the conclusion agree with the premises, it should have gone no further than to affirm that the Universe may not *sensibly* differ from an infinite one. Unscientific and illogical conclusions of a very startling character are easily got by suppressions of this kind—suppressions which lead us all unconsciously to mistake appearances for realities.

Proceeding, however, with this quotation, we observe further that the Professor, having perchance, after all, some doubts as to the validity of this deduction, or possibly forgetting he has *proved* it, essays to prove it again; he says, "and this (finiteness of the Universe) comes about in a very curious way. If you were to start in any direction whatever, and move in that direction in a perfect straight line, according to the definition of Leibnitz, ... you would arrive at this place. Only if you had started upwards you would appear from below."

Mark, now, the qualification put upon straight lines, "*straight according to Leibnitz*,"—put, no doubt, all in good faith, as explanative of straight lines, it does still, I feel assured, confer upon them properties which straight lines have not, and in such a way as has not manifested itself to him, able as he undoubtedly is. To those geometricians whose grosser ideas forbid their translation to that high realm of thought where this new geometry is analytically conceivable, it *does* seem that a definition of straight lines which allows of the idea being held that a man can get back on his tracks by going straight away from them, is a definition that is *just* a little wrong.

Our idea of what straight lines are is a fixed and definite one, whether or not we can get a diagrammatical or verbal definition of them,† and it is

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* Referring, I suppose, to that happy time when the firmament was held to be a solid, studded with sparks, and the earth a plane supported on pillars. Delusions once started seem to be ever perennial, except indeed that they are modified to *suit the times.* I daresay in a few centuries this geometry will give way in its turn to something if possible, still more transcendental, and so *ad infinitum.*

† This so-termed definition is on all sides acknowledged to be no definition at all in a strict sense. Euclid's meaning is *clear*, although the terms used are ambiguous, and do not exactly fit it. But our conceptions of what is the necessary property of parallel lines should not be affected thereby. The fact that the definition when "worked out" lets in lines which were not contemplated by Euclid does not make these parallel, but merely shows the faultiness of this definition.

not to be strained or overturned by a statement which falls short of or overreaches its mark.

That the Professor should experience a sense of "relief" in hugging to himself this dwarfed idea of the Universe is not the least of the many curiosities we have been favoured with. Coming from one appreciative of the utility and beauty of science—from one who has often given it a helping hand, it does seem an anomalous thing that he should thus delight in a conception which narrows its field down from an infinite to a finite extent, so that he can avoid contemplating what he is pleased to style "the dreary infinities of homaloidal space."

Well, tastes differ, and mine accords with a belief which is diametrically opposite to this of Professor Clifford and his disciples, a belief that not only is the Universe infinitely extended, but that its constituents are infinite in kind, infinite in quantity, presenting aspects infinitely diverse to us, according to our standpoint, and in none of these aspects, whether in infinitesimal parts or as a whole, to be conceived of by any finite mind, however discriminating or comprehensive its grasp; a sealed book to all, except by scientific aids, but not wholly to be revealed even by these; an eternal enigma always resolving, yet never to be resolved—a Universe whose laws and phenomena are to be interpreted and discovered in so far as can be, rather by active research than by those mystical constructions which we have just considered, and the criticism of which has been the prime object of this paper.

For my part, I blame making so much in this way of the gap "in the chain of reasoning," by which the truths of geometry should be logically connected and represented; but more I blame this illegitimate fecundity of idea—this ill-directed creative power—which, out of the shortcomings of one of its definitions, and the axiom made to supply its deficiencies, would breed this monster to thus devour all that has preceded it. And I conceive that those who forsake geometry, as now defined and understood, to take up with the new, the transcendental philosophy, are really straining out a gnat to swallow a camel.

Art. VIII.—*On Life.* By W. I. Spencer.

[*Read before the Hawke's Bay Philosophical Institute, 11th October,* 1880.]

The paper which I propose reading this evening was not intended originally to be placed before the members of this Institute. As you are aware, a proposal was made some time ago that I should undertake the direction of a class of biology, in connection with the Athenæum. Owing to one cause and another, however, the opening of this class was delayed until the season was so far advanced that, for the present, it had to be abandoned. As I had prepared what was intended to be the introductory lecture, it occurred to me that it might not be unwelcome to the members of the Philosophical Institute, especially as it was upon a subject of the highest interest, but one which, at the same time, has not been treated at any of the meetings of the various branches of the New Zealand Institute, so far as I am aware. The subject, then, with which I purpose to occupy you for a short time this evening is *Life* and its correlation to physical force. The definition I have given of my proposed subject will be sufficient to show you that it does not include those higher processes of animal life, which include consciousness, sensation, and mental phenomena,—it does not refer to that breath of life which, we read in the book of Genesis, God breathed into the nostrils of man,—but to the physical life which the mould that grows in our jam-pots enjoys in common with man, and the mushroom and the oak equally with the elephant and the whale.

What then is this physical life? It is not a substance, it is not an existence, it is not an entity. We become cognizant of it through a series of phenomena inseparable from matter. But our only knowledge of matter depends upon the ways in which it affects our senses—in other words, we know nothing of matter, excepting through the physical phenomena it exhibits, which phenomena are capable of making such impression, through our nerves, upon our brains, that they, in their turn, are capable of calling into play the faculty of sensation or consciousness. In the first place, we have the power of recognizing matter in actual motion, that is to say, matter which has been set in motion by some external force, whatever that force force may be. Secondly, from this we gather that there are certain powers which are able to set inert matter in motion, and we term these the forces of nature. And in the third place, we recognize certain properties in matter itself —inherent in and essential to it; and these, for the most part, are the result of inertia.

As a brief illustration of the way in which matter in motion makes itself cognizable by our brains, I may mention firstly sound. If a piece of metal be struck, or a string in a state of tension be made to vibrate, or air be blown into a tube under certain conditions, the vibrations thus produced are communicated to the surrounding atmosphere, and these sonorous vibrations are of a peculiar nature. They are not waves in the sense of a progressive sideway movement, but a series of elastic attenuations and condensations which travel in lines coincident with their own movements. When the sound-waves strike the ear they are conveyed by a specially arranged apparatus to a portion of the brain where that peculiar sensation is aroused which we term sound. We *hear* the vibrations.

It is not at all necessary to the perception of sound that the vibration should be received by and traverse the ear. The ear itself is merely a mechanism for augmenting and transmitting the sound, just as a relay instrument is used in long telegraph lines to increase and pass on the almost exhausted current. Sonorous vibrations can traverse wood, water, metals —in fact any substance which possesses the requisite degree of elasticity, even the bones of the skull, for it is well known that in certain forms of deafness the ticking of a watch held between the teeth is distinctly audible, when its application to the ear produces no sensation. But the vibration of sound can, by appropriate means, be rendered visible; they can also be counted, and we know precisely how many vibrations per second are required to produce a note of any given pitch. But there are other modes of motion which we are capable of perceiving through the medium of our senses. If we take a piece of iron and hammer it on an anvil, after a time the percussion produces motion amongst the molecules of the iron, and this motion is perceptible to our senses—if we place a finger on the vibrating iron we *feel* the vibrations, and say it is hot. If the hammering of our supposed piece of iron be continued stronger and faster, or if it receive one tremendous blow as from a Nasmyth hammer, the molecular vibrations become so rapid that they are capable of setting in motion the particles of the hypothetical luminiferous æther by which they are conveyed to the eye, and we *see* them. This we term light. Together with the production of light electrical phenomena are called into play, and the relationship between heat light and electricity is so intimate that it too must be included amongst modes of motion. All these then,—sound, heat, light, and electricity,—are simply molecular vibrations which are perceptible by our senses.

As examples of the natural forces, I may mention gravitation, that force which draws masses of matter towards each other;—chemical affinity, that force by virtue of which bodies of dissimilar nature unite to form compounds of definite constitution;—and cohesion, the power which holds the particles of substances of a like nature in contact. The *properties* of matter may be considered as either general or special properties. The former include impenetrability, extension, divisibility, compressibility, and inertia; the latter, solidity, fluidity, tenacity, ductility, elasticity, hardness, transparency, and many more. The question for our consideration is, can we relegate that series of phenomena we term life to either of the foregoing categories? Before we attempt a solution, I will endeavour to explain to you a few of the processes of life, and also something about the matter which exhibits these processes. For life can by no means be dissociated from matter—without a peculiar form of matter we never find life, without life we never find this matter. Professor Huxley has aptly designated it, "The physical basis of life." In fact, it may be termed "life-stuff," to use a form of expression lately come into vogue. This "life-stuff" has received the name of protoplasm from the Greek πρῶτος and πλάσμα, meaning the first formation.

The simplest form in which this protoplasm has as yet been found, may sometimes be discovered if a drop of an infusion of some animal or vegetable substance which has been allowed to stand a few days, be placed under the microscope. There, if the magnifying power be sufficient, you may see a minute mass of jelly-like substance, looking very like a particle of white of egg escaped from its shell. Watch it, however, and you will quickly perceive that although it is to all appearance structureless, it is never for a single instant at rest. It is continually changing its shape—pushing out first at one side and then at another finger-like projections, which extend a certain distance and are then retracted, to be followed only by further extensions and retractions in other directions. Occasionally two of these little streams of semi-fluid stuff will meet and unite into one, or the end of it will apparently fix itself to the glass, and the main body will draw itself up to it, thus producing a tardy kind of locomotion. These jelly-like bodies are not always perfectly clear, often their substance is occupied by minute dots, or by a spot which has the appearance of an empty space, and which is in consequence termed a vacuole. If you find one of the dotted bodies, you will see the dots running through the interior of the body, racing up the protrusions as they are formed and again returning when they are withdrawn, showing thus that the matter within the cell is in a state of continual motion. If you are fortunate enough to see a minute animal or vegetable come within the grasp of the finger-like protrusions when this jelly-like being is hungry you will see that it is gradually drawn towards the central portion, which slowly changes its elastic shape so as to form a hollow in which the particle of food is enclosed, and in which it is digested. The digested portion becomes absorbed, and the bit of jelly, if there be any indigestible part left, quietly opens out either at the place where the food was admitted or some other place, and exudes it. This organism has received the name of Amœba, or Proteus Animalcula, from the perpetual variations taking place in its shape, and it is probably the simplest form in which we are able to recognize those phenomena of irritability and mobility which we designate life.

In the vegetable kingdom we find bodies of a very similar kind, minute, simple, single cells, either apparently empty or containing green or red colouring matter; and which sometimes are stationary, at others whirl and gyrate round the field of view in a manner which contrasts strongly with the slow motion of the amœba, but which are evidently and certainly only minute masses of living protoplasm enclosed within an outer coating—in fact, vegetable cells, just as the amœba is an animal cell.

The chemical composition of this protoplasm is very complex. It is a combination of C., H., O., and N., and often contains also S. and P. Its precise composition has not been determined, but it is probably nearly the same as that of the white of the egg—pure albumen, the formula of which is :—

C.	H.	N.	O.	S.	P.
53·5	7	15·5	22	1·6	0·4

Of these protoplasmic cells, which I have so far described merely as separate individualities, all living animal and vegetable structures are compounded. We can discover them in all the living tissues of the vegetable kingdom—in the roots, leaves, flowers, and seeds of herbs, shrubs, and trees; and in the tissues and blood of animals,—in that of man himself. If a drop of blood be drawn from one of our fingers and placed under the microscope, we see a multitude of reddish corpuscles, flattened on the two sides, and which show a tendency to arrange themselves in lines, like strings of beads. But amongst these is a much smaller number of larger sized colourless cells (the so-called white corpuscles), which, if kept at a proper temperature, and under appropriate conditions, exhibit the same phenomena as the amœba—move slowly from place to place, change their shapes, and project and withdraw those finger-like processes which have acquired the name of pseudopodia. In living vegetable cells we do not, under the microscope, see the same elastic movements as in animal cells, because the limiting membrane is generally formed of cellulose, which does not admit of the protrusions and retractions seen in the amœba and the white blood corpuscles; but we have abundant evidence that the protoplasmic contents are in a state of perpetual mechanical motion. In the sting of the common English stinging nettle, and in various fresh-water Algæ, under sufficient magnifying power, minute granules in the fluid cell-contents may be seen circling round and round the interior of the cell, showing that the structureless protoplasm is in a condition of unceasing movement. One of the most beautiful specimens of this cyclosis with which I am acquainted, is to be found in the *Closterium lunula.* This microscopic plant, which is very common in the ditches and pools in this vicinity, belongs to the Desmidiaceæ, a family of the confervoid or green Algæ. The whole plant consists of a single cell of an elongated form, somewhat lunate shape, broader in the centre, and tapering towards each end to a rounded extremity. The interior is occupied with chlorophyl, excepting at the extremities, where are clear transparent spaces, and a very narrow channel between the cell-wall and the green endochrome. In the clear space at each end is a black spot which, under sufficient magnifying power, is resolved into a number of excessively minute cells, each with a dark circumference and clear centre. These cells are in a state of continual motion, in and out amongst each other, changing their relative position, and circling round and round. Frequently cells leave the terminal group, pass down between the cell-wall and the endochrome-wall for a certain distance; then, altering their course, return in the opposite channel, and rejoin their friends at the extremity of the frond,—the whole diorama forming a scene of wonderful activity and exquisite beauty. So that we may fairly infer that the physical difference between the animal and vegetable living cell is only one of mechanism. But these living cells have other functions to perform than mere mechanical motion, whether that motion be external or internal. They have to perform certain vital acts—they have to grow, and they have to multiply; and their growth is carried on in a manner peculiar to the organic kingdom. It is not a mere increase in size, like the growth of a crystal which, as you know, may be suspended in a solution of the substance of which itself is composed, and, as evaporation takes place, becomes enlarged simply by the deposition of the matter, which can no longer remain in solution, on its exterior. Living beings, on the contrary, grow by the admission of matter (the chemical composition of which is often quite different from themselves) to their interior, where it first undergoes a process of chemical change by which it is assimilated to their own composition, and is then incorporated into the living bodies themselves.

The multiplication of these cells occurs in at least three different ways. First, as may be seen in any fermenting solution, the yeast particles increase by gemmation or budding. A full-grown cell may be seen with a much smaller one sprouting as it were from it, and thus strings of several cells are sometimes formed. These secondary cells having attained a certain growth, detach themselves, and in their turn carry on the process. Second, by the process of cell division. A constriction appears in a cell, and gradually becomes deeper, until eventually it divides the cell into two, which become independent bodies. Third, by the division of the protoplasm of the parent cell into numerous secondary cells; the parent cell then bursting, the secondary cells become free, to go in their turn through the same process. By one or other of these methods all animal and vegetable growth takes place, and may be watched, not only in those living beings which consist of a single protoplasm cell, but also in the growing parts—the seeds, roots, and tender sprouts—of the higher plants, and in the eggs of animals.

So far you will perhaps have noticed that no distinction has been drawn between animal and vegetable life, and indeed it would appear that structurally, chemically, and physiologically, no distinction is at present demonstrable.

Not only are there numerous classes of living beings whose animality or vegetability is disputed, but there is a distinct class (the Protista) which is separated from both the animal and vegetable kingdom, and defined as "A kingdom of organic nature, which is intermediate between the animal and vegetable kingdoms, and which comprises the so-called lowest forms of life." And yet, again, other forms appear at one stage of their existence to be animals and at another vegetables. There is a fungus—the *Æthalium seplicum*—which sometimes infests the tan in hot-houses, and which at one period of its growth is undoubtedly a vegetable, but the mycelium of this mould exhibits amœboid movements, and characteristics which would place it in the dominion of the animal kingdom. Of this living being Professor Huxley asks the questions, "What is it? Is it an animal? Is it a plant? Is it both, or is it neither?" By certain biologists it is referred to the Protista as being neither, but Professor Huxley seems to consider this as only doubling a difficulty which at first was single.

It is therefore apparent that he considers that the same living being may be both an animal and a vegetable. An analogous phenomenon may be observed in the *Volvox globator*, a unicellular confervoid Alga, spherical in shape, and studded with minute cilia, by the aid of which it performs a continual rolling motion. In the interior of this plant are to be seen numerous bright green globules, which are, in fact, young *Volvoces* waiting to be liberated by the bursting of the parent cell. Occasionally, however, one of these globules will lose its green colour, become transparent, the contents escape, and at once assume the characteristic appearance and movements of the amœba.

The identity of animal and vegetable life is further confirmed by various facts in their physiological actions. Thus we know that certain plants belonging to the Droseraceæ, or sun-dew tribe, have the power not only of closing their leaves when stimulated by the contact of an insect so as to entrap their prey; but also, after having entrapped, to digest it—to assimilate the digestible portions and to exude the indigestible; and for this purpose the plant secretes a peplie fluid, not dissimilar to the gastric juice of animals. The actions of certain therapeutical agents also are so identical in their effects on animal or vegetable living matter that little doubt can remain as to the oneness of their composition and vitality. We all know that if animals are subjected to the vapour of chloroform or ether they quickly fall into a state of profound slumber, from which they cannot be awakened by any ordinary phpsical means, but which soon passes away when the anæsthetic is withdrawn. Exactly the same series of phenomena is exhibited by plants under favourable circumstances. On this point, in a lecture delivered before the British Association, in August, 1879, Professor Allman, at that time President, says:—" We owe to Claude Bernard a series of interesting and most instructive experiments on the action of ether and chloroform on plants. He exposed to the vapour of ether a healthy and vigourous sensitive plant by confining it under a bell-glass, into which he introduced a sponge filled with ether. At the end of half an hour the plant was in a state of anæsthesia; all its leaflets remained fully extended, but they showed no tendency to shrink when touched. It was then withdrawn from the influence of the ether, when it gradually recovered its irritability, and finally responded, as before, to the touch." It is not, however, the motor power of plants alone that is arrested by anæsthetics. " Claude Bernard has shown that germination is suspended by the action of ether or chloroform. Seeds of cress, a plant whose germination is very rapid, were placed in conditions favourable to a speedy germination, and while thus placed were exposed to the vapour of ether. The germination, which would otherwise have shown itself by the next day, was arrested. For five or six days the seeds were kept under the influence of the ether, and showed during this time no disposition to germinate. They were not killed, however, they only slept, for on the substitution of common air for the etherized air with which they had been surrounded, germination at once set in and proceeded with activity. * * * Experiments were also made on that function of plants by which they absorb carbonic acid and exhale oxygen. * * * Aquatic plants afford the most convenient subjects for such experiments. If one of these be placed in a jar of water holding ether or chloroform in solution, and a bell-glass be placed over the submerged plant, we shall find that the plant no longer absorbs carbonic acid, or emits oxygen. It remains, however, quite green and healthy. In order to awaken the plant it is only necessary to place it in non-etherized water, when it will begin once more to absorb carbonic acid and exhale oxygen under the influence of sunlight."

But although it appears that the protoplasm of animals and vegetables is, in its chemical composition, microscopic characters, and physiological manifestations, identical; yet that there are variations, probably due to difference of molecular arrangement, is equally manifest,—for we know that every plant and animal in the Universe produces protoplasm, which can only reproduce its own kind. We know that a man or an elephant could never be developed from the protoplasm of a plant; nor could the egg of a fowl or a fish ever produce anything but another fowl or another fish. But we may go further, and show that the difference does not end here.

Animals and plants derive their nourishment from different sources. The pabulum of the vegetable kingdom is derived from the inorganic world in the form of water, carbonic acid, and ammonia. Animals, on the other hand, are unable to assimilate these simple compounds, and can only live on protoplasm already prepared for them, either by vegetables or by other animals, which have, in their turn, absorbed previous vegetable protoplasm into their own bodies. Again animal and vegetable chemistry are, as it were, essentially antagonistic. The chemistry of vegetable life is synthetic, it takes simple compounds and, after rejecting those portions it does not require, builds of the remainder compound substances of great complexity. Animal chemical processes are analytic; they consist in seizing these highly complex matters, and reducing them to the simple compounds in which they originally existed.

From this we learn that the essential element of life consists in the eternal and incessant circulation of matter. The vegetable kingdom takes water, carbonic acid, and ammonia, separates and discharges the oxygen it does not require, for the use of the animal kingdom, forms complex compounds of the remainder—protoplasm, vegetable albumen, gluten, starches, oils, fats, sugars for food, those volatile oils to which the scent of flowers is due, resins, camphors, guttapercha, turpentines, india-rubber, alkaloids as quinine, morphine, strychnine, and many others; indeed, the number of these vegetable products is infinite. Again, animals seize upon the oxygen exhaled by plants, and convert it into carbonic acid. They feed upon the protoplasm provided for them by the vegetable kingdom, and after utilizing it for the higher functions of animal life—locomotion, consciousness, sensation, thought, reason—they return it to the inorganic kingdom as water, carbonic acid, and ammonia, to be again taken up by vegetables, and recommence the never ending cycle of physical and chemical change. Letourneau remarks, "In living beings, in effect, matter is in a state of extreme mobility; it is subject to a perpetual movement of combination and decombination, without repose, without truce; its elements go and come, have reciprocities of action, aggregate themselves, disaggregate themselves; there is a whirl of atoms amongst unstable compounds, capable of forming, disaggregating, metamorphosing themselves, of renewing the woof of the living tissues." And Professor Huxley tells us that, "the wonderful noon-day silence of the tropical forests is, after all, only due to the dullness of our hearing; and could our ears catch the murmur of the molecules as they whirl in the innumerable myriads of living cells which constitute each tree, we should be deafened as with the roar of a mighty city."

If you have followed me hitherto you will see that all the physical and chemical phenomena of life which I have endeavoured to describe are purely modes of molecular motion—first, the locomotion and cyclosis of animal and vegetable cells, and, second, the chemical motion of combination and dissociation of elements. For chemical combination is merely a molecular motion of the combining elements. When hydrogen and oxygen are mixed in a vessel, they may remain in contact for an indefinite time—but if an electric spark or a lighted taper is applied, they immediately rush together and form water. But the force which produces this sudden activity is merely matter in motion, which imparts its own vibrations to the hydrogen and oxygen, and thus produces their union. The application of electricity in the form of a galvanic current, by producing a different form of motion, separates the elements again, shakes them asunder as it were, into hydrogen and oxygen, which may be collected in separate vessels. Thus the latent life of a seed or an egg is analogous to the chemical affinity of hydrogen and oxygen—the tendency to active vitality is there, but requires an appropriate stimulus to call it into action. This stimulus is heat in due proportion, which is, like the burning taper or the electric spark, only matter in motion, and in such form of motion that it is capable of communicating it to the hitherto inert protoplasm.

A most interesting series of experiments has been made by Dr. Siemens, the result of which he communicated to the Royal Society in March last. You all know that plants only form that green colouring matter termed chlorophyl under the influence of sun-light, and that chlorophyl performs its special function, that of decomposing carbonic acid, in the day-time. Plants kept in darkness are blanched, and during the night the evolution of oxygen by them ceases. Dr. Siemens has, however, shown that the electric lamp can take the place of the sun, and that under its light plants will develope chlorophyl, dissociate the elements of carbonic acid, and evolve oxygen, the same as when exposed to direct solar influence. Here, then, we have the cycle of the vital physical forces complete. Heat is converted into light and electricity—light is converted into heat and electricity—electricity is converted into heat and light. For not only does the chlorophyllian action continue under the influence of the electric lamp, but seeds will germinate, and plants grow, and produce those starches and sugars which are in reality the great deposits from which animals derive their heat.

Again, many animals possess the power of emitting light, and this faculty appears to exist in some cases in connection with muscular action, in others with nervous influence; in others again a special apparatus of photogenic cells exists, and these cells seem invariably to be in intimate relation with the nervous system. Whilst in one class, which is not endowed with a nervous system, the luminosity appears to be the result of some unknown property of the protoplasm of the phosphorescent being.

In this round of organic life there is no loss or destruction of material. Plants take their C. H. O. N. from the inorganic world, and having utilized the elements restore them again to the source whence they were originally obtained, either through the processes of decay, or through the processes of animal life. So in like manner it is demonstrable that in the round of life there is no loss of energy. The heat, the light, the electric force, which plants, as it were, absorb to carry on their life, are not lost—they are, like the material elements, transmuted into other forms—into mechanical motion and chemical motion ; but the very compounds in the manufacture of which the chemical action is expended—sugar, starch, fats, and oils—are the main sources of the heat of animals, the very compounds by the absorption and reduction of which animals are enabled to maintain a temperature above that of the circumambient atmosphere. So, also, animals which possess a nervous system evolve electricity. Our brain is a galvanic battery ; our nerves are telegraph wires, conveying messages to and fro between the external world and our consciousness, which, as it were, sits behind the operating machine—the brain—receiving and sending messages, manipulating the machinery, just as a telegraphist does with the ordinary telegraphic apparatus.

In this outline sketch, which I have endeavoured to lay before you, of life and its physical correlatives, you will perceive that we have had to deal with nothing but ordinary chemical elements, and ordinary physical forces. As I said before, life is not an energy, it is not a force, it is not an entity. When we analyse its processes we see nothing more than a series of actions and re-actions produced by heat, light, and electricity, within a mutable, unstable combination of carbon, hydrogen, oxygen, and nitrogen.

Art. IX.—*Watershed Districts. County or other Division of the Country to be determined by the Area of the Watershed.* By. J. Rees George.

[*Read before the Wellington Philosophical Society, 10th October*, 1880.]

The subdivision of the country for representation and local government purposes is a question that with politicians is generally decided in some haphazard manner, and chiefly by taking the nearest river-bed as a boundary, but is one that should receive more scientific treatment, and is therefore fairly open for discussion at the meetings of the Wellington Philosophical Society; and I propose, as shortly as possible, to show that the area of the watershed of any district is the boundary that should determine such divisions both for local government and representation purposes.

Navigation, drainage and water supply, the prevention of pollution, and the improvement of the rivers of the colony, greatly interest all residents and property-owners, and the system which now obtains of making the centre of a river-bed the political division of counties, road districts, and municipalities, is one eminently calculated to render impossible any systematic method of carrying out works connected with these subjects.

The rivers of the Colony are, as a rule, but little else than mountain torrents, in some cases navigable, with difficulty, a few miles from their outlets; and therefore greater reasons exist that the control of such navigation should be placed under a central administration; the whole country, in fact, should be mapped out into watershed districts, each containing one or more river basins;—this would appear, at first sight, to involve a large amount of work, but the information requisite for the purpose already exists, and in mapping out the country for local government and representation purposes, the ridges would form the natural boundaries in place of the river-beds which, as a rule, are adopted.

Drainage and prevention of floods could frequently be dealt with, and great improvements effected at a small cost, were it not that local jealousies (from each river bank being under a separate system of government) prevent anything being done.

A general system of water-supply could be decided upon,—and erected at such times as might be required to supply the population,—without incurring the excessive outlay now required to supply each small village and district with a separate water-supply system of its own.

The central authority of the district could undertake the removal of obstructions to the navigation of rivers, protecting the banks, and such-like works, without the necessity of the creation of Harbour Boards, whose chief object is to spend borrowed money in the district, whether required or not; and, as a rule, interfere with, and quarrel with, the neighbouring authorities, and do more harm than good. With the exception, perhaps, of the Lyttelton Board, the works carried out under their supervision have generally had the most mischievous effect in place of effecting improvement—the Timaru works being an example.

The present County Councils could, by a slight amendment of the law, become the governing authorities of the watershed district, so far as all works affecting the surface of the ground are concerned. Road Boards, Municipalities, and Harbour Boards should only be allowed to carry out such works as might be approved by the central authority; and in sparsely populated districts these last-named governing bodies could be dispensed with altogether.

The election to such a body would be sought after by men of the highest class, and there would be every inducement offered to the officers to lay out works on a comprehensive system, leading in the end to great economy in administration, and dispensing with the services of a large body of officials now necessarily employed by every petty authority.

It is impossible, within the limits of a paper of this character, to discuss the various interests that would be affected by the proposals, and the details as to monetary matters, rating, and expenditure. The object of the paper will be attained if the attention of those in authority is directed to the advantages that would arise to the community by adopting the boundaries of watersheds as political boundaries.

The river Thames, in England, is perhaps the strongest case that exists to show the advantages that would arise by a central authority controlling a watershed. At every few miles along the river-bank a different local government prevails, each with a separate system of management, of drainage, and of methods of polluting the river. The Metropolitan Board of Works, the River Conservators, the Thames Valley Main Drainage Board, the Lower Thames Valley Drainage Board, the Board of Works, and various other authorities, make feeble and abortive attempts to control these local governments. Isolated improvements are carried out, but there is no general system, and the result is that more money is wasted by abortive works and law proceedings than would suffice under systematic management to perform all necessary works.

The river Manawatu, in the colony of New Zealand, is one where the advantage of one authority controlling the whole watershed is apparent. The river drains a large extent of country beyond the near dividing range of mountains, and frequently heavy rains on the eastern or Wairarapa side of the hills cause disastrous floods throughout the Manawatu district. There is no doubt that a comprehensive system of works on the eastern side, with the gradually deepening and straightening of the course of the river on the western side, would materially prevent damage from floods. In the course of time the eastern side may become thickly populated; offensive drainage may arise from manufacturing or mining pursuits, to the damage of those on the western side; which no authority, except the General Government of the colony, can prevent.

The alteration, above proposed, in the present method of defining political districts, is one that can at the present time be carried out without much inconvenience, but every year creates vested interests, and renders an improvement in the system more difficult and costly.

Art. X.—*The Cause of Gravitation.* By T. Wakelin, B.A.N.Z.Univ.

[*Read before the Southland Institnte*, 1st *September*, 1880.]

The title to this paper is merely descriptive. Some philosophers object to the word cause. The reader can supply any other word, as antecedent, which he may think more correct.*

It is generally advisable to survey the ground from which we start in making any enquiry. Some of the most eminent astronomers and physicists, the reader will perhaps rightly consider, should be referred to for this information.

"The illustration of supposing the sun connected with the earth by a steel bar, will serve to give us some notion of the wonderful connection which that mystery of mysteries, gravitation, establishes between them. The sun *draws* or pulls the earth towards it. We know of no means of communicating a pull to a distant object more immediate, more intimate, than grappling it with bonds of steel. The velocity of sound, or of any other impulse, conveyed along a steel bar, is about sixteen times greater than in the air. Now suppose the sun and the earth connected by a steel bar. A blow struck at one end of the bar, or a pull applied to it, would not be delivered—would not begin to be felt—at the sun till after a lapse of three hundred and thirteen days. Even light, the speed of which is such that it would travel round the globe in less time than any bird takes to make a single stroke of his wing, requires eight and one-third minutes to reach us from the sun. But the *pull* on the earth which the sun makes is *instantaneous*, or at all events incomparably more rapid in its transmission across the interval than any solid connection would produce, and even *demonstrably far more rapid* than the propagation of light itself."†

"The opinion of most leading astronomers is that the velocity of the gravitational pull, so to speak, is infinite—that is, it is instantaneous. If it were not so, the members of the solar system would get beyond control, and the whole system would run into disorder."‡

The law of gravitation is that every mass of matter attracts every other mass with a force directly proportional to the mass, but inversely as the square of the distance. The mass of a body can be determined by its inertia. This would be the more rigorously exact and mathematical method of determining the mass of a body. The determination of mass at

* Even thus qualified this title is perhaps not strictly appropriate.

† Sir John Herschel:—"Lecture on the Sun."

‡ R. A. Proctor.—A note in one of his works. (The words are imperfectly given from memory).

the surface of the earth is made, however, by simply weighing small bodies. For comparatively small masses "it has been established by experiment, that the two modes of comparing masses perfectly coincide."* The mass of matter in a planet can of course only be inferred from the degree of gravitational force exerted by that planet.

The *pull* which the earth exerts upon, say a ton mass of iron at the surface of the earth, is what we mean by the *weight* of that mass. The force of gravity at the surface of the sun—that is the gravitational *pull*—is nearly twenty-eight times that at the surface of the earth.† The same mass of iron at the surface of the sun would therefore weigh nearly twenty-eight tons. If this ton mass of iron were placed at the distance of Mercury from the sun the pull of the gravitational power of the sun would give this mass a weight of only $9\frac{1}{2}$ pounds. At the distance of the earth from the sun, the pull exerted by the sun would give to this ton mass only a weight of $1\frac{1}{3}$ pounds. Under a vertical sun at mid-day, a ton mass at the surface of the earth, owing to the pull exerted by the sun, would weigh in a spring balance $2\frac{2}{3}$ pounds less than it did at midnight at the same place. It is this very small difference in the force of gravity on opposite sides of the earth (where mid-day and midnight), that causes the earth to gravitate to, and on account of its motion to revolve around, the sun.

The bearing on this enquiry of the next two or three extracts is not perhaps very direct, but the extracts will aid us considerably in forming an opinion of what the "gravific" force may be.

"From this phenomenon (Faraday's lines of magnetic force) Thompson afterwards proved by strict dynamical reasoning that the transmission of magnetic force is associated with a *rotatory* motion of the small part of the medium. He showed at the same time how the *centrifugal force due to this motion would account for magnetic attraction.* The explanation of electrostatic stress is less satisfactory, but there can be no doubt that a path is now open by which we may trace to the action of a medium all forces like electric and magnetic forces." "Such a state of stress as is necessary to produce gravitation we have not however been able hitherto to imagine." ‡

The æther fills space, and is necessary in the undulatory theory of light—long accepted—to account for the transmission of light. "It interpenetrates all the transparent bodies, and probably all opaque bodies too. We must consider the æther in dense bodies as somewhat loosely connected with the dense bodies, and we have next to enquire whether when these dense bodies

* Deschanel's Natural Philosophy, "Mass," p. 55.

† Newcombe, 27·71 times.

‡ J. C. Maxwell's article, "Attraction," in Encyclopædia Britannica, ninth edition (now being published).

are in motion through the great ocean of æther, they carry along with them the æther they contain, or whether the æther passes through the solid as the water of the sea passes through the meshes of a net when it is towed along by a boat.

"The experiment (to determine this question) was tried at different times of the year, but only negative results were obtained. We cannot, however, conclude absolutely from this experiment that the æther near the surface of the earth is carried along with the earth in its orbit. If the æther is molecular, the grouping of the molecules must remain of the same type, the configuration of the groups being only slightly altered during the motion."* The density of the æther is extremely small compared with that of air, even in the vacuum of a Sprengel air-pump.

One who has made a special study of the subject of this paper in effect remarks† :—The forces we have to deal with are vast, and, to our ordinary perceptions, occult. We need not, however, on this account doubt their existence any more than we need doubt the existence of light in space surrounding a luminous body, but which light we cannot see. Force is measured by momentum. *When the mass is extremely small and the force great the velocity must be proportionately great.* In accounting for gravitation we must look for an extreme velocity with extreme tenuity of matter.

The pull exerted by the sun upon any of the planets is transmitted with an "infinite velocity"—that is, the pull is made "instantaneously" both at the sun and planet. If we try to gather in the logical meaning of this we shall see that the force that causes the planet to gravitate to the sun exists both at the sun and at the planet's place in space. If there is a medium, then why should not the force be in the medium and not in the sun? That the force that causes gravitation should exist in space has been the hope and the aim of perhaps most philosophers since the time of Newton. This notion seems somewhat in conflict with what is strikingly manifest—that all planetary bodies are held in their orbits by a central body; but, if we conceive the idea that the action of the central body is *directive* and not *productive*, then the apparent antagonism is cleared away. In this case the central body may so influence the æther of space as to cause it to surround the body as the atmosphere surrounds the earth, the density, say, and in any case the force, decreasing with the distance from the centre of the body.

If gravitation is owing to any action of the æther, it would seem to be most likely that of a current. If we hold a plank end-ways against a current of water, the force necessary to hold it may not be much. If we hold

* J. C. Maxwell's article, "Æther." Encyc. Brit., 9th ed.

† S. Folver, Preston, July or October number, Journal of Science, 1878.

the plank transversely against the current, especially with its face fair against the stream, the force required would be very much greater. The water acts only on the outsides of the plank. If we hold the plank above the ground in any other way the "gravific" current of æther will carry it to the earth with exactly the same force or weight in whatever position it may be held. This supposed current does not act then only on the outsides of the plank; it must act on every particle of it. The æthereal current must flow through the plank as a current of air would flow through a sail made of netting. Every central body would in this case be a reservoir, into which the æther rushes with very great rapidity.

Let us apply this notion of a current to the case of a planet and its satellite. The attraction is mutual between them; there must therefore be a current flowing, in space, from the planet to its satellite, and another æthereal current at the same time flowing from the satellite to its planet. The currents would therefore oppose each other, and one would be destroyed. The attractive power would be reduced, and the larger body would not move at all towards the smaller; we cannot therefore consider gravitation to be caused by currents.

The notion, however, of a current of extremely attenuated gas flowing through a solid, helps us very considerably in our conception of what is required. If the æther could be stationary, and act like a current, this kind-of-current theory would account for gravitation. Clothes are run through two elastic-rollers of a mangle. If the rollers are made to revolve, and the clothes are brought within their grip, the clothes acquire the velocity of the rollers. If, between the same two rollers, we place a long bar of smooth steel, and the rollers be adjusted so as to press lightly on the bar, they will make many revolutions before the bar acquires a perceptible motion. It seems as if a medium that would act on every particle of matter, as these rollers act on the bar of steel, would produce the gravitational motion of bodies. We might at once suppose that revolving spheres of matter, as of the common india-rubber balls, would be sufficient. If the spheres revolve and come in contact with matter under a very small pressure, the matter they are in contact with would begin to acquire the motion of this revolving shell. As one side moves one way, and the other side the opposite way, the body would not move from its place, whatever other motion it might acquire. These revolving spherical shells are then insufficient.

Let us take a piece of gutta-percha, or india-rubber tubing, of a suitable length, say eight to twenty times the diameter of the tube. Let this tube revolve exactly as the rollers of a mangle revolve, and let the velocity of rotation be increased to any necessary degree. As the rate of rotation increases the tube expands. At the most suitable time, while the rate of rotation is increasing, let the revolving tube be bent round till the ends touch; join the two ends fast. We have now a rapidly revolving tubular ring,* the length suitably chosen and the velocity of rotation having also been suitably determined, the insides of the tube may be considered to touch, or rather nearly to touch. The outsides of this tubular ring are going one way, while the insides of the tubular ring, almost touching, are moving in the opposite direction. If two masses of matter touch this *tubular ring* on opposite sides they will both be impelled in the *same direction.* If two masses of matter touch a *revolving sphere* on opposite sides they will be impelled in *opposite directions.*

The æther may be conceived to be made up of these tubular rings, which may be called "æthereal corpuscles."† *The axis of revolution is a circular axis.* One of the fundamental laws of mechanics is that no revolving body, or system of bodies, can, by the mutual interaction of its parts, either accelerate or diminish its rate of rotation. The æthereal corpuscle would therefore continue to revolve with an undiminished velocity so long as it came in contact with nothing. These corpuscles must be conceived as so small that they will freely enter the pores of any solid.

Mass for mass they may be considered as much stronger than steel, that is as we know the strength of steel by subjecting it to a strain. In particular it would be found advisable though not necessary to ascribe an almost perfect elasticity to the matter of the shell of this tubal ring. If this is not done, the corpuscles must be considered as of every size. It would be best to proceed with the enquiry on the supposition that these corpuscles are all of the same mass. If we alter the direction of our enquiry this would not be necessary, though less satisfactory.

These corpuscles constituting the æther, of course do touch each other, but, their direction of rotation being the same, there would be no conflict unless any of the corpuscles move slower than the contiguous ones. In case of conflict, all contiguous corpuscles would adjust their directions of rotation to the larger and therefore predominant mass close to them. We must follow out this notion of adjustment:—If a mass of matter were suddenly placed in the æther—say, far from any other mass of matter,—and kept immoveable in its place, the corpuscles would proceed to adjust themselves to it. For convenience of conception, a mass of matter may be con-

* In Chambers' Encyclopædia, article "Vortex," and in Tait's "Advances in Physical Science," (last lecture), will be found wood-cuts of smoke-rings. They will illustrate the action, and to some extent the form, of this tubular ring.

† See note to Sir John Herschel's lecture on "Weather," where he speaks of "æthereal molecules."

sidered as spherical and nearly smooth, and as impermeable to the corpuscles. Some, one way, would be more stable than another. Whatever this way might be, all the corpuscles around the body would revolve in the same direction. It becomes, then, a question whether the corpuscles will so adjust themselves to the body that the direction of rotation of their outsides shall be towards the body or from it. There is a slight pressure supposed to be exerted by the corpuscles on one another. For convenience, one æthereal corpuscle vastly enlarged may be considered as acting on a smooth table—*firstly*, with the *insides revolving downward*, and, of course, the outsides revolving upward. Let it be tilted considerably on one side. It will at once turn right over, owing to the reaction from striking the table downwards. While thus revolving with its *outside downwards* let the corpuscle be again tilted considerably. The motion of the outside being down the reaction will be such as to cause the corpuscle to resist being tilted over. *That position, then, of the corpuscle when it revolves with its outsides downwards is the position of greater stability.* All masses acted on by these corpuscles will thus be impelled towards the central body.

The sun being vastly the predominant body in the solar system, the æther will, to a proportionate extent, adjust itself to it. The motion of rotation of the æthereal corpuscles will be directed to the sun, unless more strongly affected by other bodies. *The sun thus has a directive action on the medium, causing all bodies to gravitate towards itself.* We have now to enquire in what way minor bodies, as the planets, affect the æther. They do, of course, affect it in the same way as the sun (considered only as a solid body) affects it. To what distance from the surface of any planet does the planet affect the æther more powerfully than the sun does? When we know this we shall know when bodies will gravitate towards the planet instead of towards the sun.

The corpuscles in contact with any mass of matter will have their velocity of rotation constantly diminished by such contact. The tension and elasticity of the corpuscles being great, and the velocity being diminished, the corpuscle will contract. The corpuscles outside the first series being in contact with slower-revolving inner corpuscles will have their velocity of rotation diminished, and will likewise contract in size. And so on with the æther immediately surrounding the planet or any other body. At the surface of any body, as the sun, a planet, or satellite, the size of the corpuscles will be enormously reduced—that is, the æther (every corpuscle being of equal mass) will increase in density as we near the surface of those bodies. And the size of the æthereal corpuscles will increase the farther we go from such bodies.

Let us take any body, as a planet, and from its central point draw two lines indefinitely into space, with an angle so extremely small that at the surface of the planet they just touch the opposite sides of a single corpuscle. If we now bring to mind that the corpuscles not far distant from the surface of the planet *have all been reduced to their different sizes by actual contact*, we shall see that a column of corpuscles singly, one above another, will just touch both these narrow angular lines. Whatever the distance of the surface from the centre of a planet, at twice that distance from the centre the diameter of the corpuscle will be exactly double of the diameter of the corpuscle at the surface of the planet. The diameter of the corpuscle at three times the distance, will be three times the diameter of the corpuscle at the surface, and so on. At some distance therefore from the planet the density of the æther surrounding the planet will be equal in density to the æther surrounding the sun. At this point bodies will gravitate indifferently either to the planet or the sun. Owing, however, to the motion of the planet through the æther, there may be a deep zone or stratum of neutral action. Inside this neutral space, however, the æther surrounding the planet would travel with the planet through space.

The form of this æthereal corpuscle is a matter of great importance. Revolving with an enormous velocity the tension of the shells of the tube must be extremely great. The centrifugal force being so very great, will therefore determine the form of the corpuscle, the matter of it being considered extremely elastic. It will expand more internally, both above and below the plane of the circular axis, than it will externally. The inside of the corpuscle will consequently be but slightly curved, while the outside will be very considerably curved, almost spherically so. What velocity of rotation will determine the different sizes of the corpuscles cannot be settled. The greater tension of the more swiftly revolving corpuscles, those farther from the central body, increasing with the distance, would perhaps be taken as an indication that the more swiftly revolving corpuscles are smoother. They would therefore have a less frictional effect on any mass of matter. At higher velocities, too, the friction of one on another becomes considerably less than at lower velocities. It is not yet known what this ratio of decrease is.* As these two points are of very great importance, and as the velocity of rotation is also unknown on solely dynamical grounds, no calculations, at present, can be made on the effect of the æther on the same mass of matter removed to different distances from a central body. We should want to know, besides, the form, though not the size, of the pores or spaces in the supposed mass.

Though we cannot make calculations in detail, we can determine the total amount of the effect produced by the corpuscles on a mass of matter

* Encyclopædia Britannica, ninth edition, article "Friction" (Galton's experiments).

at various distances from a centre, if we make one or two reasonable assumptions. The law of gravitation would declare that the force of gravity on the same mass of matter, at increasing distances from a central body, would vary inversely as the square of the distance, and the assumptions are that the pores or spaces of the mass of matter shall be as large as the largest corpuscle in the region of the æther in which the mass is placed, and that the pores or spaces shall be of the same volume as the corpuscle, or a volume which is an exact multiple of that volume. The æther will thus pass through the mass of matter. As the mass of matter comes from, say, a great distance to the surface of the central body, the number of corpuscles passing through it will be inversely as the cube of the distance. The corpuscles, however, being only able to touch the surfaces of the pores or spaces of the body, the *number of points of contact can only increase inversely as the square of the distance.* As this is the law of gravity, it would show that the frictional effect of each single corpuscle, at any distance, is always the same, no matter what its size and velocity of rotation may be.

As every planet is surrounded by its own æther, the æther surrounding the sun cannot act directly on the mass of the planet. Let us take the case of the moon producing a tidal wave. We may consider the action of the moon to diminish the force of gravity of the earth at that place which is under the moon. The waters of the ocean in this zone, relieved to some extent of the force of gravity, will rise into a wave, as the water in a pump rises when relieved from the pressure of the atmosphere. If we *increase the pressure between the corpuscles of the æther, we increase the frictional effect;* and if we reduce the pressure, the force of gravity will be diminished. The action of the moon may be taken therefore as reducing the pressure among the corpuscles in the æther between the moon and the earth. In the same way the centrifugal action of the *planet* is such that it diminishes the pressure among the corpuscles in the æther *between it and the sun,* and the planet must, for the same reason, increase the pressure in the æther on the side opposite to the sun. On account of this difference of pressure the planet will be constantly deflected from the straight course it would otherwise take. Owing to the rapid motion of the planet through space, the force of gravity would probably be greatest on the outer forward quarter of its surface—that is, the force of gravity would be greatest between midnight and sunrise. We might think, and perhaps it may be the case, that the additional pressure upon this quarter of the planet causes it to revolve.

Note.—One of the reasons why it would be most important to consider the corpuscle extremely elastic, or, at any rate, capable of extreme tension, is that the force of explosives, as of gunpowder, may be due to this tension. Imagine a particle of matter to be of the form of a cone, and let a corpuscle become impaled on it, it will rush down the cone and grip it with enormous force. These cones may be taken as of all degrees of fineness or thickness. When very short and thick, the corpuscle gripping it might easily, as by a sudden blow, be thrown off. Owing to its extreme tension it would revolve with extreme rapidity in the direction opposite to what it had when it rushed down the cone. It would therefore expand with great and sudden force, which is the action of an explosive.

Art. XI.—*On the neglected Forest Products of New Zealand.* By T. Kirk, F.L.S.

[Read before the Auckland Institute, 25th October, 1880.]

Tar.	*Burgundy Pitch.*
Creosote.	*Kauri Resin.*
Oil of Tar.	*Turpentine.*
Pitch.	*Oil of Turpentine.*
Lampblack.	*Potash.*
Resin.	*Charcoal.*

Woodware.

The value of the tar, pitch, resin, turpentine and varnish, etc. imported into New Zealand during the year 1875, was declared to be £13,587, and it has increased at the rate of £850 per annum, the value of the imports for 1879 being close upon £17,000. It is not too much to say that nearly the whole of this large sum might be retained in the colony and expended in producing the articles from native products, which are either entirely neglected or are exported in the raw condition to be manufactured in other countries and returned, after incurring heavy charges for commission, outward and inward freight, and (so far as varnish is concerned) an *ad valorem* duty of 15 per cent. The object of the following paper is to draw attention to the profitable outlet for labour presented by our abundant supply of raw material suitable for this class of manufactures.

Tar and pitch can be produced from material which at present is not only wasted but is a constant source of danger—the tops, branches, and other small timber which is usually left on the ground after falling and which often leads to the destruction of the forest by fire.

To what extent a substitute for turpentine may be furnished by our native pines can only be determined by actual experiment; there can, however, be no doubt but that the *kauri*, *rimu*, and *kahihatea* may be made to yield considerable quantities.

With our large supply of *kauri* gum, a substance of such value as to take the place of the costly gum mastic, there can be no valid excuse for continuing to import large quantities of manufactured varnish. We may advantageously use a portion of our *kauri* resin for manufacturing purposes within the colony, instead of sending it abroad to be manufactured for us.

Fifteen years ago varnishes manufactured from both *kauri* and *rimu* resin were exhibited at the New Zealand Exhibition, held in Otago, but the subject has been allowed to drop without receiving the attention it merits, and it is a matter for congratulation that efforts are now being made to establish this industry in Auckland.

Tar.

Tar may be extracted from many of our native trees, especially from the pines, the *kauri, totara, kahikatea, rimu, miro, matai, tanekaha*, etc., also from the tooth-leaved and other beeches, which form such vast forests in many districts, and in all probability from the large kinds of *rata* and tea-tree.

The waste tops and branches of trees felled for timber, crooked pieces, knots, roots, etc., can be utilized for this purpose, so that the manufacture of tar and allied products would not only afford a profitable outlet for labour, but would remove a great source of danger, and materially reduce the serious loss arising from forest fires.

In the forests of the White Sea and the Baltic, tar is extracted from the Scotch fir *(Pinus sylvestris)*, and the Baltic spruce fir *(Abies communis)*; the wood and roots being cut into short billets, and then subjected to a process of slow combustion.

A funnel-shaped cavity of any convenient size is excavated in the side of a sloping bank; an iron pan is fitted tightly into the bottom of the hole, and communicates with the exterior by a pipe or tube, which passes through the side of the bank, and allows the tar to be drawn off as fast as it is extracted.

The billets are now tightly packed in the cavity, ends downward, until it is completely filled, when the surface is covered with turf, which is compactly beaten down by two men, one of whom uses a wooden stamper, the other a wooden mallet—so that the outer surface is sufficiently firm to prevent the escape of the volatile products. It is absolutely necessary that this part of the process should be efficiently performed.

A small portion of the turf is now removed, and fire applied to the stack; as soon as it is kindled, the turf is replaced. The exuded tar is received into the pan at the bottom of the hole, and is discharged by the spout into casks, which are at once bunged and made ready for shipment.

The quantity of billets subjected to slow combustion at the same time is frequently enormous, amounting to 50,000 or 60,000 cubic feet. In this case the pile rises considerably above the surface of the cavity, but the whole must be carefully covered with sods, etc., as already described. A pile containing 50,000 cubic feet requires a fortnight for the process of combustion. It need scarcely be remarked that the wood must be dry before the operation is commenced.

In the Highlands of Scotland tar is sometimes extracted by a somewhat rougher method. A hole is dug in the side of a hill, a gutter being formed at the bottom of the hole, and terminating in a small aperture on the outside. The hole is filled with wood cut in proper lengths, and the top is covered with tiles or sods. The tar gradually drains into the gutter, and is discharged by the external aperture, which must, of course be very small, or air will be admitted in such quantity as to burn the entire mass.

Creosote.

Although this paper is concerned chiefly with products requiring at most a very simple process to prepare them for market, I venture to include creosote, as there can be no doubt that it will be greatly in demand as a preservative for timber used on our railways and other large works. The high rates paid for labour render the durability of timber of far greater importance in New Zealand than in Great Britain, where railway-sleepers are almost invariably saturated in creosote, on account of its antiseptic properties.

Creosote is distilled from wood-tar, chiefly from the tar of beechwood, which yields a larger proportion than other kinds. The chief supplies are obtained from the White Sea, the Baltic, and North America. It might be obtained in unlimited quantity from the beech forests of the sub-alpine parts of the colony.

The so-called creosote of coal-tar is simply "more or less impure carbolic acid," which does not occur in wood.

Amongst the products obtained from the destructive distillation of wood are acetic acid, wood-spirit, paraffin, anthracene, etc.

Pitch.

This is obtained by boiling wood-tar until nearly one-half of its bulk is evaporated, when the remainder is allowed to cool and harden into pitch. The process is usually effected in copper boilers set in brickwork, to diminish the risk of accident.

Lampblack.

This is merely the fine soot given off during the manufacture of tar or charcoal. It is deposited on the sods which cover the billets, and must be scraped off. If, instead of the rough processes described above, closed ovens were used, the lampblack would be deposited on the roof.

A superior kind is manufactured in a more systematic manner from the straw and other waste material used in the preparation of the resin of the *pinaster*. A small furnace, about four feet in length and two and a half feet in width, is set in brickwork; on each side of the furnace near the bottom is an opening furnished with a close-fitting door. The chimney, which is nearly horizontal, conducts the smoke into the centre of a small wooden chamber about twelve feet square and ten feet in height, with a hole in the roof about six feet square. The chamber is entered by a door working in a groove, and fitted so as not to allow of the escape of smoke at its joints. The walls and roof are lined with boards on the inside. The opening in the roof is covered by a double thickness of coarse flannel sewn into a conical or pyramidal shape, and supported on a light wooden framework.

The straw and waste material used in the manufacture of the tar and resin is placed in the furnace in small quantities, merely sufficient to keep the fire alight, the supply being constantly maintained. The smoke passes into the boarded chamber, and the soot is deposited on the boards and on the flannel cone, while the lighter portion of the smoke filters through the latter, which also allows the heated air to escape. The lampblack is detached by striking the boards and flannel with a stick, when it falls to the ground and is collected into small casks for shipments.

In some parts of Germany the furnace and chamber are constructed in a large shed; but in Bordeaux the whole is exposed, the chamber being covered with a tiled roof. It is obvious that a chamber of this kind might readily be constructed of corrugated iron.

Resin.

Resin, or rosin of commerce, is obtained from various pines in Europe and America. The *kauri*-resin, popularly called *kauri*-gum, is one of the most valuable known, and it may be partly due to the fact of its value and its abundance in the northern districts of the colony, that no attention has been paid to that produced by the *rimu*, the *kahikatea*, and other trees. The greater part of the *kauri*-gum sent into the market is found in a fossil condition, a very small portion being the produce of living trees, although occasionally it occurs in recent masses or "tears" of several pounds weight, at the junction of a large branch with the stem.

Although a "shake," or fissure of any kind in the trunk of the red pine *(rimu)*, or white pine *(kahikatea)*, is always found to be compactly filled with resin, no attempt has been made to collect it for commercial purposes. It may, therefore be worth while to describe the mode of extraction practised in Southern Europe.

In the Landes of Bordeaux the *pinaster* has been largely planted to fix the blown sand; the plantations thus formed not only yield a supply of useful timber and firewood, but afford support to a large portion of the population engaged in the collection of resin. In May, a piece of the outer bark about five inches wide and twenty inches long is stripped from the trunk just above its base; a cavity sufficiently large to hold a half pint of sap is cut in the trunk at the bottom of the place thus laid bare, or a trough may be attached on the outside. Above the trough or cavity the inner bark is removed to the width of four inches and the height of six. The resin escapes from between the inner bark and the wood, and is conducted to the trough, which is emptied at regular intervals. The surface of the wound is lightly chipped over once a week until the close of September, so as to expose a fresh surface; by this means its dimensions are gradually increased, but it is not allowed to exceed six inches in width and eighteen in length.

The following spring a new piece of bark is stripped off immediately above the old wound, and the process is repeated yearly until the incision is carried to the height of fifteen feet or thereabouts, according to the strength of the tree, when a new incision is made at the base parallel with the old one but leaving about two inches of bark between the two, and continued to the same height. This is repeated until the entire circumference of the trunk has been wounded, when the old incisions are found to have become sufficiently healed to bear a repetition of the process. When it is intended to remove the trees for firewood, or for the manufacture of tar, incisions are made all round the trunk at the same time and regardless of length.

The resin which hardens on the surface of the wounds is very white, and is scraped off to be used in the manufacture of wax candles; it is termed barras. The liquid resin is termed galipot: when collected it is placed in wooden vats sunk in the earth. In this state it contains fragments of bark, earth, and other impurities. In order to purify it, it is placed in large copper boilers, with brick flues or chimneys to carry away the smoke; it is kept boiling, and is constantly stirred. In order to ascertain when it has been sufficiently boiled, a small portion is poured on a piece of smooth wood; if, when cool, it crumbles freely on pressure between the fingers, it is considered ready for filtering, which is effected by pouring it over a layer of straight straw or rushes about six inches in thickness, when it is allowed to run into casks, and becomes the brown resin of commerce.

Yellow resin is manufactured by frequently adding cold water, a few drops at a time; this causes the resin to expand, when it is allowed to pass through a tube—previously fixed in the side of the boiler—into another vessel. From this it is ladled back into the boiler, the operation being continued until the resin becomes perfectly clear, when it is filtered into sand-moulds, forming cakes of from 100 to 200 pounds in weight.

The straw and waste material are utilized in the manufacture of lamp-black, as already stated.

As it is not thought advisable to make any wound of greater length than eighteen to twenty inches during one season, from eight to ten years will usually be required to operate upon the trunk to the height of twelve or fifteen feet. A short pole, with sloping notches to receive the feet, is used by the operator when the incisions are more than six or seven feet from the ground. An expert operator does not require more than two or three minutes to ascend the tree, form a new surface to the wound, and descend. He is expected to attend to between 200 and 300 trees per diem, and to take the entire management of from 1500 to 2000 trees each season. It need scarcely be remarked that eight hours does not constitute a working-day in the district under notice.

Burgundy Pitch.

This was formerly manufactured in Finland, Austria, Switzerland, and the Grand Duchy of Baden, by boiling the crude resin of the Baltic spruce, straining and evaporating until the proper consistency was attained. The manufacture of the pure article has greatly diminished of late years so that now it is not easily obtained.

The substance usually sold as Burgundy pitch is a compound made by melting Bordeaux or American resin, and mixing it with palm oil, a little water being added during the process of mixing to render it opaque. It is obvious that the local demand for an article of this kind could be readily supplied from local resources, as the manufacture can be carried on in the colony at a very small cost.

Kauri Resin.

I am particularly desirous of drawing attention to the enormous waste of this substance, which is continually going on. Whenever a *kauri* tree is cut down, the bark and chips become more or less covered with exuded resin in a few days time. Even the leaves, while still green, exhibit numerous rounded particles, or minute "tears" of the so-called "*kauri* gum." Taking into account the vast amount of *kauri* timber converted annually, the value of the resin thus allowed to waste must be enormous.

I venture to suggest that it would prove highly remunerative to extract it by distillation. At present this raw material is valueless, but if a cheap mode of extraction could be devised it would add largely to the wealth of the Auckland district. I do not despair of seeing even the sawdust of the *kauri* become of value on account of the resin which it contains.

The leaves of the hemlock spruce-fir of North America are made to yield a volatile oil of great value, by distillation, and the industry is yearly assuming larger proportions.

Although the recent resin of the *kauri* is considered of less value than that found in a fossil condition, it does not follow that its extraction from our waste tops, leaves, and chips would not prove remunerative. The recent resin always finds a market, and the difference in price is but small. Something would, at any rate, be gained by lessening the demand for the dry resin, and so deferring the period of total exhaustion. It was in 1878 exported to the value of £132,975, and in a few years will become less easy to procure than at present.

In Formosa, camphor is extracted by a rough mode of distillation, from a description of which our bushmen may perhaps derive a useful hint in connection with our neglected forest products.

Water is boiled in a wooden trough, or hollow trunk, protected from the direct action of the fire by a coating of clay; the upper portion of the trough is covered by a board having numerous small perforations. Chips of camphor-wood are placed on the board and covered with earthen pots, so that the steam passing through the apertures extracts the camphor and deposits it on the upper surface of the pots.

Turpentine.

Turpentine may be regarded as resin held in solution in a volatile oil. It is produced by numerous pines and other trees; but varies considerably in value, some kinds being used chiefly for the manufacture of resin, as that of the *pinaster* for instance; while the turpentine obtained from the silver-fir simply requires straining to free it from accidental impurities, and render it fit to be used in the manufacture of clear varnishes.

Mastic and Chian turpentine are obtained from *Pistacia lentiscus* and *P. terebinthus*, but the quantity is inconsiderable when compared with that obtained from various pines. In Europe, common turpentine is extracted from the Scotch fir, Baltic spruce, larch, *pinaster*, and silver fir. In North America, from the loblolly pine *(Pinus tæda)* and the Georgian pine *(Pinus australis)*.

Actual experiments are necessary to determine to what extent the pines of New Zealand can furnish a substitute for the turpentine of Europe and North America; but there can be little doubt that large quantities can be obtained from the *kauri*, *rimu*, *kahikatea*, and others, by incision of the outer bark in a similar manner to that practised in North Carolina and other Southern States.

In some countries the resinous matter obtained from the trunk, by excision, is collected in baskets, which are placed over earthenware jars, so as to allow the fluid portion to drain off, forming the common turpentine of commerce. The solid portion is boiled in order to purify it, when it becomes ordinary resin.

The process of extracting the turpentine from the *pinaster* has been already described under the head "Resin." Turpentine obtained from this source, however, is of inferior quality to that obtained from the Georgian pine, and until the diminution of the American supply, caused by the civil war in 1863, it was chiefly used for the manufacture of resin ; but during the continuance of the struggle it was imported into Britain in large quantities, which gradually diminished as the yield of the American product again increased, until, at the present time, it forms only one-tenth of the entire quantity imported,—it is sold under the name of Bordeaux turpentine. In North Carolina, Georgia, and Alabama, turpentine is extracted from *Pinus australis* and *Pinus tæda* in large quantities. During the winter months small cavities, termed "boxes," are cut in the trunk of the tree at about twelve inches above the ground. The boxes slope inwards, the bottom being from four to five inches below the lower-lip, and of sufficient width to hold from one and a half to three pints of fluid sap. From one to four boxes are made in a trunk, according to its size and diameter,—a trunk fifteen inches in diameter should have three boxes, each holding about a quart. The boxes are cut with a long narrow axe, and require from eight to ten minutes each to make.

In the month of March the flow of sap commences, and continues to the end of August. In the former month the bark and sap-wood are cut or hacked for a few inches above the box, which is gradually filled, the flow increasing in quantity as the weather becomes warmer, so that the box is filled in about two or three weeks. The surface of the box should be lightly chipped over once a week, and the bark hacked afresh, the wounded portion being slightly increased in height each time, until in the course of years it is carried fifteen feet or more above the box. The turpentine is removed as often as necessary, and the resin that has dried on the surface of the boxes is carefully scraped off, and often mixed with it.

If the process be carefully conducted, trees may be profitably treated in this manner for forty or fifty years. The first year's produce is always the most highly valued, and is called "Virgin dip."

The resin scraped from the surface of the wound forms the common frankincense or "Gum Thus" of the druggists, and is the chief ingredient in the incense used in Roman Catholic places of worship, serving as a substitute for the expensive *Olibanum*, or true frankincense of Arabia.

Turpentine is obtained from the larch by boring augur holes in the trunk $\frac{3}{4}$ inch to 1 inch in diameter, taking care not to reach the centre of the tree. The holes are slightly inclined upward, and have a tube or small gutter tightly fitted into each, with a tin canister or small bucket suspended from the outer end to receive the turpentine. The buckets are examined every morning, and the turpentine removed.

A mature tree will yield from seven to eight pounds of turpentine yearly for forty or fifty years.

The turpentine is often found collected in small cavities in the larch, exactly as in the New Zealand "red pine."

In some cases the cavities are closed with a plug, and the turpentine allowed to remain until it assumes a pasty condition, when it is removed with an iron spoon. The yield is, of course, greatly reduced, but the durability of the timber is preserved.

Turpentine from the larch was formerly known as "Venice turpentine."

In some pines, as the silver fir, in which the wood is destitute of resin ducts, the turpentine is contained in small cavities formed beneath the bark.

In the months of July, August, and September it is collected by Italian peasants, who visit the alpine districts for that purpose. Each carries a small sharp-pointed tin cone or flask, with which he punctures the bladders in the bark and extracts the turpentine, which he pours into a tin bottle carried at his belt. The loftiest trees are ascended by the aid of climbing-irons, so that the work of collection is extremely laborious. The turpentine is strained to free it from fragments of bark, leaves, and other impurities, when it is ready for sale. It is known in the market as "Strasburg turpentine," and formerly commanded a high price.

The barbarous plan of cutting boxes in the trees would not be adopted in New Zealand, at any rate when it is desired to continue the process of extraction for a lengthened period. Tin or zinc troughs or boxes could be readily fixed to the trunk, or even sunk in the ground at its base, and the turpentine conducted to them by grooves, or some other simple contrivance. In this way even the *kauri* might be made to yield a supply of turpentine for some years without material injury to its timber.

Of course where a clearing is about to be made, and it is not thought worth while to convert the timber, the object is simply to obtain the greatest yield in the shortest time; in this case incisions may be multiplied, and cavities deepened without taking ulterior results into consideration.

The amount of turpentine and resin which our native pines are capable of yielding, involves several points of direct interest to the botanist, as well as to the merchant and settler. I therefore venture to suggest to settlers in forest districts, and especially to the proprietors of *kauri* and *kahikatea* forests, the desirability of ascertaining the yield of the different species by actual experiment, which might be commenced at once. In any case the results would be of great value, and their publication would confer a boon upon the community. The rate of flow should be carefully noted, and the variations caused by changes in temperature observed. It would be advisable to try different methods of extraction with the same kind of tree, giving the preference to those which cause the least injury to the timber.

The Westland pine appears to merit particular attention—in common with the red silver pine it would probably afford turpentine of special value for certain purposes, although the yield of either would, in all likelihood, be comparatively small.

Oil of Turpentine.

This is manufactured by distillation on a large scale in the Southern States of America. The turpentine is placed in copper stills of large capacity, and is distilled without water; the volatile oil is received into barrels direct from the still, and is ready for market.

The resin remaining after the oil has been extracted is drawn off into a vat containing water, which separates it from all impurities, when it is packed for export.

Potash.

This is extensively prepared from wood-ashes in the forest districts of Germany, Russia, and other European countries, also in Canada and the United States of North America, where it enables the settler to defray a large proportion of the heavy cost of clearing forest land.

Potash salts are found in varying proportions in all plants, and are most abundant in the young branches and leaves.

The process of extraction is simple and inexpensive. All parts of the plant, including the leaves, are burnt in dry pits dug in the earth from three to five feet in depth, and of any convenient size. The ashes are placed in tubs or vats, each having an orifice near the bottom secured by a plug, and a false bottom covered with straw or rushes. The ashes are saturated with water, and, after standing about twelve hours, the potash-liquor is drawn off and taken to the evaporating pans, usually shallow iron vessels, sometimes with corrugated bottoms.

It is now kept in a boiling condition and constantly stirred, fresh liquor being added from time to time as required, until the whole becomes of a pasty consistence, when the heat is gradually reduced and the dry residuum allowed to cool.

In Canada the crude potash thus obtained is usually sold to the nearest storekeeper, but it requires to undergo a process of calcination to free it from certain organic matter before it becomes the potash of commerce.

After the first potash-liquor has been drawn off, water is again poured over the ash in order to remove all soluble matter, and the weak solution thus afforded is used to lixiviate a fresh supply of ashes.

The insoluble portion of the ash is used in the manufacture of certain kinds of glass, and is of great value as manure on account of the phosphates which it contains.

In this colony thousands of acres of forest are burnt annually, but I am not aware that the slightest effort has been made to utilize the ashes. Although produced in such large quantities they are simply wasted, being for the most part blown away by the wind, or washed by the rain into the nearest streams and carried to the sea. It is obvious that by collecting the ashes immediately after "burning off," especially where much "logging" has been necessary, the settler has the means of defraying a considerable portion of the cost of clearing, without any commensurate outlay. As the majority of settlers commence their clearings with but slender pecuniary resources this is a matter which possesses a direct interest for a large class.

In Britain potash is employed in numerous manufactures, and the consumption increases year by year, so that no doubt can be entertained as to the possibility of finding a market. The greater portion of the supply is obtained from wood-ashes, for although it is also procured from mineral sources, the process of extraction is comparatively costly.

In populous districts, where wood forms the chief fuel, it might prove remunerative to collect the ashes for the sake of the potash which they contain. Baron von Müeller estimates that a bucketful of ordinary wood-ashes contains about two pounds and a half of crude potash, worth sixpence per pound.

In Europe, furze, broom, and common fern are often burnt for the sake of the potash contained in their ashes. Might not our local Road Boards derive a hint from this, to assist them in defraying the cost of clearing the miles of furze and fern by which traffic is impeded upon some of our roads, and at the same time open a new outlet for labour?

Charcoal.

At present charcoal is manufactured to a small extent only; and its cost is so high as greatly to restrict its application.

The ordinary process of manufacture, although extremely simple, requires great care and attention. The wood is cut into billets from two to four feet in length, and dried by exposure to the air; when dried it is closely stacked in conical mounds from six to twelve feet high, and from ten to forty feet in diameter.

The ground is first cleared and levelled; a small framework is erected in the centre of the space, about three feet square, and consisting of four forked-sticks standing two and a half feet out of the ground, and connected at the top by four stout rods. The billets are compactly stacked round the frame until the entire area is covered, all the billets sloping towards the centre; the stack is then completed to the desired height by billets arranged horizontally, and the whole covered by a layer of earth, finished off with sods when it is practicable to obtain them.

The heap is kindled by an opening made at the top, and others near the base; after burning for three or four days these are closed, and other holes are made in the sides about half-way between the base and the apex. The holes must be closed whenever it is seen that combustion is too rapid, and care must be taken to fill up any depression that may arise from this cause.

When smoke ceases to be given off all the holes are closely stopped, and the heap is allowed to cool for three or four days, when the cover is removed and any charcoal that may still be in a burning condition is extinguished by water.

In many places the site of the mound is formed into a funnel-shapad depression with a hole in the centre, which communicates with a ditch dug on the outside to enable the tarry matters to be drained off.

Charcoal intended to be used in the manufacture of the finer kinds of gunpowder is subjected to combustion in large iron retorts furnished with refrigerating condensers, by which means nearly the whole of the volatile products can be readily obtained.

Woodware.

It may be admitted that manufactured articles can scarcely be included under "Neglected Forest Products," without using the phrase in a very elastic manner; but before closing this short series of papers, I may be permitted to refer to the importation of certain kinds of woodware requiring a very limited expenditure of labour, and that of a very simple character, such as rolling-pins, washing-boards, clothes pegs, tubs, buckets, pails, etc., etc.

It is to say the least a singular anomaly that simple articles of this kind are imported from the United States of North America and other countries to the amount of £10,000 per annnm, while material that could be utilized in their manufacture is burnt in enormous quantities, or allowed to rot on the ground, and our artizans are unable to obtain employment.

Tawa, one of our most common timbers, is specially adapted for the manufacture of all the articles named; for the smaller kinds, such as clothes pegs and rolling-pins, it can be procured in almost unlimited quantity at little more than the actual cost of carriage.

There must be something radically wrong when simple manufactured goods of this kind, weighted as they are with heavy charges for freight and import duties, can be placed on the New Zealand markets in the face of the unlimited supply of raw material at our command. The cause of this anomalous condition of matters cannot be discussed here, but I may allude to it in order that the attention of settlers may be drawn to the subject.

In country districts intervals of wet weather might often be profitably utilized in manufacturing the simpler kinds of woodware. In most cases timber could be had for cutting and carting to the workshed, so that beyond the small sum required for the purchase of tools, etc., the sole outlay would be the cost of carriage to the merchant's warehouse, which, from the northern settlements, in any case must be much less than American freight rates, while the import duty of 15 per cent. *ad valorem* would be altogether in favour of the settler, although this of itself may be a disadvantage to the community.

Art. XII.—*On the Growth of Sugar-Beet in New Zealand.*

By S. M. Curl, M.D., F.L.S.

[*Read before the Auckland Institute, 25th October*, 1880.] *

It is some years ago since I wrote in the public papers and otherwise to advocate the introduction of the sugar-beet industry in this colony, being thoroughly satisfied by the experiments I made of the growth of various beets from different countries under test culture, and the large percentage of sugar by analysis, that the establishment of sugar-beet manufactures would greatly enrich this country. Had my plans been adopted and carried out, this colony would have been rich and prosperous, instead of being deeply in debt as it now is, and in place of the farmer working his land, as he now does, at a loss, by the introduction of the sugar-beet industry quite a different state of things would quickly arise, and the farmers might every year make a profit of from ten to fourteen pounds per acre for every acre they had in beet culture, and still leave six pounds for working and manuring each acre, thus, at the same time, increasing their capital, paying good interest upon that invested, employing more labour than they can now afford to do, and meanwhile the capital invested in the manufacture of sugar and spirit would be profitably introduced, and more labourers would be employed.

That these are facts and not fancies the history of the beet industry in all countries proves beyond a doubt, and having formerly had the advantage of seeing the beet culture and manufacture in France, in Russia, in Germany, in Austria, and other countries, and seeing the profit it brought to the farmers growing it, and to the manufacturers who obtained from the roots sugar, spirit, and the waste products used for cattle feeding, &c.,—

* [This paper was first read before the Wellington Philosophical Society on the 22nd November, 1879, and its publication was postponed by direction of the Board, as the author might wish to acquaint himself with the voluminous Parliamentary papers on the subject (App. Journ. H. of R. 1876, H.-2 and H.-2a; 1877, I.-4), especially as these papers include analyses of New Zealand grown beets, showing much less favourable results.—Ed.]

after coming to this colony, by writing, and in various other ways, I endeavoured to point out the great advantages that would follow the introduction of this industry here; but, further than this, with a view to determine how far the climate and soil would be favourable to the formation and development of sugar in the beetroot here, I wrote to seedsmen in France, Germany, and other countries, and imported seed of the several kinds of beet, and grew it, and submitted it to various test cultures in this colony; and having tried the effects of different modes of culture upon the various sorts of beet, I proved to my own satisfaction and that of the friends who took an interest in these experiments, that not only would the sugar-beet grow and flourish, but that under the ordinary plough and harrow culture of the farm, it would produce a crop of from eighteen to twenty-seven tons to the acre, but that with appropriate manures and careful cultivation, this quantity could be considerably exceeded, and that, in proportion to other parts of the world, very large crops could be grown here.

But as all who know anything of beet culture and manufacture will recognize, it is not only the quantity of tons of beetroot to the acre that is the great desideratum, but more especially the percentage of sugar that the roots contain that makes the greatest difference. To determine this, I analysed, and in other ways tested, this percentage of sugar, and afterwards, by "maceration and diffusion," extracted the sugar, and crystallized what was crystallizable, and the molasses left fermented, and distilled off the alcohol, and by these several methods checked and verified the results; and I found that this climate would enable beets to be grown that had a very high percentage of sugar in proportion to that produced from the same kind of seed in the other countries from which they came, as the following details will show.

The seeds which were obtained from France and Germany were said to have a percentage of sugar in the same kind of roots, the previous year to my obtaining seed, as that given below, and the average of my tests from several roots selected at various parts of the field when grown, and tested by the different methods, gave as under.

Betterave blanche	9½ per cent. of sugar in France.
With me	12 per cent.
Disette blanche à collet rose ..	7 per cent. of sugar in France.
With me	9 per cent.
Disette blanche à collet vert ..	8 per cent.
With me	9½ per cent.
Betterave Vilmorin	16 per cent.
With me	17½ per cent.
Betterave jaune globe	6 per cent.

With me	6 per cent.
Betterave jaune sarrazin	$6\frac{1}{2}$ per cent.
With me	7 per cent.
Magdebourg	$11\frac{1}{2}$ per cent. sugar in Germany.
With me	$13\frac{1}{2}$ per cent.
Imperial	$13\frac{1}{2}$ per cent. in Germany.
With me	$15\frac{1}{2}$ per cent.
One of the best Russian varieties.	$15\frac{1}{2}$ per cent. in Northern Russia.
With me	16 per cent.
A variety from Austria	15 per cent. in Austria.
With me	$16\frac{1}{2}$ per cent.

These figures coming out as the result of cultivating some of the best varieties to yield sugar in other countries, proved to me that the beetroot would, in this country, yield a large, or larger, proportion of sugar; and as the quantity per acre was as much as that in other countries, and in some experiments greater, I saw that it only required a manufactory to be established here to enable that root to be grown, and sugar made, at a profit to all concerned; and even while there was no manufactory of sugar the beetroots fed to cattle, pigs, etc., quickly fattened them as soon as they were taught to eat this new kind of food. But, as labour is so expensive here, the beetroot will not be largely cultivated until a manufactory is established to work up the beetroot into sugar. But directly this is done the profit will be so manifest that this industry will rapidly increase.

It therefore becomes a question of how much money would be required to inaugurate this industry by establishing a factory here. I have no doubt that capitalists in other countries would be induced to establish a factory here, if they were made acquainted with the fact that we are every year spending such large sums for our sugar imported into this colony. But the Government of the colony could so guarantee this investment of capital that this sugar manufactory could be at once inaugurated.

But even if a company is formed, and the directory and other preliminaries established here, and a portion of the capital subscribed for it, the remainder would rapidly be taken up in the other countries of Europe, as they know that over 20 per cent. of profit can be easily made if this business is properly gone about; but it will depend upon this, and the promoters will have to take care that they arrange this factory and plant upon the best German and French models, and have a thoroughly competent manager, fully instructed hands of the several processes engaged to carry on the work, or, instead of being a certain success and profit, it will be a certain failure. Also the central factory should be in such a well-chosen situation that it will easily obtain its water, fuel, and supply of beetroots from the neighbouring farmers; although this can be arranged to a certain extent by having local establishments, where the beets can be received from the farmers growing them, and there dried, and then sent on to the central factory, as is done in some parts of France and Germany. The farmers could then deliver to these branch establishments the beetroots from their fields, and receive back payment at the rate of from 15s. to 20s. per ton of beets, according to the amount of sugar therein contained, which would depend upon the kind of seed sown and the care taken in its cultivation; and, as farmers could easily grow from twenty to thirty tons of the best kinds of beet with the proportions of sugar ranging from 9 to 13 per cent. on all ordinary lands, and upon selected lands higher percentages than these, (at which increasing percentages of sugar it would be profitable for the factors to pay them much more than the 20s. per ton of beets delivered) it can be seen that there would be no difficulty for the farmer to realize from each acre he laid in sugar-beets a gross sum of £20 and over per acre. Against this must be set the ploughing, seeding, manuring, cultivating, gathering, carting to factory, and wear and loss, a sum of £7 per acre, which, deducted from the £20 realized by the sale of the beet, would leave £13 profit upon every acre grown. But even if the expenses were, from locality, etc., greater, and the returns somewhat less, there would still be a very considerable profit, which, by any calculation, would be far greater than at present made by any use to which the land could be turned.

Upon examining my notes of the profit made by farmers in France, Germany, and elsewhere, I find they are much larger than my highest figures; and, better than all, instead of this being a temporary advantage to the farmer to cultivate beetroot, it is a great gain to him besides what he acquires directly from the sale of the beetroot, as it is a well-proved fact that the fields improve each year under beet culture, and that, after the beetroot comes off, the land will grow a better crop of wheat or other corn than it would before these roots were grown. In fact, the beet crop is an excellent preparation and preparatory crop for wheat or other corn, and, in addition to the roots sold, the green tops of the beet can be fed to cattle or live stock as well; and then the manure applied to the land with the beet crop, and the working this gets, so prepares the soil for the subsequent cropping that a beet crop in rotation enables the farmer to grow more wheat in a series of years than he could without the beet being grown on his land.

Again, in many parts of Germany and France when the farmer sends a load of beets to the factory he brings back a return load of the expressed beet-pulp, from which the sugar has been extracted, and with this he feeds cattle or other live stock, thus adding food for his animals, and letting them turn it into manure for his fields; so that, while feeding the leaves and pulp back to his cattle, he only removes the sugar which the beets made while growing upon his land; and, as the sugar is composed of carbon, hydrogen, and oxygen, obtained principally from the atmosphere in the shape of rain and carbonic acid, the soil is not exhausted by the beets being grown upon these lands; and judicious application of manures, in addition to the leaves and pulp, more than keeps up the fertility of the soil to the condition it held before the beets were cultivated, while the preparation of the land and culture of the beetroot, and the profit made therefrom, enable more labourers to be kept all the year round upon each farm, and at better wages, and yet be remuneratively employed, than would be possible without the beet culture. But let us leave for the present the farmers who would grow the beet, and turn to those who would manufacture it into sugar.

The larger the capital invested in beet-sugar manufacture up to a certain amount—supposing the management to be equally good in each instance—the greater the profit, and the better altogether for all concerned, as more perfect machinery and more certain results can be attained to, and although a capitalist, or a company, could start and work a factory and make sugar for a year from a capital of £25,000, yet it would be far wiser and better in every way to have a capital of £75,000, or if possible £100,000, which would pay better than either of the other sums. But as there would be no difficulty in raising the sum in Europe for such a purpose if the directory and management was what it should be, it would be well to have the larger sum invested.

But taking £75,000 as the capital of a company, let us see what similar enterprises return as profits for such a capital in other places.

Capital £75,000; £50,000 of which would be expended upon buildings and machinery and plant generally, and £25,000 would be reserved, or spent upon a year's working expenses.

In France and Germany, the average cost of producing a weight of sugar is, if calculated in English weight and money, equal to from 1½d. to 2d. per pound, varying according to the perfection of the factory, plant, etc., or about £18 per ton. A factory furnished with a plant like that proposed, could easily work up and convert into sugar thirty thousand tons of beetroot, which, supposing the beet yielded at the rate of about eight per cent. of crystallized sugar, or a total equal to 2,392 tons of crystallized sugar, would cost £43,056 to produce, and would if sold at £36 per ton, leave a profit for sale of sugar of £43,056. There would then be left from this quantity of beet, 800 tons of molasses, which if sold at £2 per ton would amount to £1,600, and there would be about 5,700 tons of beet pulp, which if sold at 10s. per ton to the farmers or dairymen, or to any one keeping live stock, would amount to £2,850, being a total of £47,506 for the year's operations, which would be a profit of over 60 per cent. upon the whole of the capital.

But large as these profits are when calculated upon the data furnished by factories working in France and Germany, they would be exceeded here, as they are based upon an average of less sugar in the beet than would be found here, for we might certainly calculate upon 11½ per cent. of sugar in our beetroots, whereas the preceding figures are calculated for only 10 per cent. as a total, and 8 per cent. as sugar extracted and crystallized. But even if matters were much worse, and did not show a profit of 60 per cent., through mismanagement and a less percentage of sugar and the produce being sold at a lower price, even then the profits must be very large, and must altogether depend upon the management of the factory.

But, whatever may be thought of the exact amount of the profits that would accrue, there can be no doubt that large profits would be made, as is proved by the rapid way in which this industry has spread on the continent of Europe, and the enormous wealth that has been developed thereby, not only amongst manufacturers, but among the farmers and others who are engaged and interested in the beet industry.

In 1850, in France, an area equal to 87,000 British acres was under beet culture, and fifteen years afterwards this area under beet culture increased to over 300,000, and it has been increasing at a very rapid rate ever since. In fact, the production of beetroot sugar has *doubled* in France every ten years.

In Germany, they are more than doubling their production of sugar every ten years. In 1850, in Germany, they made 53,000 tons of beet sugar, and in 1865 they made 187,000 tons. In 1867 France made 220,000 tons of beet sugar, and has as rapidly increased ever since. In Austria, they have over 200 beet sugar manufactories, and are always increasing the number. The increase of this industry is also equally rapid in Holland, Belgium, Sweden, Poland, and Russia. In the year 1866, there were produced in the whole world 2,320,000 tons of sugar from the beet, the maple, the cane, the palm, and the date; out of this quantity there was more than one-fourth manufactured from the beetroot, namely 638,500 tons, of which France produced 216,000, Germany 190,000, Austria 80,000, Russia 80,000, Belgium 40,000, Poland and Sweden together 25,000, and Holland 7,500.

In the year ending 1866, in France, the returns from the beet harvest in that country were as follows, reduced into English money:—

Beet sugar..	£6,250,000
Spirit distilled from beet	1,350,000
Potash from refuse of beet	500,000
Exhausted pulp sold at factories	1,100,000
Total	£9,200,000

In addition to this there were the leaves for the cattle to feed upon. In that year there were over 100,000 hands engaged in the sugar factories, and over 26,000 in the beet-distilleries; lands leased by the farmers to grow the beetroots averaged 200 francs per hectare—over £3 per acre English.

The growers of the beetroot consider that it thrives best in a temperate climate, with sufficient but not too great moisture, a moderate amount of sun but not too much heat; as all the root should grow under ground to contain the largest amount of sugar, in a soil not too dry or too hard, it follows that this climate would admirably suit it.

Wherever it has been once fairly tried it is never given up, but always increases. The labourers' wages rise, the farmer gets richer, the manufacturer becomes wealthy. The money that would have gone out of those countries for cane-sugar is now kept in, and not wasted for what they can themselves produce; and are we to be more reckless and wasteful than they, and send our thousands, every year, out of the colony for what we can produce so well here; are our commercial men such incapables that they will allow this wealth to slip past them without inaugurating an industry that would benefit them, and all concerned; are our farmers so obtuse that what a Frenchman, a German, a Swede, a Russian, a Hollander, an Austrian, a Pole can do, and improve his farm with, and have a constant and steady income therefrom, they cannot perform; are they so much behind the other nations, that they cannot or will not adapt themselves to a new culture that is no more difficult than the old, and that is in no way speculative, as most other nations have seized upon it, and are always going more fully into it, finding it so profitable and worthy of attention? Surely the men who have made New Zealand their home, and have settled upon these fertile lands, and where the climate is so suitable to the beet culture that it developes more sugar than in other places, will not much longer refrain from this magnificent industry, that will make them, and their families, well off, and render them more prosperous each year—enabling them to employ more labour, more machinery, and to more highly cultivate and always keep improving their farms and making their lands more valuable—while they are establishing an industry that will make them more independent of corn and meat-growing each year, but will enable them, if they choose, to grow more wheat and meat to the acre than they can now possibly do, by reason of the improvements that beet culture would effect in the tillage and improvement of these lands; while they will be keeping the money in the country that is now being sent out in hundreds of thousands to purchase the sugar and spirits that are now draining the money out of the colony.

Art. XIII.—*On the Causes tending to alter the Eccentricity of Planetary Orbits.*—By Professor A. W. Bickerton.

[*Read before the Philosophical Institute of Canterbury, 6th May*, 1880.]

Plate I.

In former papers it has been shown that the partial impact of cosmical bodies may not unfrequently produce a central mass and attendant bodies, which I have called respectively a sun or nebula, and planets. The sun is at a high temperature and rotates. The planets, in a solid, liquid, or gaseous state, revolve round in one general plane with orbits of varying area and of high eccentricity. All the motions, whether of sun or planets, have one common direction. Further it was shown that the planetary path is due to a portion of the original proper motion escaping conversion into heat at impact. For the same reason the temperature of the planet is lower than that of the sun, whose high molecular velocity, due to its temperature and comparatively small mass, may cause it to expand into a nebula.

The present paper requires that the central mass shall become a nebula, and shall expand beyond aphelion distance of the most remote planet. The forces acting on the planet will be the attraction of the nebula, gaseous adhesion while traversing the nebula, and at the same time exchange of molecules with those of the nebula. The heavier molecules will generally be attracted to the planet, while the lighter ones will leave it. The probability of such a system being formed, or the possibility of gaseous planets moving in a nebula, with its attendant effects on the size of the orbit and the change of apsides, is not treated in this paper. It is solely occupied with the change of eccentricity.

The following are five causes which are calculated to result in such a change:—

1st. An alteration in the amount of the attractive force exerted on the planet by the nebula.

2nd. The varying resistance and interchange of molecules incurred by the planet in its path.

3rd. The gaseous adhesion to the planet revolving on its axis within a nebula.

4th. The accretion of some of the vast number of small bodies which would exist in the nebula.

5th. Some others which are too dependent upon the special character of the impact to be discussed at present.

In compliance with the wishes of several members, I have inserted in this paper the solutions of the dynamical problems involved, whose truth I had before assumed.

The agency of lessened attraction as affecting any one planet, applies only to the period which elapses while the central mass is expanding to a nebula, and it will appear that the first revolution will especially be productive of altered eccentricity on this count. The following shows the action of these forces reduced to geometrical problems :—

Problem 1. Suppose a planet to be at that part of its orbit most distant from the sun, and, while in this position, suppose the mass of the sun suddenly diminished to a given extent,—required to trace the effect of this diminution of the sun's mass upon the orbit of the planet.

At present let the sun's mass be considered constant. Let the line *ax* (fig. 1) be tangent to the curve at aphelion, and *aa*, *ab*, *bc* infinitesimals along *ax* in the direction of the planet's course; let aa', bb', cc', be infinitesimals representing the fall of the planet during the times contained respectively in *aa*, *ab*, *ac*, then aa' b' c' will be the path of the planet.

Now suppose the mass of the sun to be decreased, the infinitesimals *aa*, *ab*, *bc* will remain unaltered, but aa', bb', cc', etc., will each be diminished to a'' b'' c''. Then the curve aa'' b'' c'' represents the new orbit. It falls without the old orbit, except at *a* where it coincides with it. Perihelion distance is therefore increased, as represented in fig. 2, by virtue of diminished attraction.

The amount of the lessening of the attractive force will depend upon the quantity of the sun's matter which expands beyond aphelion distance. The portion which so expands ceases to affect the path of the planet. As this increases the orbit will assume variously the forms of the ellipse, circle, ellipse (the foci being reversed), parabola and hyperbola. If the attraction towards the centre entirely ceased, the path would coincide with the line *aa*. These orbits are respectively shown in fig. 2.

In fig. 3 let p' represent the orbit with perihelion distance increased beyond that of *p*, this latter representing the orbit if the sun were not to expand into a nebula. Let the dotted circle *c* represent the limits to which the nebula has expanded when the planet passes aphelion. As the planet is entirely in the nebula it will be subject to constantly and rapidly diminishing attraction as it approaches the centre, *s*, hence it will not pass along p', but will move more slowly inwards (in agreement with the first problem), and will pass along the second dotted line p'', which shows great increase in perihelion distance.

The two actions which have now been discussed scarcely affect aphelion distance, but render the orbit more circular by increasing perihelion distance.

I have now to notice gaseous resistance and interchange of molecules, whose action will be found chiefly to diminish aphelion distance. The following problem demonstrates decrease of aphelion distance by a resistance at perihelion.

Problem 2. Suppose a planet to be at that part of its orbit nearest to the sun, and, when in that position, suppose a retarding force to act upon it,—required to trace the effect of this upon the orbit of the planet.

Let Px represent a tangent to perihelion, and pa, ab, bc be components in direction pn, passed over in three successive infinitesimals of time. Let $a\ \alpha$, $b\ \beta$, $c\ \gamma$ represent the total fall towards the sun in the same intervals. Then $p\ \alpha\ \beta\ \gamma$, represents the orbit. Now let the velocity in the direction px be diminished by the retarding force, and let the spaces pa', $a'b'$, $b'c'$ represent the components in the direction px in the same infinitesimals of time. The components towards the sun remaining the same draw $\alpha\alpha'$ $\beta\beta'$ $\gamma\gamma'$ parallel to px, then α' β' γ' are points in the new orbit.

This curve lies entirely within the other. Thus, by a retardation at perihelion, aphelion distance is diminished, as shown in fig. 5. If this retardation is great enough, the orbit may become a circle or an ellipse with foci reversed, as shown in fig. 5. The general action of gaseous resistance is to convert the energy of the system into heat by gradually drawing the planet into the sun, or to the centre of attraction. It is maximum at perihelion, for there the density of the nebula is greater than at any other part of the orbit. Molecular exchange results from the varying densities of the different parts of the system. The planets are cooler than the central parts of the nebula, and will most likely be denser than the matter surrounding them in their path, and have sufficient attractive power to collect the heavy molecules in their vicinity. The temperature of the surface of the planet will be raised to an unknown extent by its immersion in the nebula and its progress towards perihelion. Its light molecules have their velocity so increased as to escape the planet, while the heavier molecules of the vicinity, with their lower velocity (though equal temperature), will be attracted, picked up, and become permanently part of the planet. A greater proportion of heavy molecules will be found towards perihelion, for at the centre of the nebula will probably be its greatest density, and the original expansion of the central mass into a nebula will result in the more rapid outward escape of the light molecules compared with the heavy, in obedience to the laws of gaseous diffusion. Thus the accretion of molecules to the planet will be maximum at perihelion distance. Its effect will be to retard the motion of the planet, as, in order to give its own velocity to a molecule, it will impart some of its energy. The escape of the light molecules will not affect the planet's orbit. We find therefore that gaseous resistance and molecular exchange act as resistances to planetary motion and are both maximum at perihelion, thereby decreasing aphelion distance and rendering the orbit more circular.

Gaseous Adhesion.

When a body is moving forward in a gas, the gas adheres and produces retardation. If the body be revolving this retardation is unequal and the body is deflected. The well-known fact that if a projectile revolves on any other axis than its own direction it is deflected, is an illustration of this action, and it is to make the ball move in its true path that a gun is rifled. It has been shown in the paper "On the general problem of stellar collision"* that all the bodies developed by "partial impact" tend to revolve in the same direction; in order, therefore, to ascertain the effect of this gaseous adhesion on the path of a planet revolving in a nebula we have especially to consider the case of a body revolving in the same direction as its orbit, and on an axis perpendicular to its plane.

Problem 3. To ascertain the influence of gaseous adhesion on a rotating planet revolving in a nebula.—Let the arrows in fig. 6 represent the general direction of motion. Let *a b* represent the planet rotating in the direction of its arrow; it is evident that a particle at *a* is tending to move forward faster than a particle at *b*, for if the path of *b* were an epycycle, as it might be, it is evident that for an instant it would be at rest; hence gaseous resistance is stronger at *a* than at *b*, hence *a* is retarded more than *b*, and the direction the body will tend to take is towards *c*. In other words, gaseous adhesion acting on a planet revolving on an axis perpendicular to its ecliptic in the same direction as its orbit tends to straighten the curve.

From the above problem it is evident that on the first return when it meets the nebula it tends to increase perihelion distance and alter apsides, as shown by the dotted ellipse fig. 6. After the first return, were the nebula uniform, it would tend to make a larger ellipse, that is increase its average distance from the centre, thus the potential energy of the planet would be increased, and this increase is done at the expense of the planet's rotation. It might be supposed that this would be a very small matter, but it must be remembered that all the time the body is contracting from a more or less dense gaseous to a liquid state the whole of this potential energy will be converted into rotation, thus the total effect may be very considerable, but as this action will be chiefly at perihelion it will tend materially to alter the eccentricity. It must be clearly understood that it is the differential resistance on the sides of the planet towards and away from the sun that is discussed in this paragraph; its general retarding action was studied in the last problem.

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* "Trans. N.Z. Inst.," Vol. XII., Art. XIV.

Fig. 1.

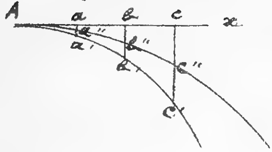


Fig. 2.

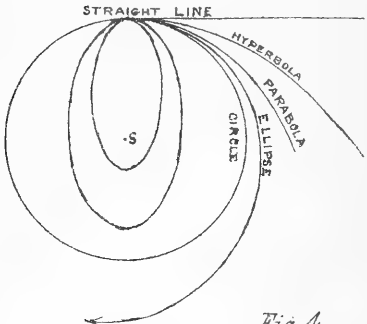


Fig. 3.

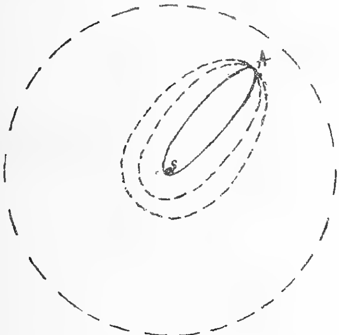


Fig. 4.

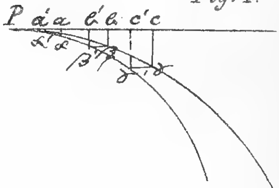


Fig. 6.

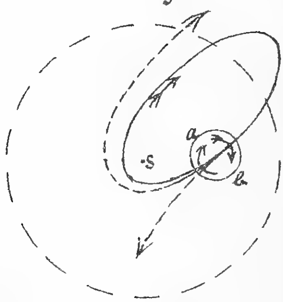


Fig. 5.

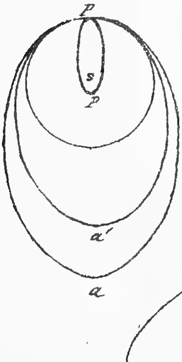


Fig. 7.

To illustrate Paper by Professor Bickerton.

On the Accretion of Particles.

When the nebula has become stable, that is no longer expanding, much of its elementary matter will be at a sufficiently low temperature to combine; and these compound molecules will tend to aggregate into groups, and it may be shown that these masses may ultimately become so considerable as to form star clusters, associated by gravitation but not coalescing. I propose discussing this difficult question in a paper on star clusters; but in this paper I shall simply state that these little bodies will in all probability revolve in independent orbits at all eccentricities around the centre of the mass; these and other masses will be occasionally picked up by the planet.

The following problem shows that component to and from the centre tends to be destroyed, and only a circular orbit left.

Problem 4.—Given two bodies revolving in eccentric orbits in the same direction around an attracting centre, to find the effect upon the eccentricity of the new orbit in the event of their coalescing.—Let *a* represent the two bodies colliding, the direction of one body is along the path *ab*, the other along *ac*, the component along the diagonal *ad* is evidently the new direction of the coalesced body; it has evidently less velocity than the mean of the two, as the component towards and away from the sun is more or less destroyed. The position of the body is also nearer after than before, so that the total effect will be to reduce mean distance, to lessen aphelion distance, and generally to increase perihelion distance, in other words to lessen eccentricity.

There can be but little doubt that this agency of accretion will be most important in giving regularity to any system. Proctor has discussed the influence of accretion of meteors, and it is certain he is right in giving it very great value. It probably played a great part in the formation of Jupiter.

Uncertain Agencies.

An agency whose effect it is difficult to estimate is that of the outward motion of the general mass of the nebula. The planet may meet this on its return towards the centre; if so it will directly oppose its return, acting exactly opposite to gravitation, that is, in the same manner as though the central mass were of less mass; the body will consequently not be attracted back towards the centre so far as it otherwise would be. This action will tend to lessen perihelion distance. This outrush will evidently be much less as the planet leaves the sun on its second revolution, thus the body will not be aided by it on its return, and consequently it may not reach its full aphelion; but it is extremely likely that the nebula will attain equilibrium before it could affect the planet on its return. In the event of a case of partial impact in which the two parts of the original bodies escaped into space—any mass escaping during, or immediately after, the impact would be exposed to a much higher attraction on escaping than on the return, because, on leaving them, the three bodies would be exercizing attraction upon the body; but, on the return journey, there would be only one body. Thus its aphelion may not be near so distant as that of a body that had only the central mass acting on it in its outward journey; but this will not necessarily affect the eccentricity, but may do so in certain cases.

Art. XIV.—*The Origin of the Solar System.*

By Professor A. W. Bickerton.

[*Read before the Philosophical Institute of Canterbury* 5th *August*, 1880.]

The order displayed in the structure of the Solar System strongly suggests the idea that it must have originated in some single event. Laplace has calculated that the probability of such a system having originated in a common cause, is not less than four millions to one. It is evident, therefore, that its origin is a legitimate subject for scientific speculation, and in order to account for the peculiarities of the motions of the planets and satellites, Laplace himself suggested the now well known hypothesis of the release of nebular rings and their subsequent coalescence. This theory has found many supporters, but when it is examined in the light of the doctrine of the conservation of energy and the dynamical theory of gases, so many difficulties present themselves as to throw great doubt upon it, in fact, as Denison says, it has been so little accepted by English mathematicians that it has scarcely been discussed, and Faye has recently given his opinion that it must be given up. A modification of the theory is offered in Newcombe's "Astronomy,"—it is that the release of rings commenced on the inside.

I hope to examine a number of the difficulties of these theories in a future paper. Proctor has discussed the probability of the system having been formed by the coalescence of an immense number of meteorites, and to this hypothesis there appear to be fewer objections than to the other two. In fact it is highly probable that such an action has aided materially in giving symmetry to the system. But as the sole agent in the formation of the solar system these suggestions have two great objections:—the extreme slowness of the sun's present rotation; and the irregularities in the system, such as the eccentricity of the orbits, the inclinations of the axes and orbital planes, and retrograde motions. It cannot therefore be considered that a satisfactory solution of the problem has been given, and it is probable from its extreme difficulty, that nothing but a nearer and nearer approximation is to be expected. It is this opinion that must be my apology for bringing before the society the somewhat crude suggestions of this paper.

Each of the hypotheses already mentioned assumes a previously existing rotating mass, extending beyond the orbit of Neptune. The papers already before the society distinctly show that a tangential collision between two cosmical bodies could certainly develope such a mass. A paper now in preparation on the origin of cosmical rotation is intended to exhibit some of these points more clearly, so that should future investigation ever reconcile the present difficulties of either of the above theories and cause their ultimate acceptance, there will still remain a probability that the original rotating mass was produced by the "partial impact" of two cosmical bodies.

The common direction of all the planets in their orbits, and the common direction of rotation of most of them, and the slight inclination of their orbital plane, unmistakeably point to a common origin of the sun and planets; while the eccentricity of the orbits, the slight difference of the orbital planes, the inclination of the axes and of the orbital planes of their satellites, and the retrogade motion of some, all point to some independent specific structure for each planet due to motions and structure existing before the common constructive agent had become effective, and not unlikely independent of that cause.

At the present stage of the enquiry there appear to be only two varieties of impact which do not possess insuperable objections, the most probable being that the solar system was formed by a moderately complete impact, and subsequent entire coalescence, of two very rare bodies possessing considerable proper motion, each of which had rotating around it in varied azimuths a number of bodies such as constitute the zodiacal light; but among them were some of planetary dimensions. It is not difficult to show how such bodies themselves may have originated.

This impact may have resulted in the whole of the two bodies spreading out into a large disk-shaped rotating nebula, ultimately extending beyond Neptune, with the separate bodies revolving around and through it. It is evident that any body revolving around another has a higher kinetic energy than an equal mass of the central body, as it has the energy of the general motion and also that of its revolution in its orbit, consequently, during impact, these bodies will pass away in advance of the nebula; but, on return, will be subject to all the agents tending to render the orbit circular that are discussed in the last paper.

It will be easily seen that supposing the satellites were originally revolving around the two bodies in all planes, at the impact the motion developed by the mutual attraction of the two bodies would be so large a component of the whole, and would always be in one plane, that the orbital planes could not be inclined at any considerable angles to each other. Apparently the next most probable suggestion is the entire escape of the non-colliding parts, and the formation of a spindle-shaped nebula. On investigating the motions of the ends of those spindle-shaped nebulæ which must often result from partial impact, it appears that the very unequal velocities of their two sides may develope centres of rotation, and these rotating masses from the end of the spindle will be generally the coolest, and composed of the densest elements. They may, therefore, have attractive power enough to keep together, and finally coalesce into planets.

It is not probable that either one or both of the non-colliding parts passed away from the central mass and returned. There are two reasons against this supposition; first, it appears very unlikely that the orbits of the planets would be so nearly circular as they are, and, secondly, it appears extremely likely that a double sun would have been formed had this been the case. In both the above suggestions of the origin of the planets the original rotation of the two colliding bodies, and also that of any body revolving around them before the collision, will tend to give an irregularity to the plane of the planets' orbits, and also to their axis of rotation; but the extreme inclination of the axis of Mercury and Venus, and the retrogade motion of Uranus, appear only explicable on the assumption that these bodies were independent satellites existing as such before the impact which gave birth to our system. Further research may, however, show that the original rotation of the colliding bodies may be sufficient to account for all irregularities.

Discussion of difficulties that have been met with in working out this theory.

One of the earliest which presented itself was the possibility of escape of the two original bodies. Many explanations have, however, suggested themselves, and it is now seen that such escape was non-essential. Any particle situated at the surface of the sun requires a velocity of 378 miles a second to escape the sun. Any mass, no matter how great, supposing its centre were situated at the same position, would require the same velocity. Supposing the sun had been formed by partial impact, it would have exerted an additional retarding influence, equal to three-fourths of its mass, upon the two retreating parts, greater than they exerted on each other in approach. The whole of this enormous energy must have been original proper motion.

Although it is not unlikely that originally the motion of the stars was much faster than at present, yet it is altogether unlikely they had a velocity of 300 miles a second. We must therefore look elsewhere for a solution, and the only one which has at present offered itself is that the distance of the centres of the bodies at impact was much greater than the radius of the sun. A considerable distance may be due to two causes—first, the volume of the two bodies ; and, second, the amount of distortion into an egg-shape, at and previous to the impact. The former may be due to rareness, or to great mass. These two actions may have caused the centres to be many times the sun's present radius distant from each other. This distance may be sufficient to bring the original energy required for escape down to a reasonably proper motion. But, explained in any way, the increased attraction after impact is a serious difficulty in conceiving of the escape of the parts of the original bodies.

The most serious objection to the suggestion of the planets having been formed from parts of the general mass of the original bodies is that the temperature would be so very high as apparently to prevent such small bodies as the planets being kept together by their mutual gravitation. This action is fully discussed in treating of the origin of planetary nebulæ. In accounting for planetary nebulæ with nuclei, the germ of the present discussion will also be found. Planetary nebulæ without nuclei may be caused by only outer parts of bodies colliding. Those parts of the original body that come into impact and retain the highest velocity after impact consist largely of the matter originally near the centre of the original mass.

Reasons have been advanced for supposing that the centre of bodies consists of the heaviest molecules, when the temperature becomes uniform. With such a mass these heavy molecules will, of course, have far less velocity than the light molecules. The escape of these light molecules from the mass will very probably take away a far larger proportion of the total energy than the proportion of their own mass to the total mass, thus leaving the attraction much more effective upon the heavy molecules. Again, when the mass has expanded considerably it may have cooled sufficiently to allow chemical union to take place, with the development of still heavier molecules, and certainly a partial destruction of the original molecular motion, and a development of atomic motion, which almost certainly gives rise to radiation. Consequently much of the energy of their union will be generally lost as radiant energy.

The ordinary principles of radiation tell us that the mass, as a whole, also will gradually lose energy during the impact and immediately after. I need not say that I have already suggested this to account for the extra brilliancy of temporary stars. The formation of these compound molecules would result in a number of small aggregations throughout the mass, and would tend to prevent dissipation into space.

Thus there are four influences at work which tend to prevent the complete dissipation of highly heated masses. 1st. Loss of heat by radiation.

2nd. Loss of energy by selective escape. 3rd. The formation of compound molecules, and 4th. The aggregation of molecules into liquid and solid particles. The extreme density of the smaller planets gives some probability to this theory of their origin. But even had they existed as independent bodies previously to the impact, there is but little doubt that the tendency to exchange of molecules, which I discussed in my last paper, would cause the nearer planets to consist almost entirely of the very heavy molecules. It is extremely probable that the atmosphere, and not unlikely the water, was picked up from the contracting nebular sun, as it gradually shrank within the orbit of the planet.

The slowness of the rotation of the inner planets as well as their density, compared with the outer planets, may also be accounted for by the much greater resistance that the inner part of the nebula would offer to their rotation, as well as to the much greater time that must elapse before the nebula shrunk within their orbit.

Mr. Cherrill's suggestion—that each of the two sets of planets may have been parts of either original body—is worth remembering. Another very serious objection to this theory of the origin of the planets is the order of the distances of the planets (Bode's Law); but this has been shown to be a very empirical and imperfect law. There are some agencies which have suggested themselves to account for it as it now stands,—one is the rotation of apsides. If we accept what is probably the case,—that, after the first revolution of the planets, their orbits had become so circular that the aphelion of the inferior did not extend much beyond the perihelion of the next superior; it appears reasonable to suppose that if the planet's apsides rotated, it would gradually tend to pick up any bodies which were revolving within those limits. This action would tend to cause the various planes of the orbits to coalesce; to render the orbits more circular; and to lessen the inclination of the axes. It might also tend to increase the rate of rotation, consequently we may imagine, as suggested in last paper, that Jupiter has been very active in this collecting action. It is certain that the apsides would rotate, for all the resistance of the nebula except that exactly at perihelion would have this effect, in addition to bringing the body nearer the sun. This rotation of apsides of more elliptical orbits therefore appears to offer a hint of the order of distance of the planets.

There are other points which have been suggested before, but which have not become more mature than when first suggested. The origin of the moons is another serious difficulty. It is possible that when the planets were in a half nebulous condition, these may have had their nuclei formed by bodies which the planet picked up in its collecting action during apsidal rotation.

Molecular exchange, resistance, and its collecting power, may have rendered its orbit circular, and have brought it into the plane of the planet's rotation. There seem no strong reasons, such as irregularity, etc., why Proctor's theory might not account for the formation of the moons. Another objection to this theory is the fact that there are comparatively few small bodies still travelling the system. There are, of course, a countless number of such bodies, but not so many as might be expected. The nebula would cause the bulk of the small bodies, except moons, to be absorbed into the sun; and the same action may have cleared the space about the planets of all matter except the satellites.

The motion of the sun and its system in space may be accounted for in so many different ways, and does not appear to offer any difficulties to any theory, that I shall not discuss it.

Recapitulation.

I recapitulate the more important of the points in what at present seems the most probable origin of the solar system.

Two rare bodies, moving with considerable velocity, rotating, and having revolving around them in all planes a large number of bodies, some of a large size, come within each others attraction, are brought together by gravitation, and come into tangential collision. During the collision most of the accompanying bodies fly off in directions which are approximately in one plane; the component of the motion not in the plane being due to their original orbital rotation. The new orbit of all the bodies tends to be highly eccentric, but the general mass expands, and by its agency the orbit becomes nearly circular. Among the vast number of bodies thrown off during impact, the larger gradually collect the lesser up, also much of the matter that coalesces from the nebula, and many heavy molecules. Where this action is very considerable, the original mass forms so small a fraction of the final planet, that its original irregular motion almost disappears, and its axis is almost rendered perpendicular. The nebular resistance will tend to lessen the distance of the smaller bodies, and convert them into zodiacal light, or absorb them entirely into the sun, except the moons, which cannot escape the planet's attraction. All the smaller planets and those nearer the sun are robbed of their lighter molecules, and become very dense compared to the general mass of the system, but, as the nebulæ contract within their orbit, they again pick up the lighter molecules which become the atmosphere.

Art. XV.—*On the Origin of Double Stars.*

By Professor A. W. Bickerton.

[*Read before the Philosophical Institute of Canterbury, 5th August,* 1880.]

Plate IIa.

In the former general papers on Partial Impact the probable formation of double stars by its means has been referred to with increasing emphasis. In the present maturing state of theory, probably, if we except temporary stars and some nebulæ, there is no phenomenon that receives such an absolutely satisfactory explanation as does the origin of associated binaries. There are three possible explanations of the origin of double stars. 1st. They may have been associated at the birth of the visible Universe, either as stars or nebulæ which afterwards condensed. 2nd. It is possible when three stars approach comparatively near each other, that by their mutual attraction one may have its proper motion increased at the expense of the other two. These latter may by their lessened motion become an associated pair. 3rd. A partial impact, in which the coalesced part is neither so small as to allow of escape of the non-colliding parts, nor so large as to produce complete coalescence. Between these two extremes all impacts must produce bodies free of each other, but associated by gravitation. This "partial impact" may have taken place when the two stars were in a nebulous state, and they may have coalesced into stars since; the reasoning which applies to stellar, also applies to nebular impacts, but is not capable of such complete demonstration.

It is the origin of binaries by impact that is studied in this paper, and I believe it will ultimately be found to account for nine-tenths of the double stars.* In all partial impacts, as above limited, the collision is attended with the formation of a central gaseous mass expanding into a nebula, and two parts which pass on,—these parts in this case form the pair of binaries under discussion. Recent criticism has shown it necessary to again most emphatically call attention to the fact that in such cosmical collisions there is no loss of momentum in the portion of the bodies that is not in actual collision, except that due to the work of sheering, and this I shall show to be insignificant.

The coalesced part will, however, exercise an increased attraction, which will prevent the non-colliding parts from attaining their former proper

* Mr. Croll in a foot-note to his paper on the origin of the sun's heat, calls attention to a paper by Mr. Johnson Stoney, in which he states that double stars may be due to a partial entanglement of two colliding stars.

motion in space, and may, in extreme cases, prevent their escaping the mass at all. It is this increased attraction after impact that is the force which causes the two bodies to become associated.

The following three lines of reasoning show how insignificant is the work of sheering compared to the available energy. It is known that a cannon ball, with a velocity of less than 2,000 feet per second, is capable of penetrating a plate of iron its own thickness. Now the velocity at impact of two suns is at least 200 miles per second, or an energy in equal mass of over 200,000 times as great as the cannon ball, but as the size increases the ratio of volume to section increases also ; in fact, it is in the ratio of the diameter, for the section varies as the square, and the volume as the cube, of the diameter. So that were the density alike, its ratio would be about a thousand million times as great in a sun as a cannon ball, or the available energy is at least one hundred million of million times greater than required for sheering were both as hard as iron.

It has already been suggested that sheering force has its limits in the latent heat of fusion ; this is probably the amount of energy required to separate the molecules from their fixed positions, but, in sheering, the molecules require only to be separated in a single plane,—an insignificant fraction of the whole in such a body as a cannon ball, and in a cosmical body so insignificant a fraction as to be disregarded.

But, even supposing it were required to separate all the molecules instead of those of a single plane, it has been shown that the energy required to do so is such an insignificant fraction of the whole as to be disregarded. In dealing with impacts of bodies such as our sun, if the body be liquid or gaseous of course there is no sheering force, and as in all of the collisions of the bodies under discussion the energy is incomparably greater than that necessary to volatilize the colliding parts, there is actually no sheering force to prevent the escape of the other parts.

From these several lines of reasoning it is evident that sheering force may be absolutely disregarded, and that there is nothing in the impact itself tending to destroy momentum in the non-colliding parts. The ratio that is required to be cut off in order for the stars to become associated depends largely upon the proper motion possessed by the original bodies.

If we take two such bodies as the sun as an illustration, their small proper motion would allow them to become associated if as small a part as one-thousandth were struck off each. In this case, however, the pair would move in orbits so highly eccentric as to almost, if not quite, graze at their perihelion. If they struck off any ratio above this up to about one-half, it is probable that they would still form binaries with increasingly circular orbits, but this problem is so much influenced by the distortion of the bodies as to be incapable of an accurate solution. This ratio is certainly not far from the truth.

Some cosmical bodies, such as 1830 Groombridge, could not form binaries by impact, for were two such bodies to come into about complete collision, the parts not colliding would possess so much energy that they must escape the total attraction, and could by no means become an associated pair. Such a collision might, of course, form a pair of variables travelling away from each other, and there are many examples of such to be found in the heavens. It is even probable that, were they to completely collide, the heat would be so great that every molecule would escape the attraction of the mass and diffuse itself into space, thus producing a brilliant temporary star.

On the other hand, a colliding pair of stars, without original proper motion, must become associated no matter how small a part might be struck off each. If the amount cut off be so great that the non-colliding parts cannot escape the general mass, an annular nebula may be formed; or, if the impact be nearly complete, the two may form a star with a diameter only a small multiple of the original stars. Calculation has shown that it must be at least the sum of the original diameters.

Without proper motion it would appear that the chance of a binary being formed to that of coalescence is about four to one; but, as this is influenced by the amount of distortion before and during impact, and also by the density, it is impossible to calculate it accurately. With proper motion, and all stars appear to have more or less of this, the ratio becomes larger, so that, taking all impacts not cosmically insignificant into consideration, it is probable that something like a fourth are attended by escape of the non-colliding parts, about a sixth coalesce entirely, and the remainder form binary or multiple stars, associated by gravitation. The history of such a pair appears to be roughly represented by the following illustration:—

Suppose two equal stars with normal proper motion to come into partial impact and strike off a fourth of each; these two parts will coalesce and form a nebula. This coalesced part will exercise a large additional attractive power upon the retreating parts, and would associate the pair. For in order that the parts shall escape, the stars would have required approximately a proper motion equal in energy to three-quarters of the energy that a similar body would require to escape the independent attraction of the central body. And this is certainly enormously above a normal proper motion. Immediately after impact the associated pair will tend to move in highly eccentric elliptical orbits.

The extremely high temperature of the central body will make a temporary star of it, and although a nucleus consisting of the heavier atoms may remain, yet most of the body will dissipate into space, or become an extremely rare nebula. I have shown in my paper "On Causes tending to alter the Eccentricity of Orbits,"* that this will certainly render the orbits more circular; although of course they may be left in their final state as a very long ellipse. The nebula will doubtless be gradually absorbed by the two stars, and as this absorption will be chiefly at perihelion, it will tend to make the orbit still more circular. What will become of the nucleus of the coalesced part itself is a difficult problem; not improbably it would become associated with one of the two stars in a highly elliptical orbit—making a triple star; or it may be drawn out into long trains by the unequal attraction its opposite sides would be subject to each time the stars passed near it, and finally be absorbed by the two stars.

The accompanying diagram (Plate IIa.) is intended to represent the several stages of the formation of such a pair of binaries. A and B represent the two stars at a distance. They describe the hyperbolic orbit represented, and if the bodies were in all respects the same, except that the volume was so small as to allow them to escape without collision, then they would pass away in a curve, represented by the dotted curve on the other side of the axis. If we suppose them to come into collision, and the middle piece to exercise such an additional attraction that the new orbit is represented by the long semi-ellipse,—then, on their return to the centre, instead of passing to P' it passes to p, its permanent perihelion, owing to matter passing outside its orbit and lessening the central attraction. On its several passages through perihelion it suffers resistance, and is brought to $a'a'$. After thus being retarded an indefinite number of times, it finally takes up the orbit represented by the thick line.

Of course, the centre of gravity of such a pair may have a motion of its own, and, doubtless, during the actions here illustrated, apsides would rotate; but, as such rotation is quite unimportant in accounting for the final orbit, the diagram is not complicated with its illustration.

It is probable that for many years after birth the two stars would be variable, as it is evident that the side from which the central mass was struck must be very much the hottest. Struve has discovered that more than a score of double stars are variable, and a very large number more are suspected of variability. The occasional variability of binaries seemed to be so certain on this theory of their origin that I was searching more than a year for evidence of their variability. Finally, my attention was called by the late Dr. Powell to a paper in the "Intellectual Observer" for 1862, in which I obtained this information. Assuming this theory to be right, these variable doubles are recently associated—probably they have not been

* See Art. XIII.

so more than a thousand years or so; for, cosmically, the variability of a star is a mere transitory state, as it appears certain that irregularities of surface temperature must ultimately right themselves, although it is singular what a number of phenomena seem to tend in the direction of keeping a star that has been unequally heated by partial impact from having its uniform temperature restored. This matter is fully discussed in a paper in preparation on variable stars. Many doubles are coloured. I shall show in the same paper that in all probability the final state of variability in a star is a metallic absorbing atmosphere producing a coloured star; so that coloured doubles are probably the next youngest pair to the variable binaries. But although the variability of a star is a temporary state, their association with each other is not so. After having once absorbed the nebula their orbit is fixed, nothing but another impact can separate them and that is more likely to make a multiple star of them.

The final coalescence of the visible Universe will only weld them into the general mass. It is not wonderful therefore that some 10,000 such pairs exist in the Universe. The fact that there are so few speaks to us in powerful language, telling us that the Universe is not so old as we have pictured it to be—that the first day is scarcely over in proportion to the time before its final coalescence. Without doubt this Universe is quite a new member of the Cosmos, of which it is not improbably as a mere drop in an ocean.

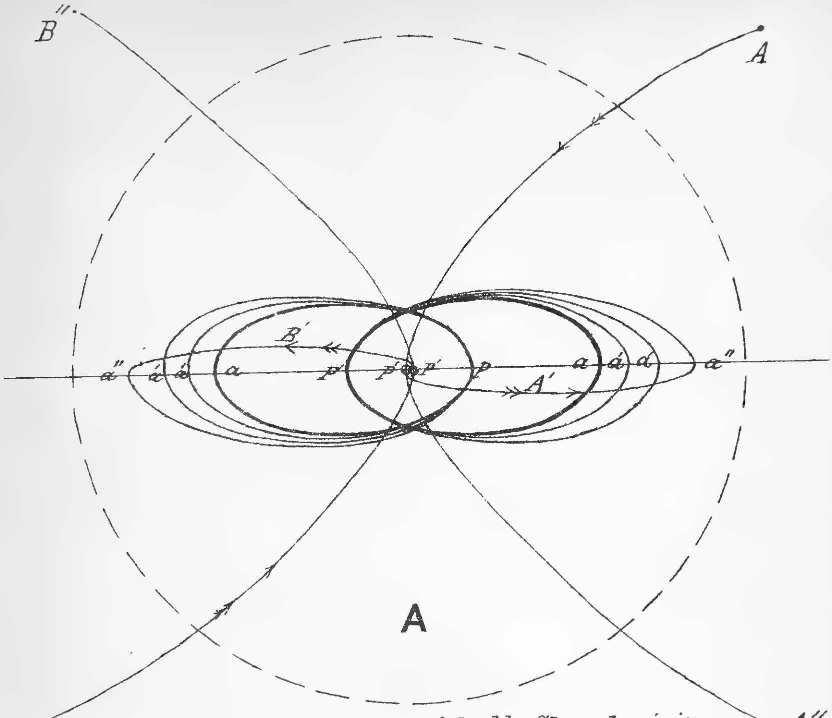
Art. XVI.—*On a simple Method of illustrating the Motions of the Earth.*

By Professor A. W. Bickerton.

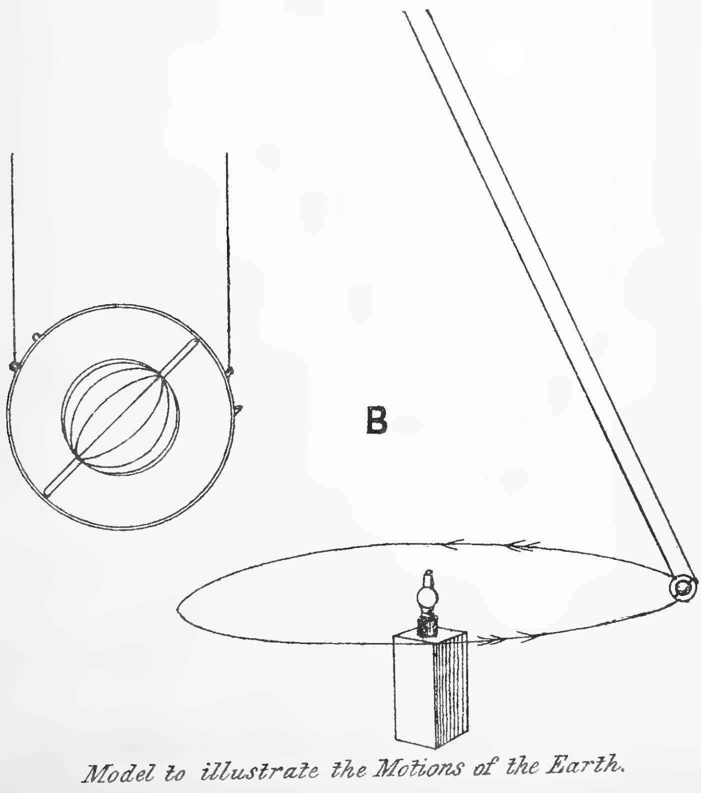
[*Read before the Philosophical Institute of Canterbury, 2nd September*, 1880.]

Plate IIb.

This model is one of the extempore pieces of apparatus that I designed for the purpose of illustrating a course of experimental lectures, which were delivered with the special object of showing that many of the most important of physical phenomena might be illustrated by apparatus at a cost not exceeding a few pounds. The model itself cost less than a shilling, and I made it in about half-an-hour. Since it was made I have found it useful to illustrate so large a number of cosmical phenomena that I thought it of sufficient importance to bring before the Institute. A much larger number of phenomena may be illustrated by its means than by the expensive models usually sold for the purpose. Among these are day and



Sketch representing orbit of double Star at origin.



Model to illustrate the Motions of the Earth.

night, seasons, the solstices, and equinoxes and the precession of equinoxes, eccentricity of orbits, the lines of the globe, etc. It has also the advantage over the ordinary model of possessing nearly all the dynamical peculiarities of the heavenly bodies themselves. It is, as it were, a double pendulum, and so it may easily be made to illustrate the laws of motion, resultant motion, the properties of the pendulum, Foucault's pendulum, and a large number of facts of both the kinetics and kinematics of dynamics. The accompanying diagram (Plate IIB.) represents it on a large scale, and shows it in use. The angle is shown exaggerated.

The model consists of a ball of wood or other material with a thick knitting-needle through it: this represents the earth and its polar axis; the ends of the needle are sprung into two centre punch dents in a light brass ring, the ball thus rotates on the needle as on an axis. This brass ring is hung in a vertical plane in such a manner that the needle makes an angle of 23° to the vertical. There are also other points of suspension for exaggerating the inclination, to render the phenomena more evident. The two cords are attached to the ceiling so as to hang parallel.

On swinging the apparatus as a conical pendulum, the direction of the axis remains all the time parallel to itself. If a lamp be placed in the centre of this cone, and the ball be made to spin, the phenomena of day and night and summer and winter are at once illustrated. The solstices and equinoxes are of course shown with the greatest readiness; the equator, tropics, and polar circle also show themselves, and the peculiarities of polar seasons can, of course, readily be shown. By making the swing of the pendulum an ellipse instead of a circle, and placing the lamp at a focus, the long winter and short summer of great eccentricity are explained. This illustration of the rate of motion during eccentric orbits is, of course, not mathematically accurate. With the apparatus moving in an ellipse it becomes easy to explain the reason why, in the northern hemisphere, the sun is nearer in winter than in summer. By merely spinning the whole model on its two cords, and so twisting them up, the precession of the equinoxes is readily understood.

By these two experiments it is easy to render Croll's theory of glaciation intelligible, by taking a card to represent the moon's orbit to the plane of the ecliptic the causes of the lunar and solar eclipses and their cycles are rendered intelligible. The whole of the motions being due to inertia, and the centrifugal point being the centre of the circle, we have a true central force acting on the body. Thus planetary dynamics is almost exactly represented.

By taking off the ring and hanging two similar balls the exact isocranism of equal length pendulums may be shown, and this may be amplified by having the oscillations of one small and the other large. By hanging two balls of equal volume and different mass, the oscillations of the lighter will be destroyed much quicker than those of the heavier one; thus illustrating the greater power to do work possessed by the heavy body, as the resistance of the air is the same in both cases.

A large number of experiments of resultant motion may be proved by first showing the isocranism of all lengths of vibrations, and then striking the moving pendulum when at its several points of motion. These form a most instructive series of experiments. The conversion of circular into straight, and straight into circular, elliptical, and diagonal motion, is of course very easily illustrated.

As is well known, the peculiarities of kinetic and potential energy are better shown to a class by a pendulum, than probably by any other method.

Art. XVII.—*Probability of Impact.* By Professor A. W. Bickerton.

[*Read before the Philosophical Institute of Canterbury, 4th November*, 1880.]

The remarks made by several members show that the general statement as to the improbability of stellar impact which Proctor made in his lecture, but which was specially directed against Croll's theory of the origin of the sun's heat, are taken also to include tangential impacts. I entirely agree with Proctor in his opinion of Croll's hypothesis, and in 1878 I wrote a letter to "Nature," showing it to be in the highest degree improbable. It requires the stupendously unlikely event that two equal bodies, when at the limits of effective attraction, are directly approaching each other with a velocity of 250 miles a second. Those who have followed the reasoning in connection with "Partial Impact," must see how amazing is the gulf that separates the two suggestions.

Even if such an impact as Croll suggests were probable, such an event would not assist in removing the difficulty of the age of the sun's heat, for in my paper on "The Origin of Nebulæ," I have shown that a nebula must be dissipated into space if it possesses more energy than that possessed by infinitely diffused gaseous matter. Therefore, if at impact the sun received so much heat that it made a nebula hotter than would be the case if it had condensed from diffused gas, then such a nebula would tend to dissipate rather than condense. On the contrary the hypothesis given by Proctor, that the sun is highly condensed in the centre, affords so satisfactory an explanation to me, that when I read the article suggesting this theory I at once accepted it. It is also evident to any one who understands my theory of "selective escape," that to be denser in the centre than at the outside is an absolutely necessary condition of any body largely gaseous, and consisting of a mixture of molecules of varying weight.

I shall now attempt to show that although the kind of impact Croll suggests may well be considered improbable, yet the grazing impacts discussed in my papers are not only not improbable, but that evidence actually demonstrates their occurrence. But it must not be supposed that my theory suggests that even partial impacts between bodies of true stellar mass of our own Universe are frequent events. The present evidence appears to show that, out of the tens of thousands of millions of stars that stud our galaxy, only one or two graze each other sufficiently to produce a temporary star in a hundred years.

Proctor has, in my opinion, incontestably shown that the stars cluster much more thickly in the Milky Way than in the other parts of the heavens. Although these stars are mere points to us, yet we must not forget they are suns; and it is almost certain that hundreds among them have disks many thousand times larger than our earth.

These stars are all moving almost indiscriminately, with perhaps an average velocity of twenty miles a second; yet the space separating them is so large, compared with their dimensions, that in a finite portion of time it is improbable that any two approach each other in a straight line and come into direct impact, for if two stars are not approaching each other directly gravitation can never make them do so. It is quite otherwise with a graze; it is probable that gravitation increases a hundredfold the probability of partial impact among bodies of very great mass compared with the chance there would be from direct motion alone.

Supposing the average velocity of stars to be twenty miles a second, and a body with such independent energy to approach Sirius and graze its surface,—the energy developed by its attraction will be many thousand times its indedendent energy, unless the density of Sirius is incomparably less than that of our sun; and if this were the case its volume would be so great that the chance of impact would be much increased.

This furnishes a striking illustration of how enormously the deflection due to gravitation will increase the probability of a grazing impact between large cosmical bodies. It must be remembered that the probability of impact is not simply proportional to the deflection but is directly as its square.

It is impossible by the most careful watching to avoid collisions between vessels on mid-ocean, but how much would the probability be increased if all the ships that travel the Atlantic were steered by blind men, and if each attracted another approaching near with such force that their own independent motion was nothing to that developed by the pull!

Moreover, just as where the ships are most thickly spread we should find most wreckage, so in the thickly strewn galaxy we find nearly all the phenomena which tangential collision may be shown to be capable of producing.

But even without the influence of gravitation, the indiscriminate motion, the vast size, and countless number of the stars, must result in occasional collisions. Let us examine the case of the molecules of a gas as an analogy.

The velocity of a gaseous molecule at ordinary temperature is nothing to the stellar velocity, and the space occupied by the molecules in a good vacuum is many million times less than the volume of the molecules, yet spectrum analysis shows that such molecules are in incessant impact, and there is practically no gravitation. The explosion of a large vessel of oxygen and hydrogen appears instantaneous, yet each molecule of hydrogen and each of oxygen must find the other in their excursions during the duration of the explosion. Newcombe compares the motion of the stars with the dance of the molecules, and surely if the impacts are so inconceivable in number in the one case, they may sometimes happen in the other. As though to make the analogy stronger, the case of chemical mutual exchange may be considered a kind of molecular partial impact.

To repeat an argument I have used before, cosmical impact is actually in constant occurrence. Every meteorite that strikes the earth is an instance of it, and what occurs on a small scale must surely be expected on a larger, but is of course of rarer occurrence. But supposing our present knowledge, instead of rendering it highly probable (as it is thus seen that it does) that partial impact occurs, made it instead appear improbable, then the vast number of celestial phenomena which receive a perfectly scientific explanation by partial impact—and are so utterly inexplicable on any other theory that positively no explanation exists—furnish such remarkable evidence of these impacts that their apparent improbability would have to be set down to our imperfect knowledge rather than to any improbability in fact.

Thus it is apparent that though Croll's idea of a direct impact may be highly improbable, and if it occurred could not possibly explain his difficulty, yet tangential collision—whose phenomena have been described under the title of "partial impact"—is both in itself probable, and is known to be constantly occurring on the small scale. Therefore, when this consideration is combined with the amazing mass of evidence the phenomena of the heavens offer, the probability of such impact is erected into a position as near certainty as it is probable that human knowledge can attain. But if Proctor means that all impacts are improbable, he does not seem to me to be logically consistent, for his idea of the Universe is that it is eternal, while the life of a sun is, to him, distinctly finite. The number of the finite in infinity is infinity, therefore what a vast cemetery of dead suns our Universe must be if there is no resurrection.

If the chances are as small as supposed—that a million million bright suns are rushing about and pulling each other, and never clash—surely among the inconceivable multitude of the extinct suns that an eternity must thus have sown broadcast, beaconless, and blindly wandering, the chances are not hopelessly small that their ceaseless attractions and never-ending journeys may sometimes make them clash together, and thus receive the Promethean spark that would cause their inert mass to become once more suns instinct with life and beauty.

Without "partial impact" every attempt to conceive of an eternal Cosmos appears to lose itself in vague cloudy words, while the conception that flows from this idea is as clear and sharp as a rock at noonday.

Although it may be a splendid poetic achievement to talk of a Cosmos of which dead suns are to form the constituent atoms, it is quite another thing to conceive of one. Surely if the present order can be intelligibly and scientifically shown to be a possible phase of an eternal rhythm, as it certainly can be, whatever such a cosmic philosophy may lack in poetic fancy is compensated by intellectual satisfaction.

II.—ZOOLOGY.

Art. XVIII.—*Notes on* Balænoptera rostrata, *Fabricius*, (B. huttoni, *Gray*).

By Professor Julius von Haast, Ph.D., F.R.S., Director of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 30th December*, 1880.]

Plate III.

On the 7th February of this year the information reached me that in the early morning a whale had been stranded on the Sumner beach, and that it had been taken possession of by Mr. Joseph Day, of that place. Proceeding without delay to that locality, I found the animal in question to be a male specimen of the small pike whale (*Balænoptera huttoni*, Gray) twenty-three feet four inches long, and of which a skeleton is in the British Museum. The animal had died only a short time before, and was consequently quite fresh; and, as the greatest care had been taken to preserve it from injury, a welcome opportunity was offered to me to make a careful description on the spot, and to take the necessary measurements. The whale was almost lying on its back, so that the extensile bag formed by the plaits at the throat and upper portion of the breast had fallen in, the animal thus appearing remarkably flat-headed—in fact, the head reminded one, when the large mouth was shut, of that of a huge reptile. The plaits counted across amounted to sixty-four.

Those in and towards the centre began only at a distance of about one foot from the top of the lower jaw, while the others reached close to its sides, ending in the same manner on the lower chest. The side plaits were continuous, thus differing from those of the centre, which were interrupted two or three times, with short intervals between them.

Colour.—Back, dorsal fin, and sides, slaty-black; breast, throat, and belly, white. The black colour advances considerably near the shoulder upon the throat, then retreats again, and the white colour advances up the side so as to surround the base of the pectoral fin, of which the lower portion is also of a clear blueish-white tinge, the effect of which is still more heightened by the black terminating on it in beautiful fringe-like patterns in distinct designs, and ranging between bright and dark slaty-black.

Immediately above the caudal fin the white disappears, and the lower surface assumes a dark greyish colour.

The centre of the caudal fin is, however, white, both sides and the posterior edge being slaty-black, and the same remarkable patterns, having sometimes the form of a wave toppling over, form the boundary between both colours.

The contrast between the black and the milky-white, and the cloud-like appearance of some of the marks in bright violet upon the latter is very striking.

Tongue, bright violet; lower portion of mouth, violet. Palate, near tip of snout slaty-black, gradually getting lighter and changing to violet.

Form.—Our New Zealand specimen agrees so closely with the description of the form of *Balænoptera rostrata* from the northern hemisphere, that I have no doubt, after comparing also the skeletons, that our small New Zealand pike whale is identical with the northern species, and that therefore the generic distinction as given by Gray has to be abandoned. I shall therefore not transcribe my notes as to its general appearance, nor add a drawing of the Sumner specimen, as this has been done by others, including Prof. F. W. Hutton, who has published a drawing of a small specimen (of the length of 16 feet 2½ inches, taken in October, 1873, off Otago Heads) in the Annals and Magazine of Natural History.*

I was informed that the specimen under consideration showed marks of having been wounded all over and probably driven ashore by a swordfish, but on examination I did not find that any of the small fresh wounds upon it could have been inflicted by such an animal.

All the wounds of fresh appearance were roundish, and only about half an inch in diameter and of no depth, being all near the lower portion.

However, there were a considerable number of scars on different parts of the body, some of them three inches long and two inches broad, having also a continuous line of a more pronounced scar along the centre, which might be attributed to a *Histiophorus*.

MEASUREMENTS.

	Ft.	in.
Total length in a straight line	23	4
Length of gape	4	10
From tip of snout to anterior corner of eye	4	1
Eye, longitudinal diameter	0	2½
„ vertical „	0	1
From tip of snout to base of pectoral fin	7	8

* "Ann. and Mag. Nat. Hist.," ser. 4, vol. XIII., pl. xvi.

	Ft.	in.
Length of pectoral fin measured along lower edge	2	7
Greatest breadth of pectoral fin	0	11½
From centre of caudal flipper to posterior margin of dorsal fin	6	0
Length of dorsal fin at base	1	8
Height ,, ,, ...	1	11
Breadth ,, ,, ...	0	6
From centre of caudal flipper to posterior end of vent ..	5	11½
Length of vent	0	6
Interspace between vent and orifice of the prepucium ..	0	7
Length of orifice of prepucium	1	4
Length of two testal folds. (The two testal folds lie about 11 in. from the lower end of the former.)	0	5½
From centre of caudal flipper to beginning of plaits ..	11	3
From tip of snout to the blowholes	2	11
Length of blowholes	0	7
Length of depression or furrow between blowholes ..	0	9
Distance of blowholes from each other at anterior end ..	0	1
,, ,, ,, posterior end ..	0	4½
Greatest circumference 13 feet from notch of caudal flipper*	10	10

Skeleton.—Although further on I shall give a few particulars of the skeleton under review, in order to contribute towards the better knowledge of this interesting species, I have to observe that when comparing it with the figure of *Balænoptera rostrata* in the "Ostéographie des Cétacés," plates XII. and XIII., I could not find the least difference in its general characteristic features. This became still more striking when I compared the measurements of the parts of our skeleton with those given in the publication of the Ray Society at page 273, of a young female with loose vertebral epiphyses.

As the Sumner skeleton, in which the vertebral epiphyses are also still unanchylosed, is only two inches smaller, I have thought it more convenient and instructive to give, in the following table, the measurements of the principal parts, to show how very closely they agree with each other.

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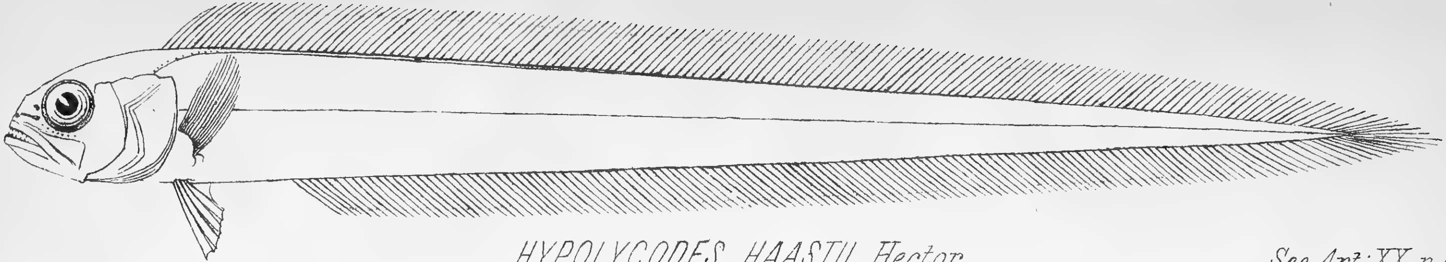
* This measurement is only approximate, as owing to the heavy weight it was impossible to pass the tape quite round, so that only one half of the circumference of the body has been measured as correctly as possible.

Professor Hutton gives the greatest circumference of the Otago specimen as ten feet. In comparing the two drawings the Sumner specimen appears to be far more slender than the former. In some respects age, and most probably the beginning of decomposition of the Otago specimen, may have something to do with its having a more robust appearance.

COMPARATIVE MEASUREMENTS of the skeletons and their parts of *Balænoptera rostrata*, Fabricius, from Bergen (Norway) and Sumner (New Zealand) :—

	Bergen skeleton. ft.	Bergen skeleton. in.	Sumner skeleton. ft.	Sumner skeleton. in.
Length of skeleton in a straight line	23	0	22	10
,, skull ,, ,,	5	$2\frac{1}{2}$	5	$2\frac{1}{2}$
Width of skull across temporal bones	2	$11\frac{3}{8}$	2	$8\frac{1}{2}$
,, beak at the base	1	9	1	$9\frac{1}{2}$
,, ,, ,, middle	1	$1\frac{1}{4}$	1	2
Length of ,, ,, ,,	3	$4\frac{3}{4}$	3	$4\frac{1}{2}$
,, one lower jawbone along the curve on the outer side	5	$5\frac{3}{8}$	5	$4\frac{3}{4}$
Circumference of lower jawbone at the middle	1	0	0	$11\frac{1}{2}$
Length of corpus at atlas	0	2	0	2
Width of atlas across processus transversi	1	0	0	$11\frac{1}{2}$
Length of lateral processes of axis	0	6	0	6
,, corpus of third cervical vertebra	0	$1\frac{1}{8}$	0	1
,, ,, seventh ,, ,,	0	$1\frac{1}{2}$	0	$1\frac{3}{8}$
,, ,, first dorsal ,,	0	$1\frac{3}{4}$	0	$1\frac{3}{4}$
Width of ,, ,, ,,	0	$5\frac{1}{8}$	0	$5\frac{1}{8}$
Length of ,, eleventh dorsal ,,	0	5	0	$4\frac{3}{4}$
,, ,, first lumbosacral vertebra	0	5	0	$4\frac{7}{8}$
,, lateral processus, first ,, ,,	0	$9\frac{1}{2}$	0	$9\frac{1}{4}$
,, corpus of seventh ,, ,,	0	$5\frac{7}{8}$	0	6
,, ,, spinosus of first caudal vertebra	0	$7\frac{1}{4}$	0	7
,, ,, sixth caudal vertebra	0	$6\frac{1}{8}$	0	$6\frac{1}{8}$
,, ,, thirteenth caudal vertebra	0	$1\frac{3}{4}$	0	$1\frac{3}{4}$
,, first ribs along the curve on outer edge	2	$2\frac{3}{8}$	2	2
Width of ,, at lower end	0	$4\frac{1}{8}$	0	$4\frac{1}{2}$
Length of fourth ribs along the curve on outer side	4	0	4	$0\frac{1}{4}$
Width of ,, at lower end	0	2	0	$1\frac{7}{8}$
Length of eleventh ribs along the curve on outer side	2	8	2	$7\frac{7}{8}$
,, shoulder blade	1	2	1	2
Width of ,,	1	$11\frac{1}{2}$	1	11
Length of acromion	0	$5\frac{1}{2}$	0	$5\frac{3}{4}$
,, processus coracoideus	0	$3\frac{1}{2}$	0	$3\frac{1}{4}$
,, os humeri	0	10	0	$9\frac{3}{4}$
,, radius in a straight line	1	5	1	5
,, ulna in a straight line without olecranon	1	$3\frac{1}{4}$	1	$3\frac{1}{4}$
,, ossa pelvis	0	6	0	7
,, the longest baleen	0	$8\frac{1}{4}$	0	$9\frac{1}{2}$
,, sternum	1	$2\frac{1}{4}$	1	$0\frac{3}{4}$
Width of ,,	0	$9\frac{1}{2}$	0	$9\frac{3}{4}$



HYPOLYCODES HAASTII, Hector.

See Art: XX. p. 194.

2. Plate of baleen.

1. Sternum.

BALŒNOPTERA ROSTRATA Fabricus. (B. Huttoni, Gray.)

See Art: XVIII.

The sternum of the Sumner skeleton is somewhat different from the one figured in the "Ostéographie des Cétacés," and I therefore add a figure of the former (Plate III.) from which, it will be observed that that bone is more rounded in its anterior portion, more keeled, but that it resembles in its posterior portion that of *B. robusta*, as figured on page 283 of Lilljeborg's Memoir on the Scandinavian Cetacea in Recent Memoirs on the Cetacea, published by the Ray Society. From the latter it is, however, distinguished in being rounded in its anterior portion.

It has therefore not altogether the form of a Latin cross, according to Van Beneden and Gervais, as observed in other skeletons examined by them. However, as all the other bones show no difference from those of the northern skeletons, we can safely assume that the form of the sternum is not of specific value, and that other skeletons of *B. rostrata* will be obtained in which the sternum will resemble the one under consideration.

Of those portions of the skeleton showing any peculiarity, the cervical vertebræ have to be mentioned, although in the northern skeletons a similar asymmetry has also been observed.

Cervical Vertebræ.

All the seven cervical vertebræ are free. However, as the terminal epiphyses of the body of the vertebræ throughout are still separate, thus proving the animal to be of immature age, we cannot claim this as a specific character for the southern species, as Dr. Gray has done.

In fact, according to Dr. Hector, the second and the third cervicals in Gray's type specimen in the British Museum show marks of adhesion, and specimens of these vertebræ in the Colonial Museum are as firmly anchylosed as in *B. rostrata*.*

Of these cervical vertebræ the axis and the sixth have the two lateral processes on both sides formed into a ring, the extremity of the former being square, and of the latter pointed. The upper transverse process on the left side of the fifth cervical vertebra is as long as that of the sixth, but is not united to the lower process, the latter not reaching within one and three-quarter inches of the extremity of the upper one. On the right side of this fifth cervical they are united and form a ring, the anterior end being thin and more square than that of the sixth. On the seventh the upper transverse process, which is also directed forward and compressed from before backwards, is large, while the lower appears as a small protuberance.

Dorsal Vertebræ.

There are ten dorsal vertebræ.

A similar protuberance (for the parapophysis) exists also in the first dorsal vertebra, of which the diapophysis is still compressed from before

* Hector in "Trans. N.Z. Inst." Vol. X., p. 337.

backwards, but much stouter than that of the preceding seventh cervical. The same process, although short and stout, takes a horizontal position in the second dorsal, getting gradually, as we advance, longer and flatter.

The facets for the attachment of the ten ribs are situated on the posterior side of the diapophyses. These latter processes in the first six dorsals are directed still forward, gradually assuming a straighter position, which is first obtained in the seventh.

Lumbar vertebræ 12
Caudal ,, 18

Their form and dimensions agree so fully with the description of *B. rostrata*, that I need not repeat it here.

There are consequently 48 vertebræ in all.

Chevron bones.

There are ten chevron bones, of which the second is the largest.

They resemble very much in their form those of the skeleton of *B. rostrata* in the "Ostéographie des Cétacés" by Van Beneden and Gervais, plates XII. and XIII., where, however, only eight are figured, although they state that there are nine.

The two last chevron bones of the New Zealand skeleton have the two lateral disc-like parts of which they consist, not united in the mesial line.

They are small, especially the last one between the 10th and 11th caudal, which is only ½ inch long and ¼ inch high.

It was fixed to the cartilage, and did not touch the lower edge of either vertebra.

Baleen.

Owing to the care of Mr. Joseph Day, who has presented this skeleton to the Museum, the baleen remained uninjured, and I was thus able to place it again into its proper position in the skull.

There are 220 plates on each side, of which six to eight form the fringe in front of the nose, uniting both sides.

As I had one of the sides (the right one) photographed, I am thus enabled to offer a faithful representation of this characteristic portion of the skull (Plate III.).

The baleen is white.

The first 150 plates, counting from the posterior end, have generally a black edge gradually shading off towards the middle of the blade on the outer side from the base half-way upwards.

Beginning with a length of about 2 inches at the gape they rapidly increase in size, till, at the 56th from the posterior end, they are 9½ inches long, with a breadth of 3 inches.

After retaining this length for some distance they gradually get shorter, till near the top of the nose they have dwindled to a length of 1½ inches. On the inner side of this principal set of baleen, and close to the palate, a smaller fringe is observable, of which the baleen, where longest, reaches the length of 1½ inch, by a breadth of 1 inch.

This inner fringe is separated by a well-defined line of division from the larger baleen, and shows, at the same time, three or more lines of division, so that the base has quite a reticulated appearance.

That the larger and smaller series are quite distinct from each other is well exhibited on the base, because, although in some parts the line of the large baleen is continued into the inner fringe, in others this is not the case, the inner baleen beginning on the line of division between the baleen plates of the larger series.

Art. XIX.—*Notes on some Specimens of migratory* Salmonidæ.

By W. Arthur, C.E.

[*Read before the Otago Institute, 24th August,* 1880.]

Plates IV. and V.

Before referring specially to the individual specimens I have been able to secure, I may perhaps be permitted to remind you that the study of the Salmonidæ is that of the most difficult and perplexing branch of ichthyology. This is due to the following circumstances:—the close relation between some of the species; the numerous varieties of the same species; the confusion arising from the same fish being differently named in different localities, or erroneously named; and lastly, the want of completeness and precision of description in the writings of many who have undertaken to describe fish.

General remarks on well known species.

To illustrate in a general way the many varieties which occur of the same species, I would direct your attention to the species *S. salar*, *S. trutta*, and *S. fario*, of the British genus *Salmo*.

I have seen individuals of the species *S. salar*—the true salmon—from the Tay, the Tweed, Solway, Clyde and tributaries, Awe, Orchy, Lochy, Ness, Dee (Aberdeenshire); from several English rivers, as the Tyne, Dee, etc., and from the west of Ireland. These were all specifically the same fish, yet possessing individual characteristics sufficient to indicate and distinguish the fish of one river from those of any of the others. For beauty of colouring, symmetry of form, and every good point, the Tay salmon I regard as unsurpassed—he is the king of fishes! The head is well formed, sharp and of moderate size, the lower jaw in the males having a prominent hook; the body full and robust, with arched back and full belly, all covered with a mass of burnished silvery scales, a few black *x*-shaped spots above the lateral line mostly, and the tail broad and square, or slightly emarginate. In weight, too, they excel, having been taken as heavy as 60 and 70 lbs.—while it is a common event to kill 30 lb. salmon in Loch Tay with rod and spinning lures in February or March. I have seen Irish salmon in the London market as high as 56 lbs. in weight, but they were not equal in appearance to the Tay fish, being dull in colour and rather coarse looking.

The salmon of the other Scotch rivers enumerated, I would describe generally as rounder in the head and longer relatively in the body than those of the Tay. Yet none differ so much from the latter in external appearance as the salmon of the Awe and Orchy rivers. When fishing these streams in August or September, I have found the salmon dark in colour and possessing a most extraordinary and characteristic head. The skull or cranium is low, the head elongated, and the snout so much produced as to resemble very much that of a pig! An Awe salmon could be identified anywhere by its head.

The weight of salmon (*S. salar*), other things being equal, appears to have some relation to the latitude and the size of the rivers which it frequents. Thus, for example, the Forth and Tay salmon attain a greater average and maximum weight than those caught in the small rivers of the Hebrides, which run about 7 lbs. and do not exceed 12 lbs. It would seem as if the higher the latitude and smaller the rivers, the smaller the fish.

A good deal of imagination has been indulged in trying to find a function for the hook on the lower jaw of the male fish. It was believed at one time to be used in the excavation of the "ridd" in which the female deposits her spawn. But such is not the case, at all events there is no case on record of the male having been seen so occupied; for many observers have watched the female, and state how they have seen her roll on to her side and lash the water with her tail, and so gradually form the hollow or "ridd" in the gravel, wherein she forthwith deposited her ova. Others again fancied that the hook was the weapon provided by nature for the males to do their fighting with rival males during the spawning season. I scarcely think this can be correct either; for the teeth being really the weapons of offence and defence, it follows that the hook, which is at the snout, must in biting hinder the teeth from doing so much injury as otherwise they would inflict.

Its design therefore seems rather to indicate the prevention than the infliction of injuries. Its alleged enlargement during the spawning season, must be the result of a sympathetic action due to the peculiar condition of the male at that period.*

The *salar*, in common with the sea-trout and brown trout, is not found native in any waters in the southern hemisphere. Also, it is not met with further south than 40° to 42° of north latitude.

Then among *sea-trout*, we have of species *S. trutta*, *S. eriox*, *S. cambricus* (Sewin), *S. galivensis*, and so on, almost every British river having a variety or varieties peculiar to itself of one or more of these species. Their local names too are very numerous and equally perplexing. I knew a river in Argyllshire, the Edchaig, which enters the Holy Loch near Kilmun, and which during the month of June has a run of very fine *S. trutta*. These fish vary individually in weight from 1½ lbs to 5 or 6 lbs. Clear, silvery and fat, they are splendid fish for sport or for the table. Later on in August and September a smaller variety of *S. trutta* runs up this river, known locally as "blacknebs" from the dark colour of the head, these also are very excellent fish; while a few bull trout, or *S. eriox*, find their way up towards the end of the season. These different runs of fish all go locally under the designation of sea-trout. I might also mention Loch Lomond and its tributaries as being frequented by varieties of this species; for the streams flowing into the loch on the west side contain from June to the end of winter a variety of sea-trout between *S. trutta* and *S. eriox;* while the Endrick water, on the east side, has a breed closely resembling the true *S. trutta*, but which do not run up till August and September, during which latter month a number of salmon and grilse also go up to spawn. All these sea-trout lie in Loch Lomond for a time, and never ascend the streams which they prefer till a freshet or "spate" has come down.

So also with *S. fario*, the common trout. In the same water as above, Loch Lomond, I have recognized at least six different varieties. There are for instance the dark, almost black coloured, the brown, the golden and the silvery. Some are distinguished by having very large but very few spots; others by an ordinary number of black and red spots; a third variety by crowded round black spots and a few red ones; while the silvery kind has numerous black but no red spots. In Endrick water there are at least two

* Since writing the above I have seen a letter in "Forest and Stream," for July, 1880, by Professor Hind, of Nova Scotia, wherein for the first time the fact is disclosed that the male salmon breaks the hymen, or membrane enclosing the ova, by seizing the female behind the pectoral fins between his two jaws, when she rolls on to her side. May not the milt also be liberated through the males fighting?—W. A.

distinct varieties,—the clear silvery breed in the lower reaches, where the river is comparatively still, the water deep and the bottom sandy; and the golden breed in the upper waters, where the river tumbles over rocks, or ripples over coarse stones and gravel. The fins vary in colour, the belly fins are generally brown or olive, but sometimes of a golden tint, while occasionally the ventral and anal fins have a white anterior margin. Similar differences have been noticed in the trout of other waters, but I need not enlarge further, neither shall I attempt now to account for the many varieties of *S. salar*, *S. trutta*, and *S. fario*.

I have referred above to the limits within which the three best-known species of the genus *Salmo* are found. In connection with that I may mention that some years ago I met a Lieutenant Houston, of the United States Navy, who had been engaged on a surveying cruise along the coast of South America. He informed me that on the west coast of Patagonia he and his brother officers had caught and eaten trout. These were taken in a small stream, which ran out of a lake 4,000 feet above sea-level, and flowed into Smyth's Bay. While I do not question the good faith of this statement, I suspect that the fish may have been a charr, and do not think it could be the common trout, *S. fario*.

Acclimatized Salmonidæ.

The introduction into New Zealand waters of different species of the Salmonidæ from Great Britain, America, and Tasmania, which has been in progress during the last twelve years, renders the identification of these from one another a matter of some interest and importance. The circumstances of the culture of these fish in the colony are totally different from what they are in an old country like Britain, where the fish are indigenous. In England, Scotland, or Ireland the different species have their well-known and defined localities and seasons, so that, as a rule, when an example or specimen of a particular fish is wanted, it is known exactly where to go for it. But here in New Zealand, and more particularly as regards Otago, I find that, excepting the brown trout, we know as yet very little about the whence or the whither of the migratory Salmonidæ introduced from other countries. Thus, I would observe, no correct record appears to have been kept by which we can assert positively what English river contained the progenitors of our salmon put into Jacob's river as fry in 1874, 1876, and 1878. That is to say, although Mr. Howard, of Wallacetown, has informed me that the salmon ova came originally from the Tweed, Tyne, Ribble, Hodder, Lune, Avon, and Dart rivers, yet who can now say from which of these rivers the ova were taken which eventually hatched at the Wallacetown ponds? The Californian salmon introduced are supposed to be *S. quinnat*. Nor have I been able to trace the origin in England of the young sea-trout liberated in Shag river by Mr. Young in 1871, only that the ova were got by Mr. Clifford in Tasmania from the Salmon Commissioners. This knowledge, though not essential to identification, would be interesting and useful in observing variations if such should occur through the difference of our rivers from the parent streams. And the more so if there be any truth in the report which Mr. Ellis, of Merrivale, heard in Riverton and communicated to me, viz., that during last summer young salmon were caught in the estuary of Jacob's river, and eaten by well-known inhabitants of the above town. As to this, I have to add that Mr. Howard went specially to Riverton to ascertain the truth of the above report, and he has assured me that he is not yet satisfied that it is so. Neither can the fact be decided until the fish seen has been caught and examined by some competent authority.

The English salmon and sea-trout, the American salmon (Californian) and the white-fish, are none of them natives of New Zealand waters, and it yet remains to be seen how they will succeed and how adapt themselves to our rivers. Excepting the sea-trout, we have no *proof* yet of the success of any of the others,—the young fry of all of which have been liberated in our rivers or lakes, some of them years ago.*

I will now proceed to describe certain specimens of migratory Salmonidæ as examined by me. With the assistance of the drawings of these fish which accompany this paper, I hope my descriptions may be the more readily understood. I need only add that I have made these drawings from the fish themselves by accurate measurements, laid down to life-size and afterwards reduced. In the case of the Sawyer's Bay *S. trutta* alone, the fish was only a short time in my possession, so that I did not get it so accurately delineated as the others. The head and fins, however, were retained by me, and made use of in the drawing which represents them.

Specimens examined.

1. *Salmo quinnat*, a smolt seventeen months old, hatched out with many others in November, 1877, at the Opoho breeding-ponds, Dunedin. It is now preserved in spirits, and is in the possesion of Mr. F. Deans. It is from ova obtained from California in 1877 as that of the *S. quinnat*, by the Colonial Government of New Zealand, and presented to the Otago Acclimatization Society.

General description: Colour,—iron or dark steel grey on head and back, passing into silvery on sides and belly; sides and gill-covers very silvery.

* It may be interesting to note here that in May, 1878, several hundreds of *S. salar* were caught running up the Connecticut river ten to fifteen pounds in weight, the result of fry planted there in May, 1874. Salmon have been extinct for three-quarters of a century in that river of the United States.—See report of Fish Commissioners of Canada, 1879.

Back fins, tail, and pectoral fins, dark steel grey, but lighter than the back; ventral and anal fins white. Round black spots plentiful along back, but few or none below lateral line, which is very distinct and raised; spots also on top of opercula and head; a few at base of dorsal fin and at base of tail. No red spots visible—par marks eight, still faintly visible, under the deciduous silvery scales.

In *form:* Head well developed, lower shorter than upper jaw and showing tendency to become hooked, upper jaw also hooked; maxillary long, drooping, and extending slightly behind the vertical from posterior margin of the orbit—it is also narrow, fine, and rounded at the end. Eye large, full, and black, with whitish yellow iris. Opercula well rounded or semicircular in margin. Preoperculum with a distinct lower limb, vertical margin at right angles to axis of fish and slightly sinuous. Suboperculum very large, larger than operculum, in shape nearly a perfect quadrant; junction of operculum and suboperculum forming an angle of 45° with axis of fish or with a vertical line. Body well filled out, outline of back slightly convex, body tapering towards tail; fins small relatively to body; tail very large and forked, spread $1\frac{3}{4}$ in.; longest caudal ray, $1\frac{4}{10}$ in., shortest, $\frac{4}{10}$ in.

Dimensions: Length from snout to extremity of tail, $7\frac{1}{10}$ in.; to origin of caudal rays, 6 in.; depth, $1\frac{4}{10}$ in.; girth, $3\frac{4}{10}$ in.; head, $1\frac{1}{2}$ in.; from snout to centre of eye, $\frac{11}{20}$ in.; eye to origin of dorsal, $2\frac{1}{4}$ in.; eye to origin of pectoral, $\frac{9}{10}$ in.; pectoral to origin of ventral, $1\frac{7}{10}$ in.; ventral to origin of anal, $1\frac{7}{10}$ in.

Fin rays: D.11, P.14, V.10, A.14, C.19.

Branchiostegous rays: 13 to 14.

Length of fins: D.$\frac{8}{10}$, P.$\frac{9}{10}$, V.$\frac{3}{4}$, A.$\frac{7}{10}$ in.

Teeth: Mandible, maxillary, head and body of vomer, palatines, and tongue all armed with teeth, those of mandible strongest and largest.

Scales: Deciduous, 17 in transverse row from adipose fin backwards to lateral line.

Of the same hatching with above specimen 13,000 young *S. quinnat* were reared, and then were put in the Kakanui river by Mr. Deans, manager of the Otago Acclimatization Society, in January, 1878.

Note.—The pyloric cæca of *S. quinnat* are 155 in number, according to Sir S. Wilson.

2. Columbia salmon, *Salmo paucidens* (?),—a salted specimen as imported into Dunedin from America.

General description: In *form,*—body of a fine handsome shape, well filled out; back finely arched, and hinder part of fish tapering off towards the tail; flank very deep, and fish fat; head inclined to be large, maxillary fine, broad and flat, projects $\frac{1}{8}$ in. beyond vertical from posterior margin of orbit;

premaxillary projects slightly over mandible. Opercula rounded in outline, margin of suboperculum projecting beyond general outline of gill-covers, suboperculum very large relative to the other opercula, and approaching a sector of a circle in shape; preoperculum crescent-shaped, somewhat sinuous in outline, with a distinct rounded lower limb. Fins small relatively to size of body, tail very large and finely forked.

Colour: Head light brown, black back, sides and belly white, with faint pink or flesh tint on belly; bright strong silvery scales, rather large, all over the body. Dorsal fin brown, adipose blackish brown, pectoral white with black edge and tip; ventral and anal fins white; tail brown with black tip or margin. No spots visible anywhere. Lateral line distinct, but not raised or coloured. Flesh dark vermilion.

Dimensions: Weight 6 lbs. (before curing probably 7½ lbs.), length to origin of caudal fin, 21½ in., to fork, 23¼ in., total 24½ in.; depth 6 in.; girth 14 in.; head 5¼ in.; tail, width 5¾ in., longest ray 4 in., shortest 1½ in.

Fin rays: D.11, P.15, V.10, A.15, C.19.

Branchiostegous rays: 13. *Vertebræ:* 60.

Length of fins: D.2½, P.3¼, V.2½, A.2½ in.

Teeth: Very fine along body of vomer, on palatines and maxillary (head of vomer missing); coarser on tongue and on mandible, particularly towards the snout.

Scales: Bright, large and transparent, 15 to 16 in transverse row from adipose back to lateral line. L. lat. 140, L. trans. $\frac{20}{34}$.

NOTE.—Owing to tissues being somewhat decayed, the teeth and scales could not be correctly examined or enumerated.

3. *Salmo trutta.* This specimen was caught in the Frith of Clyde, and was sent to me preserved in spirits by an old friend and enthusiastic angler, Geo. Maclachlan, Esq. It reached me in November, 1878, by the "Timaru."

General description: A female, in fair condition, but evidently not come to maturity: back slightly arched, but shape of fish somewhat distorted by packing in a bottle; of a dark slate *colour* on back, passing into cream colour below the lateral line, and white on belly. The characteristic silvery scales present all over the body; the lateral line being black, distinct and raised, much more conspicuous and well defined than in any *S. fario.* Scales compared with those of common trout of same weight, and found to be only half the size and clear in colour, (scales of *S. fario* dark on posterior half). Black spots *x*-shaped, not numerous, and situated mostly above the lateral line; one round black spot on upper part of operculum; one or two indistinct on dorsal fin, none on adipose or tail. *Head:* finely shaped, one-fifth of extreme length of fish, small and sharp at the snout; maxillary flat and fine, projects $\frac{1}{16}$ in. behind vertical from posterior margin of orbit, breadth one-sixth of extreme length from snout. Sub-operculum rounded in outline, preoperculum slightly sinuous, margin and lower limb distinct ; tail forked. Fins, dorsal and pectoral dirty slate colour, with black on margin and in streaks; adipose and caudal black or nearly so ; ventral and anal fins white ; all small and fine as compared to size of fish ; dorsal and tail with ragged and comb-like margins.

Dimensions: Weight, $1\frac{1}{2}$ lbs. ; length, $15\frac{1}{12}$ in. ; depth, 3 in. ; girth, 8in.; head, 3 in. long.

Teeth: Remarkably fine and delicate, points like needles ; two present and one gone on head of vomer, row along body of vomer ; rows on palatines, maxillary and mandible.

Fin rays: D.11, P.13, V.9, A.10, C.19, with the usual 6 or 7 sub-rays at root of tail or caudal fin.

Length of fins: D.$1\frac{3}{4}$, P.2, V.$1\frac{6}{10}$, A.$1\frac{7}{10}$ in.

Scales: 16 in transverse row from adipose fin back to lateral line. L. lat. 138, L. trans. $\frac{22}{40}$.

Branchiostegous rays, 10. *Pyl. cæca* not examined, to avoid injuring fish.

4. *S. trutta*. A female, netted by Chinamen in Sawyer's Bay, Otago Harbour, April 27th, 1880.

General description: In *form*, a remarkably handsome fish ; very fat, deep in the flank, and so full in body as to dwarf in appearance the tail and fins. Back arched; head very small, fine and clean cut, only one fifth the extreme length of fish; dorsal and caudal fins ragged and comb-like in margin; caudal fin slightly forked. *Colour:* Steel grey, with blue tint on head and back, white sides and pure white belly; bright silver coating of deciduous and characteristic scales over the whole body—except where rubbed off. Lateral line distinct and raised. Dorsal, adipose, and caudal fins light blueish black. Pectoral white, with blue-black streaks; ventral, white; anal white, with light-bluish streaks in middle. A good deal of steel-blue colour about head and along scales on back. *Spots:* A few black ones, *x*-shaped, situated above and below lateral line; two round ones on gill-covers ; a few on posterior part of dorsal fin, but none on adipose or tail ; no red spots. *Head:* Silvery in colour, and small in size. Eye, small and round; pupil, black; iris, olive-coloured. Maxillary fine, broad and flat ; projects very slightly behind vertical from posterior margin of orbit. Mandible slightly longer than maxillary, and inclined to project into a hook. Opercula rounded in margin. Suboperculum nearly a sector of a circle. Preoperculum slightly sinuous in margin. Lower limb not defined. *Contents of stomach:* A small quantity of white mucus only. Roe-lobes very small, just about 1 to $1\frac{1}{2}$ inches long. Ova, about the size of small pin-heads or turnip seed. Flesh, of a pale pink colour. When cooked, this fish ate much finer than any brown trout which I have tasted in Otago.

Dimensions: Weight, 2 lbs. 14 oz.; length, 17½ in.; depth, $4\frac{6}{10}$ in.; girth, 11¼ in.; head, 3½ in. long.

Teeth: Very fine on maxillary, palatines, and vomer. On head of vomer two, and one rudimentary. None at all along body of this bone. On mandible and tongue not so fine, coarser.

Fin rays: D.11, P.13, V.9, A.10, C.19; 5 sub-rays above and 5 under origin of tail, as usual. Length of rays, D.2, P.$2\frac{3}{10}$, V.$1\frac{9}{10}$, A.$2\frac{4}{10}$ in.

Scales: 15 in transverse row, from adipose back to lateral line.

Branchiostegal rays: 10. *Pyloric cæca,* 40; surrounded by much fat.

5. *S. cambricus.*—A Welsh sea-trout, from the river Usk. This is one of three specimens (smolt stage) preserved in spirits, in the Otago Museum.

General description: This specimen is discoloured, owing to the action of the spirits in which it is preserved, in common with but not so bad as the other two. In *form:* Rounded outline, but not very full or deep in the body; thickness maintained towards the tail. Head contained 4½ times in extreme length of fish; snout rounded; jaws of equal length; maxillary, broad and fine; posterior end accurately circular, and does not project beyond vertical from posterior margin of orbit. Operculum large, hind margin straight, and forms right angle with lower margin. Suboperculum narrow, longer than broad, of rectangular form, but with the posterior angle very circular, and projects behind the operculum. Preoperculum with a rounded outline; lower limb not distinct. Eye large and round. Fins average size. Tail forked. *Colour:* Brown back, silvery sides; scales deciduous; white belly; par marks, ten, faintly visible. Spots black, round, and numerous on gill-covers and body above and below lateral line (which is distinct but not prominent). Dorsal fin spotted; three spots on adipose; tail immaculate. So far as can be made out, dorsal fins and tail dark; pectoral, neutral, and anal fins white.

Dimensions: 7⅓ in. snout to tip of tail; head, $1\frac{6}{10}$ in.; other dimensions proportional.

Teeth: Fine, present on mandible, maxillary, and palatines; vomer, crescent-shaped; head armed with a few teeth, shaft of bone with two distinct rows along outer edges.

Fin rays: D.11, P.13, V.8, A.9, C.19, with the usual four or five sub-rays above and below.

Scales: 15 in transverse row from adipose back to lateral line.

Branchiostegal rays: 11. The pyl. cæca and vertebræ not examined.

The other two specimens (*S. cambricus*) differ from above in the ventral fins having 9 rays, and in having no spots on the adipose fins.

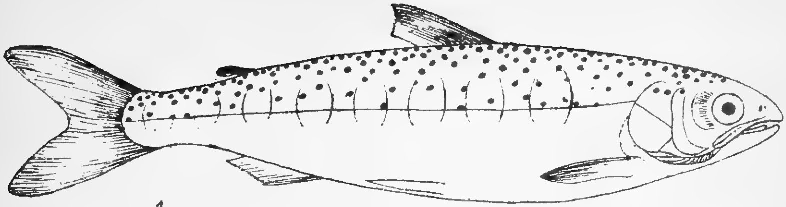
Remarks suggested by above specimens examined.

Salmo quinnat:—In the absence of a specimen of the mature fish, the above description of the smolt may serve as an approximate guide to identification of this species when it may be met with in our waters. The adult will probably be found to have fewer vomerine teeth, and to be fuller in body or "thick" as stated by Mr. Lord—the silvery scales also will be more permanent. The only descriptions of this fish accessible to me, are those by Dr. Günther, Mr. Lord, and a letter from Dr. Comrie, R.N., written from Vancouver Island, and now in my possession. These are anything but complete, with the exception of Mr. Lord's. Dr. Günther classes this salmon under the genus *Oncorynchus*, in which the anal rays exceed 14, and he calls it a "migratory trout from the Columbia river." The two other authorities I have named call it a salmon, and speak of it as ascending the Columbia and Fraser rivers, sometimes attaining the great weight of 75 lbs.—the average weight being 25 lbs. The only migratory trout referred to by Mr. Lord is *S. spectabilis* or the *S. campbelli* of Günther. The specimen examined by Dr. Günther may possibly have been accidentally labelled in error, as certain others were which he mentions in his catalogue. As to the number of anal rays, it will be seen that I found just 14 in this smolt, and I would explain that by assuming that this young salmon resembles other species of the Salmonidæ wherein a reduced number is not uncommon in young fish, such, for example, as in the *S. cambricus* described above in this paper.

The *S. quinnat* is proved to be capable of living and breeding in fresh-water rivers when cut off from all access to the sea; but that it can continue indefinitely to thrive and propagate, is not thereby determined as yet. It seems also that the grilse in an open river do not breed for several years, and probably not until they become mature fish. Their journeys up the rivers of North Western America, are in distance and duration also regulated by age and the condition of the water. Very young fish only ascend a short way and then come back again to salt water. No runs of fish take place during floods, but only when the flow of water is steady, irrespective of its being high or low.*

I may observe here that Dr. Günther has described at least four species of the genus *Oncorynchus* as frequenting the rivers of North Western America, and probably there are several more species of this salmon which have not come under his notice. But it is interesting to observe that this genus is numerous in species and capable at the same time of great modification in habits; while the *S. salar* of British waters is the only species

* App. to Jour. H. of R., 1878.



1 3/5 nat. size.

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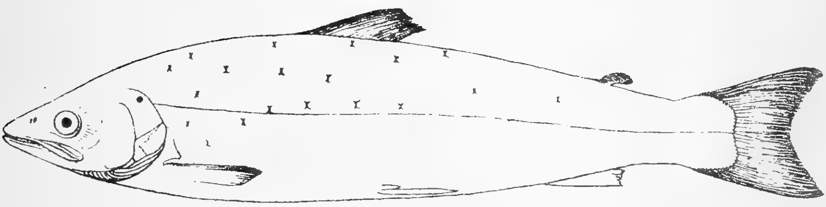

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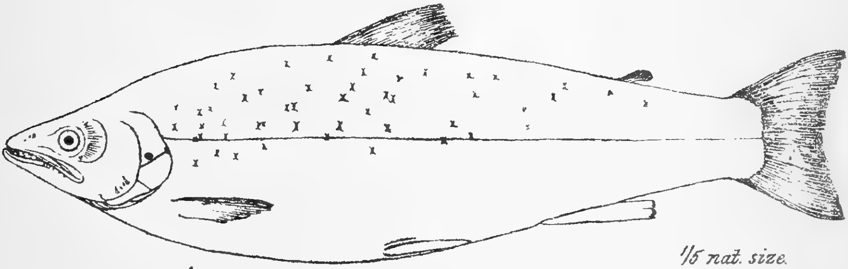

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SALMONIDÆ.

W. Arthur, Del.

of the true salmon we have in these waters, and it refuses to thrive and propagate when cut off from the sea. Stoddart gives a striking instance of this latter fact in his "Angler's Companion to the Lakes and Rivers of Scotland."

The *habits* of the *quinnat* so far as I can find them to have been observed during the past, may be described as follows:—In the short coast-rivers they spawn in January and February. In the large rivers of North-western America, which spring from the Rocky Mountains and other Sierras, they spawn from June to September. The young fish descend to the sea from these interior streams with the floods consequent on the melting of the snow by the summer heat of the following year or season. They appear then to remain in the sea and estuaries for several years, the grilse running up the rivers a certain distance and then going back to the sea without spawning. These journeys seem to become longer as the fish approaches maturity, until the third or fourth year, when the female is in spawning condition. After spawning (which the female only accomplishes once), she dies, and but a small proportion of the males ever get back to the sea, as I shall presently show more fully. The very largest fish occasionally caught, are males, supposed to have survived several trips up the rivers, and to have attained their great weight during their residence in salt water.

This salmon may be caught with bait or spinning-lures in the estuaries or bays on the coast; but in the rivers they refuse artificial or natural flies and baits of all kinds, excepting occasionally pieces of their own roe. They never feed in the rivers.

Some species of Californian salmon spawn every year, others every alternate year.

The *quinnat* lives in rivers of California where the temperature of the water has been found in August to rise as high as 84° Fahr. The English salmon prefers cold, clear waters, and probably would die in water of so high a temperature.

As to the economic value of this salmon, it seems to me to be more than doubtful. The following quotations I give from several authorities possessing more or less information:—

"Soon after commencing work I was encamped for many months on the banks of the Chilukweyuk River, a tributary of the Fraser. About a mile from my camp was a large patch of pebbly ground, dry even at the highest floods, through which a shallow stream found its way into the larger river. Though barely of sufficient depth to cover an ordinary sized salmon, yet I have seen that stream so filled that fish pushed one another out of the water high-and-dry upon the pebbles. * * * It seems to me that thousands of salmon ascending these small mountain streams never can spawn from sheer want of room. * * * At the end of the pebble stream was a waterfall, beyond which no fish could by any possibility pass. Having arrived at this barrier to all further progress, there they obstinately remained. Weeks were spent in watching them, but I never, in a single instance, saw one turn back and endeavour to seek a more congenial water-course; but, crowded from behind by fresh arrivals, they died by the score, and drifting slowly along in time reached the larger stream. It was a strange and novel sight to see three moving lines of fish—the dead and dying in the eddies and slack water along the banks; the living breasting the current in the centre, blindly pressing on to perish like their kindred.

"Even in streams where a successful deposition of the ova has been accomplished, there never appears, as far as my observations have gone, any disposition in the parent fish to return to the sea. Their instinct still prompts them to keep swimming up-stream, until you often find them with their noses quite worn off, their heads bruised and battered, fins and tail ragged and torn, bodies emaciated, thin, and flabby; the bright silvery tints dull and leaden in hue, a livid red streak extending along each side from head to tail, in which large ulcerous sores have eaten into the very vitals.

"The Indians say all the salmon that come up to spawn die; but if all do not die, I have no hesitation in saying that very few spring salmon ever reach the salt water after ascending the rivers to spawn." *

"Having killed and eaten salmon in almost every part of the world they inhabit, California included, I hope I shall not be considered presumptuous in giving a tolerably decided opinion as to their relative merits, and have no hesitation in saying that the best breed of salmon I have ever met with is our own, and the worst the Californian. * * * But another and most serious objection to their being brought over here should be considered, viz., the fearful prevalence of disease among them. The mortality among salmon in California is simply incredible. I have seen many thousands of them dead and dying from apparently a fearful leprosy." †

"Mr. Livingston Stone, Dep. U.S. Fish Commissioner, in charge of the Government hatching establishment on the McCloud River, reports officially that, in his opinion, all of the salmon of that river die after depositing their spawn. This is possibly true, but it does not account for the fact that in the spawning season the McCloud contains grilse and fish evidently of three, four, and five years old, unless we are to imagine that some salmon, after being hatched and going to the ocean, remain there two, three or more years without returning to the parent stream for purposes of spawning. * * * From the letter of a fisherman, he says,—'As to the return

* "The Naturalist in British Columbia," by J. Keast Lord, 1866.

† Article in "Fishing Gazette," London, 1879, by Sir Rose Price.

of the seed salmon to the sea after depositing the spawn, I am inclined to the opinion of Mr. Stone, so far as the greater part of the female fish are concerned. I think very few of these, but many, though not all of the males, return. I should judge that five per cent. of females and twenty per cent. of males might be an approximation. I express this opinion diffidently. * * * * The female salmon seldom or never spawns but once.' "*

"*Fraser River Salmon:* The general opinion exists that these salmon die after spawning, prior to their return to the sea. My convictions are that this opinion, although strongly defended, is entirely an erroneous one, not supported by sufficient data or proof to establish its correctness. I am free to admit that a large number of salmon never return to the sea, and indeed the immense number found dead and in a dying condition in so many streams, is an abundant evidence of this fact; but I contend that this circumstance is simply and wholly the result of natural causes, and not owing in the slightest degree to any inability to return to salt water. * * * * *Salmo quinnat* has never been seen in the Fraser, nor a suck-eye in the Columbia. Some varieties spawn each year, others every alternate one."†

Although the two latter quotations are from articles written in defence of Californian salmon, the *S. quinnat* included, they bear out the fact, so graphically stated by Mr. Lord, as to the dreadful and loathsome mortality among the spawning fish; there can be no doubt, therefore, that the *S. quinnat* is a most undesirable fish for our New Zealand rivers, and particularly for such rivers as are stocked with trout. The whole article in "Forest and Stream" from which I have taken the above extract, loses much of its interest and value from the loose nature of some of its statements. For example, the first sentence quoted above, is a contradiction in terms, and the description given of the death of the salmon through exhaustion, shows by the writer's own words, a very decided lack of "ability to return to salt water" at all! The "suck-eye" mentioned, is I believe the *S. paucidens* of Günther and Lord. Both Mr. Lord and Dr. Comrie describe the *S. quinnat* as an inhabitant of the Fraser river, and Mr. Lord, together with Dr. Günther, reports *S. paucidens* as going up the Columbia river, so that, so far as I can find, the balance of evidence on these points is against the writers in "Forest and Stream."

The *S. paucidens* (?) has been so named by me because I cannot find any other described species to agree so well with the marks of this specimen. At the same time it differs from the fish noticed by Dr. Günther and Mr. Lord, in that its back is not straight but highly arched, and it is greater in

* New Zealand Parliamentary papers, Californian salmon and whitefish ova, 1878.

† "Forest and Stream," New York, 17th June, 1880

weight than the average (3 to 5 lbs.) which they mention. Dr. Comrie, however, writes that *S. paucidens* runs from 5 to 6 lbs. and has a maximum weight of 10 lbs. The teeth of this, the "weak-toothed" salmon, were not easily found by me in the vomer and palatines of above specimen, possibly on account of the "curing" of the fish. Possibly also the arched back may be due to packing into small barrels. As they appear in the Dunedin market, these fish are all as nearly as possible of the same weight, 6 to 7 lbs.; whether this is accidental or not, I have not means at present of determining. As food they are excellent.

This fish, as well as the *S. quinnat*, among other things differs remarkably from the *S. salar* of British rivers in the size and shape of the sub-operculum, which is very large relatively to the operculum and has a rounded margin which, with the two joints, forms a figure approaching a sector of a circle. This *S. paucidens* likewise has no spots anywhere, and the same may be said of several other specimens I have looked at of the same fish. The tail also is very large and forked.

The *S. trutta* from the Clyde, and which may now be seen in the Otago Museum, I have compared with Dr. Günther's description of four specimens from the river Tweed, varying in length from 18½ inches to 35 inches. The relative length of the head to the body and the depth relatively to length of body, without the caudal, agreed very well; but all the fins of the Clyde fish are larger than those of the Tweed sea-trout. The fin-rays of the Clyde specimen are fewer by one or two—in the dorsal, pectoral, and anal fins—than those given by Dr. Günther; the ventral being the same in the number of rays. But they agree almost exactly with those given by Yarrell. The gill-covers in form and the colours of the body fins agree with the descriptions of those by Günther and Yarrell. The difference in the number of fin-rays from those given by Günther is apparent rather than actual, as the latter seems to have included the rudimentary or sub-rays, which I have omitted. The vomerine teeth differ also in being nearly all present in this Clyde specimen, while in the Tweed specimens of Dr. Günther they are only present in small numbers on head of vomer. The fish, which undoubtedly is a sea-trout, is evidently not a mature fish or rather not come to its full growth. Its general appearance suggests this in the want of fullness of body, while the size of the tail and head and presence of so many vomerine teeth confirm the supposition.

The sea-trout from Sawyer's Bay agrees in most of its markings with the Clyde one described above, also with Günther's and Yarrell's fish. It is also identical with the stuffed *S. trutta* in the Otago museum, taken at Otago Heads in 1874. That is to say, it has the correct and liberal coating of bright silvery scales, the gill-covers are silvery, the back and all the fins bluish black or white, the spots not numerous, black and *x*-shaped, the gill-covers rounded and proportioned accurately or nearly so, maxillary fine, and teeth comparatively fine, those on the vomer only present on head of this bone. The Clyde *S. trutta*, the *S. trutta* in the museum, and this fish all agree very closely in the size of the fins relatively to length of body, and these are all smaller relatively than in such examples of *S. fario* in Otago as I have yet examined.

But, on the other hand, it differs from the typical *S. trutta* and from *S. fario*, in that the lower jaw projects very decidedly beyond the upper one, even though it be a female, and when the mouth is shut it is just the same. This mark is the same in all the other individuals (three or four) which I have known caught in Otago Harbour, and which I have seen. Curiously enough a trout caught in Lake Wakatipu, by Mr. J. P. Maitland, in the beginning of this year, of about 1½lbs. in weight, had a head identical with this *S. trutta.* It also had no spots on its body, which was covered with brilliant silvery scales, and only two dark round spots on the left gill-cover. But the vomerine teeth were complete, excepting on the head of the vomer, which was toothless. It is only fair that I should state this, because no sea-trout were ever liberated in any tributaries of the Wakatipu, which is 200 miles from the sea, nor in any feeder of the Clutha River; and, also, because some people who take an interest in this subject are in doubt as to whether we have the *S. trutta* in Otago at all or not.

There is just one other fact I must mention particularly about this Sawyer's Bay sea-trout, which is, the smallness of the ova, only the size of pin-heads, and the whole lobes not more than an inch and a-half long. This is an extraordinary condition for a migratory trout, or any trout, to be in during April, which corresponds to October in England—when sea-trout begin to spawn. At the same time, I must not omit to observe that large females of this same species caught in the harbour in November are often full of large ova almost ripe, the fish themselves being in splendid condition. November in New Zealand corresponds to May at home.* These two facts, and also this, that no undoubted sea-trout has yet been taken in any of our rivers, may mean much, but what the meaning may be it would be premature as yet to decide. Do these fish spawn during the same month of the year as at home, and is the spawning effected in the little streams entering Otago harbour in every little bay, or do they spawn in the tidal way of the harbour itself? If in the small streams, we should most likely during the

* Californian salmon, which in a state of nature spawned in January and February, in the head waters of coast rivers, have been found to spawn in September when cut off from the sea and confined to short coast streams.—(App. to Journ. H. of R., 1878.) W. A.

six years these fish have now been in our harbour, have seen or heard of the young fry being in these streams, but we have not. Such a thing as a sea-trout spawning in salt water is unknown, and it will be very surprising if our *S. trutta* are found so to do. There is thus a mystery as to the habits and movements of our *S. trutta*, sufficient almost to throw doubt on their identity. Still we are in this position—we have a trout got only in the salt water, specifically differing from the common trout of our streams, and agreeing in its distinguishing marks with *S. trutta*. It is caught in the salt water varying in weight from 1 lb. to 18 lbs., and is often found in spawning condition in the beginning of our summer. Hitherto no well verified example has been taken in any of our streams. Much remains, therefore, to be discovered of the habits in our waters of this fish, which I do not doubt, after the examinations I have made, is the real *Salmo trutta*.

The sea-trout of Otago were brought from Tasmania as ova by Mr. Clifford, 137 young fish being turned into Shag river in 1871, at which time also I understand a few more were put into the Water of Leith, at Duncan's mill.

Distinguishing Marks.

These marks, I will endeavour, in closing this paper, to summarize briefly; and in doing so I may say that I give them partly from my own observations, and partly as I find them given by the best authorities. They refer only to adult fish.

Of the *S. quinnat* and *S. paucidens*, I cannot venture to lay down from my own experience rules for their identification from other salmon of the same genus, the *Oncorynchus*, as my knowledge of these fish is as yet very limited. It would require years of residence and study in California or Columbia to acquire such knowledge correctly, and as yet I have not been able to find any author who gives a full and accurate description of these fish. At the same time there is no difficulty in recognizing the difference between these and the *Salmo salar*. They belong to a different genus, the *Oncorynchus*, where the anal rays exceed 14, while in the *S. salar* these are always less, being rarely more than 10.*

But of the *S. salar* I may say that it may be most readily distinguished from the other species (*S. trutta* and *S. fario*) of the genus *Salmo*, by its strong and uniform coating of burnished silvery scales, 12 in transverse row from adipose to lateral line; its fine sharp and clean-cut head; its arched back and deep belly, its taper and cylindrical shape towards the tail, its large square tail, sometimes emarginate; by the fewness, and x-shape of its

* Mr. Lord describes the margin of the operculum as having spinous projections which give it a serrated form.

black spots, the absence of spots on the fins, and the colour of the fins, the dorsal, adipose, and tail being black, and the pectoral, ventral, and anal white, with more or less dusky shading; the form and proportions of the gill-covers, and the deciduousness of the vomerine teeth—these teeth being fewer than in *S. trutta*.

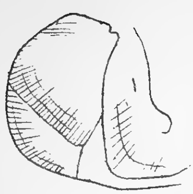
The salmon also attains a much greater weight than the sea-trout, and its anal fin appears to be smaller in proportion to whole length of the body than in *S. trutta* and *S. fario*. Comparing a number of Günther's specimens of *S. trutta* and *S. fario* with three of *S. salar*, in regard to this proportion of the anal fin, I find in the two former the ratio is as 1 to 12, while in the latter it is as 1 to 16. (See table appended to this paper. Refer also to drawings of gill-covers.)

The *S. trutta* is a shorter fish for equal weights than the *salar*, and it is deeper or thicker at the origin of the tail; the tail is generally square. The colour of the back is darker, and the silvery scales (15 to 16 in transverse row) more deciduous than in *S. salar;* the spots are more numerous, but of the same colour and shape, and there are usually a few present on the posterior part of the dorsal fin. The fins are similar in colour to those of the *sclar*, the belly fins being rather whiter. The gill-covers differ to some extent, the lower limb of the preoperculum being rounded and not so angular, and the vomerine teeth are longer present than in *S. salar;* also the fins are longer, particularly the anal fin.

The *S. fario* may be generally distinguished from the two preceding species by its olive-brown colour, round black spots, and its crimson spots. But the same variety alters in colour according to sex, age, season, food, and water. I find this so with our Otago-bred trout, from which my comparisons are mostly taken, just as many observers have at home in the fish of English rivers. (Since beginning this paper, I have had several excellent opportunities of again seeing our breeding-fish in spawning condition in the Acclimatization Society's pond. The males, and more especially the largest from 8 lbs. to 10 lbs., are in colour a brown-yellow with a pink tinge in the body, the back-fins and tail very pink, and the spots black and red, very distinct; the hook on mandible very large. Even the females, which were silvery, had all pink-tipped adipose fins and faint red spots in some cases above and below the lateral line. To-day, 11th August, I saw and handled a number of these splendid trout from 3 lbs. to 8 lbs. in weight). Some of our streams too have tidal estuaries, and the large trout which are believed to visit the tidal water will, no doubt, acquire a more silvery hue than those which do not. This tends to complicate the distinctions still more, and to make it more difficult to detect the difference between these and the true sea-trout. Yet, so far as my examinations have enabled me to judge, I find that no matter how silvery the common trout may have become, its dorsal fin has always a good number of round black spots arranged in rows; the adipose is brown with more or less of pink round the margin, it also has nearly always two or three dark spots; the pectoral, ventral, and anal fins are always brown or olive-yellow, occasionally the ventral and anal have a white margin along the longest ray. The maxillary is coarser and generally longer, the suboperculum is somewhat four-sided, with the posterior angle more decided than in *S. trutta* in which it is circular, but this character varies a good deal. The teeth are coarser, and those of the vomer much more permanent than in the sea-trout. I have frequently in old and large fish found them not only on the head but well back along the shaft of that bone. I have also found the fins coarser and larger relatively to length of body, and covered with thicker skin than in the two preceding species. Scales 14 to 17 in transverse row from adipose fin to lateral line. *S. fario* like *S. trutta* is thicker at origin of tail than *S. salar*. In doubtful cases I have noticed that the head when kept for a week assumed the normal brown colour of the common trout, while the heads of such as I believed to be sea-trout retained their silvery hue.

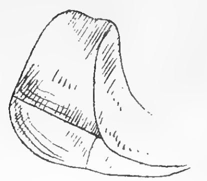
In the three species, *S. salar*, *S. trutta*, and *S. fario*, I do not believe any dependence can be placed on the numbers of fin rays, vertebræ, or even pyloric cæca (excepting in the case of *S. levenensis*), as a means of distinguishing the one species from the other. Still these have their place and their value, and when any doubt arises as to the identity of any particular Salmonoid, its removal should be the result of a careful consideration of all the invariable distinguishing marks, together with that of such also as are not invariable or not essential.

I append a table, the investigation of which will bear out generally my observations on the difference in the size of the fins, as also on the ratio of the least depth of the tail to the whole length of the fish.



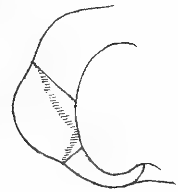
S. Salar

S. Eriox



S. Trutta

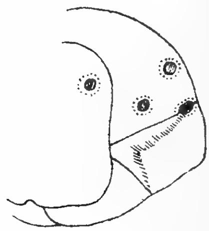
S. Quinnat
(smolt, nat: size.)



S. Paucidens (?)
1/3 nat: size.

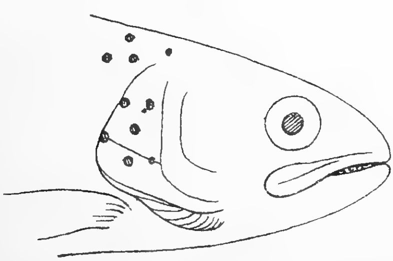
S. Trutta
Clyde.)

S. Trutta
(Otago.)



S. Fario
(Otago)

(½ natural size.)



S. Cambricus, Smolt.

TABLE showing the Ratio of Length of Fins, and of least Depth of Tail to the Total Length of the Fish.

l is length of fish; d, least depth of tail; D, P, V, A, the various fins.

Description of Fish.		Proportions of each Fish.					Means.				
		$\frac{l}{D}$	$\frac{l}{P}$	$\frac{l}{V}$	$\frac{l}{A}$	$\frac{l}{d}$	$\frac{l}{D}$	$\frac{l}{P}$	$\frac{l}{V}$	$\frac{l}{A}$	$\frac{l}{d}$
S. salar—											
Male, 46 inches	Described by Dr. Günther.	10 00	8·36	10·00	13·81	13·81					
Male, 36½ inches	Described by Dr. Günther.	10·08	8·11	9·73	18·25	14·60					
Male, 22 inches	Described by Dr. Günther.	10·37	8·39	10·37	16·06	12·57					
Male, 38⅕ inches, R. Usk... ...	Casts from Buckland.	9·00	8·68	10·61	10·91	14·68	9·39	8·65	10·38	13·29	13·87
Female, 41 3/10 inches	Casts from Buckland.	8·26	9·38	10·87	10·32	14·75					
Female, 30¼ inches	Casts from Buckland.	8·64	...	...	10·43	13·44					
S. quinnat—											
(Smolt), 7 1/10 inches	Described by W. Arthur.	8·87	7·88	9·46	11·83	14.2	8·87	7·88	9·46	11·83	14·2
S. paucidens (?)—											
24 inches	Described by W. Arthur.	12·00	7·38	9·60	9·60	...	10·90	7·45	9.70	9·70	12·25
24½ inches	Described by W. Arthur.	9·80	7·53	9·80	9·80	12·25					
S. trutta—											
Male, 35 inches	Described by Dr. Günther.	11·66	8·23	10·76	12·72	11·66					
Female, 27¾ inches	Described by Dr. Günther.	9·63	9·63	11·70	12·33	13·09					
Male, 18½ inches	Described by Dr. Günther.	9·89	8·72	11·42	12·33	12·33					
Male, 24 inches *(S. cambr.)* ...	Described by Dr. Günther.	9·60	8·36	10·12	12·83	12·83	9·24	8·20	10·68	10.70	12·35
Female, 22½ inches *(S. cambr.)*	Described by Dr. Günther.	10·00	8·18	9·49	12·03	12·85					
Cast by F. Buckland, 24½ inches		8·16	8·16	12·24	9·07	11·62					
Female (Clyde R.), 15 1/12 inches	Described by W. Arthur.	8·62	7·54	9·42	8·87	12·58					
Female, Otago, 1874, 15½ inches	Described by W. Arthur.	8·85	8·85	10·33	7·75	11·07					
Female, Otago, 1880, 17½ inches	Described by W. Arthur.	8·75	7·60	9·21	7·29	10·30	8·80	8·22	9·77	7·52	10·68
S. eriox—											
Male, 20 inches, Dr. Günther ...		10·70	8·88	11·42	12·34	13·33					
Cast from F. Buckland, 32 2/10 in.		10·73	8·05	9·20	8·70	10·73	10·71	8·46	10·31	10·52	12·0
S. fario—											
Male, 10⅜ inches	Described by Dr. Günther.	10·37	6·40	8·78	13·82	11·95					
Male, 28½ inches	Described by Dr. Günther.	10·36	7·12	8·30	8·14	12·66					
Male, 16 inches	Described by Dr. Günther.	9·13	7·54	8·83	11·68	11·68					
Male, 20 inches	Described by Dr. Günther.	10·00	7·63	9·43	12·34	13·33	9·29	7·42	9·16	9·86	12·12
Male, 29¾ inches, Shag R. ...	Described by W. Arthur.	9·15	7·44	9·91	8·50	11·90					
Female, 29¾ inches, Shag R. ...	Described by W. Arthur.	7·82	7·44	9.15	7·44	12·35					
Female, 17½ inches, Leith ...	Described by W. Arthur.	8·75	7·60	8·75	8·75	..					
Female, 33 inches, J. Wilson ...	Described by W. Arthur.	8·80	8·25	10·15	8·25	11·00					

EXPLANATION.—10·00 in column l-D means whole fish is ten times the length of dorsal fin, and so on; or dorsal fin is $\frac{1}{10}$ the total length of fish.

Art. XX.—*Notice of a new Fish.* By Dr. Hector.

[*Read before the Wellington Philosophical Society, 26th June*, 1880.]

Anacanthine Gadoidei.—Fam. *Lycodidæ.*

Hypolycodes, gen. nov.

Diagnoses from Lycodes.—Gill-openings wide; ventral fins equal in length to the pectorals.

Characters of genus.—Body elongate, much compressed, and terminating in a tapering tip. Eyes large, lateral. Skin (in spirits) loose, with minute imbedded scales. Lateral line distinct anteriorly, ascending from the operculum close to the base of the dorsal, along which it is continued for half the length and then fades.

Dorsal and anal fins continuous; caudal absent. First dorsal ray not articulated.

Ventrals jugular, close but not connected; equal in length to the pectorals, which are directly over them in position.

Gills, 4; branchiosteous rays, 5; pseudobranchia present, air-bladder, pyloria cæca, and anal papillæ absent.

Teeth trenchant, conical, curved in single row, most numerous on upper jaw. Teeth on vomer, palatines, and pharyngeals.

Tongue free, rounded, smooth. Mucous tubipores about the head.

Hypolycodes haastii, spec. nov.

D.150, A.120, P.17, V.5, L.L.116.

The length of the head is one-eighth of the total length; and the greatest height, measured immediately behind the gills, is equal to one-tenth of the length. The dorsal commences on the nape, and slightly in advance of the position of the pectorals and ventrals. The vent and commencement of the anal is not less than twice the length of the head from the snout. Snout short, conical and rounded, expanded and projecting in front and on the sides, but only slightly overhanging the lower jaw.

Intermaxillary free, and attached by a membrane posteriorly to the expanded maxillary, which branches back to the middle line of the eye. Thirty-six teeth in the upper jaw, the second pair in front being slightly larger. The teeth in the lower jaw are fewer in number, but of equal size. The vomerine teeth are few and blunt, the palatine and pharyngeal minute. A row of mucous pores below the orbit. The nostrils with short tubular processes. Inside the mouth depends a membranous fold and a mesial filament. The diameter of the eye is equal to one-third the length of the head. The gill-covers are large, rounded below, meeting in the mesial line. The membranes are not bound to the isthmus, so the gills open widely. The superior angle of the suboperculum is strengthened by a spine.

Total length, 7½ inches.

Colour (in spirit) uniform brown, with a bright silver patch on the opercles and expanded maxillaries.

Locality.—Waimarama, East Coast, Wellington. Collected by E. Meinertzhagen, Esq., and entrusted to me for description by Professor von Haast, F.R.S.

This remarkable little fish is closely allied to a form from the Falkland Islands, described by the Rev. L. Jenyns, in "Zoology of the Voyage of H.M.S. Beagle," under the generic name of *Ilnocœtes*, which he places with the Blennidæ. Dr. Günther has however removed that fish to the genus *Lycodes*, which he places with the Gadidæ, or cod-tribe of soft-rayed fishes. The fish now described, although possessing characters sufficient to require a separate genus, clearly supports the systematic position assigned to the *Lycodidæ* by Günther.

Art. XXI.—*Description of a new Species of* Trachypterus.—By F. E. Clarke.

[*Read before the Westland Institute, 11th August,* 1880.]

The fish I have the pleasure of bringing under your notice this evening is doubly interesting, not only on account of its being a new species of a rare genus—a genus which (as far as I am at present able to discover) has, as yet, been represented in the seas of the southern hemisphere by one specimen only,* which was captured near Valparaiso, and is now, according to Dr. Albt. Günther, in the Vienna Museum;—but also from its having been taken in a living state and existing some short time in captivity. This has enabled us to obtain a *perfect* specimen of a genus notable for the excessive fragility of its members, so much so, that I think I can safely say it is "the most perfect" specimen yet procured, and thus possesses one or two distinctive points as yet undescribed or unnoticed in other members of its genus, but which, at the same time, I may add, do not seem to entitle its classification as a new genus—as these peculiarities may only obtain from its not having reached an adult state—although other members of the genus almost as small (from the Mediterranean and around Madeira) have been described.

To give some idea as to the general occurrence and condition of these rare fish, I cannot do better than extract in full Dr. Günther's description of habitat, etc.,† of the family Trachypteridæ, to one of the genera of which family the fish now under your observation belongs:—"Deep-sea fishes, found at present on the shores of the Atlantic and Mediterranean, one species in the East Indies, another on the West Coast of South America, a third from New Zealand. Probably they have a wider range, but their being so rarely thrown on shore, and their speedy decomposi-

* [The author has overlooked the occurrence of another specimen of this species, *T. altivelis*, Kner. (Hutton in "Trans. N.Z. Inst.," Vol. V., p. 264), in the Auckland Museum; and other specimens, since collected, are in the Wellington and Dunedin Museums.—Ed.]

† Cat. Fish. Brit. Mus., Vol. III., p. 300.

tion, have prevented naturalists from observing them. It is very difficult to obtain specimens, and nearly impossible to find perfect ones. Nothing is known of their development and of the changes they undergo with age. Only a few specimens have been carefully examined."

The "third species from New Zealand" to which Dr. Günther refers, is one of another genus to the one now in question, *i. e. Regalecus*, three specimens of which have been observed during the last twenty years on the coasts of New Zealand, one of which 15 ft. 10 in. in length, ran ashore near the entrance of Nelson harbour, in October, 1860, and was described by W. T. L. Travers, Esq., in the Nelson *Colonist*, and a transcript of which description appeared in an early volume of the "Transactions of the New Zealand Institute." The second, 12 ft. 5 in. in length, was found on the beach at New Brighton, Canterbury, and is described and figured by Dr. Haast and Dr. Powell, in the Transactions.* The third, as noted by Dr. Haast in one of the papers last alluded to appears to have been stranded on the West Coast, near the Waimangaroa river, Taramea district, July, 1877, and was 14 feet 4 inches in length. We can add undoubtedly a fourth occurrence of *Regalecus*, near the locale from which the fish I am about to describe was obtained, namely, Hominy Cove, about three or four miles south from Jackson's Bay. Mr. James Teer in February, 1874, found a fish freshly washed up on the beach there, which fully answered to the description of *Regalecus*. He had no means at the time of preserving it, as he was prospecting for gold, but hung the fish, which he stated to have been about 14 ft. in length, over the branches of a small tree, intending to take some portion of it back with him; when he returned to it he found it almost completely destroyed by the rats. Portions of the backbone and skull of this specimen you can see among the varieties of our local museum.†

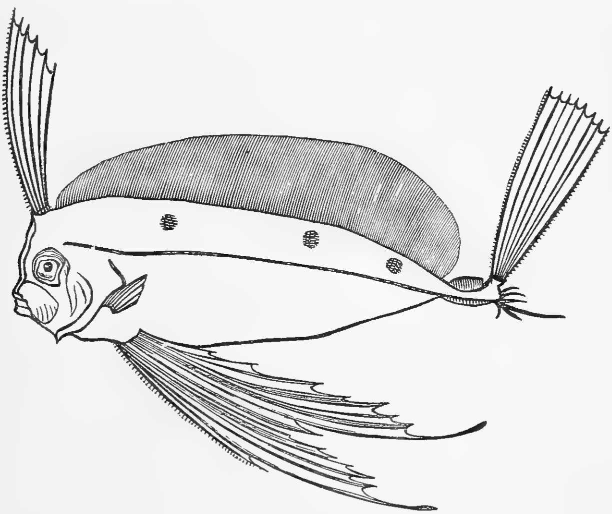
Altogether the family Trachypteridæ contains, without exception, the most singular specimens of the finny tribe, which consequently, from their appearance, attract the fullest attention and observation from even the most casual classes of enquirers. In shape, they are usually long, deep, and very much compressed and flattened on the sides, so much so that their local appellations always embody some idea of these peculiarities—such as ribband-fish, lath or deal-fish, band-fish or blade-fish, and also oar-fish. They are all covered with brilliant silvery skin or scales, and their fins are described in most cases to be of vivid scarlet or red hues; and in addition are generally of the two extremes as far as size is concerned—either very large or very small. Our member of the family is unfortunately of the latter extreme, as you may perceive from the individual now before us

* "Trans. N.Z. Inst.," Vol. X., p. 246, and Vol. XI., p. 269.

† [See also, for specimen from Cape Farewell Sand Spit, "Trans. N.Z. Inst.," Vol. X. p. 533.—Ed.]

"embalmed in alcohol," and from the coloured drawing taken when it first reached me. This fact, however, does not detract much from the grotesqueness of its physique. The fish was obtained by Mr. Charles Robinson, of Arawata, Jackson's Bay, in a pool at high-water mark, which he had constructed as a store-pond for the purpose of keeping mussel-bait alive for fishing, and had evidently been embayed in the pool on the tide retiring. Mr. Robinson placed the fish in a tin full of sea-water, in which it lived for some short time, giving ample opportunity for the full appreciation of its beauty. After it died it was handed to Mr. Macfarlane, R.M., for me, who placed it in a weak solution of carbolic acid and forwarded it by Mr. Marks of the Haast, who was opportunely proceeding to Hokitika. I must express my thanks to these gentlemen for their kindness and attention in the matter, as we were thus enabled to get the fish in a complete state of preservation and perfectly fresh, the only damage accruing to it being a deterioration and change in the colour of the fins, which were described to me by Mr. Robinson as being, when the fish was alive, "like brilliant red feathers more than fins, this, coupled with the bright silver sides, made it gorgeous in the extreme." How much more so would the larger varieties of the family appear to one enabled to view them in their pristine elegance of form and colour, undulating among the vast undisturbed ocean depths and caverns they no doubt inhabit.

I now proceed to give as full a description as I am enabled to make without injuring the specimen before you.



Trachypterus arawatæ, n.s.

D.6—122, and 1 low rudimentary adipose fin.

P.9, V.1+5, A. low rudimentary adipose fin.

C $\frac{8}{6}$, upper soft portion. lower spiny do.

All the fins very fragile indeed; the first portion of the dorsal fin very high, perched on the summit of the forehead, and very distinctly divided from the second portion; the first, second, and third rays of almost equal length; the front of first ray evenly serrated with very minute spines. Second portion of the dorsal with regular rounded margin, reaching its greatest altitude at about the centre of the fin, and carrying this altitude to the second third from beginning of fin. *The rays of this fin are distinctly articulated.* The little rudimentary dorsal, which forms another of the distinctive characters between this and other specimens, commences immediately in the rear of the second part of dorsal, and terminates $\frac{1}{20}$ of an inch from the base of the upper portion of caudal fin. The upper portion of the caudal fin is almost rectangular to body; its base is very narrow; first and last rays slightly thicker than the others, and also finely serrated with very minute spines; the centre rays are the longest. The lower spinous portion of caudal fin runs generally in the longitudinal axis of the fish, but the three upper and three lower spines are recurved inferiorly and superiorly respectively; the first spine is minute, and at the anterior base of this portion of the fin; the third ray is much produced (more than twice the length of the second ray), and is slightly spatulate at tip.

Now comes the greatest point of difference between other specimens and the one under consideration:—The low rudimentary adipose anal fin, which starts immediately at the base of the spinous lower portion of caudal fin, and terminates slightly in front of the vertical from end of second part of dorsal fin; it is gently rounded, and like the adipose dorsal is highest in the centre. The ventrals are very long, and commence a little behind the vertical from posterior base of pectorals; the second ray is the longest and is also slightly spatulate at tip; the first ray is serrated along margin with spines a trifle less fine than those along margins of first dorsal and upper portion of caudal fins. The pectoral fins are minute, commence close to margin of free portion of operculum, and are low down on sides.

The eyes are large; upper front and lower margin round, posterior margin flattened, pupil small, round, and bead-like; they are situated close to margin of profile, and a little above midway between summit of head and chin. Profile of head almost vertical, becoming positively so on the specimen being subjected to the action of the alcoholic solution which coagulated the albumenous portions of the head and slightly altered the proportions from the fresh state. Before immersing in the solution before mentioned, the anterior portion of the face and forehead was soft, rounded, slightly projecting, and semi-transparent, the marginal bones on each side in low ridges. Nostrils single, simple aperture; close in front of eyes. Lateral line commences over top of eyes, runs back in gentle curve over top of gill-opening, thence proceeds straight along side to near tail, then bending quickly downwards, in vertical from end of second part of dorsal fin, reaches the lower margin of body at tail, along which it runs on each side of the rudimentary anal fin, to its termination; it is armed with minute spines along almost the whole of its length; spaced further apart towards anterior portion, growing closer and slightly larger towards tail; they are *not confluent* where they reach the lower margin of body at tail. Gill-openings large; posterior terminating portion of inferior maxillaries armed with blunt spine; free portions of superior maxillaries wide; mouth small. Dentition, internal economy of mouth, verification of gill-rays and arches, and intestines, etc., I have not fully examined and described at present, as doing so would entail partial destruction of the specimen, which has already slightly suffered from the examination and handling necessary on copying, etc. Vent situated under two-thirds of the length of body from snout. Thickest part of fish behind eyes $\frac{3}{20}$ of an inch; back a trifle sharper than belly; sides flat; body high, tail very attenuated.

Measurements.

	Inches.
Length of fish, (body and tail not including caudal fins) ..	2.53
,, head	0.58
,, upper portion of caudal fin	1.05
Extreme length of lower portion of caudal fin	0.35
Length of rudimentary anal fin	0.30
Height ,, ,, ,, ...	0.03
Length of rudimentary 3rd portion dorsal fin	0.20
Height ,, ,, ,, ,, ,, ...	0.05
Direct length of 2nd portion of dorsal fin	2.05
Height ,, ,, ,, ,, ,, ,, ...	0.44
Width of base of 1st portion of dorsal fin	0.12
Height of 1st do. do. ,, ...	1.05
Extreme length of pectoral fins	0.24
Width of base ,, ,, ...	0.07
Extreme length of ventral fins	1.95
Width at base ,, ,, ...	0.08
Greatest diameter of eye	0.18
,, depth of body (a little behind pectoral fins) ..	0.80
Distance from snout to pectoral fins	0.60

Colour.—As immersed in weak carbolic solution, was uniformly bright silver, with three circular dark greyish spots arranged along and close to upper margin of back; fins brownish; eyes silver, pupil black; lateral line yellowish.

Received from Mr. Macfarlane, 29th January, 1880.

Type specimen to be forwarded to Colonial Museum at Wellington.

Art. XXII.—*Contributions to New Zealand Malacology.*

By Professor F. W. Hutton.

[*Read before the Philosophical Institute of Canterbury, 4th November,* 1880.]

Plate VI.

Placostylus bovinus. The odontophore has 120–130 teeth in each transverse row; these rows are slightly curved forwards at the margins. The central teeth have sharp acute points; the laterals are blunt and rounded, with a slight cusp outside.

Paryphanta gilliesii, *Smith*, in the Annals of Natural History, Series 5, Vol. VI., p. 159. From Nelson. The shell is thin and flexible.

Nanina. For a description of the animal of this genus see Strickland, "Proceedings of the Zoological Society of London, 1848," p. 142.

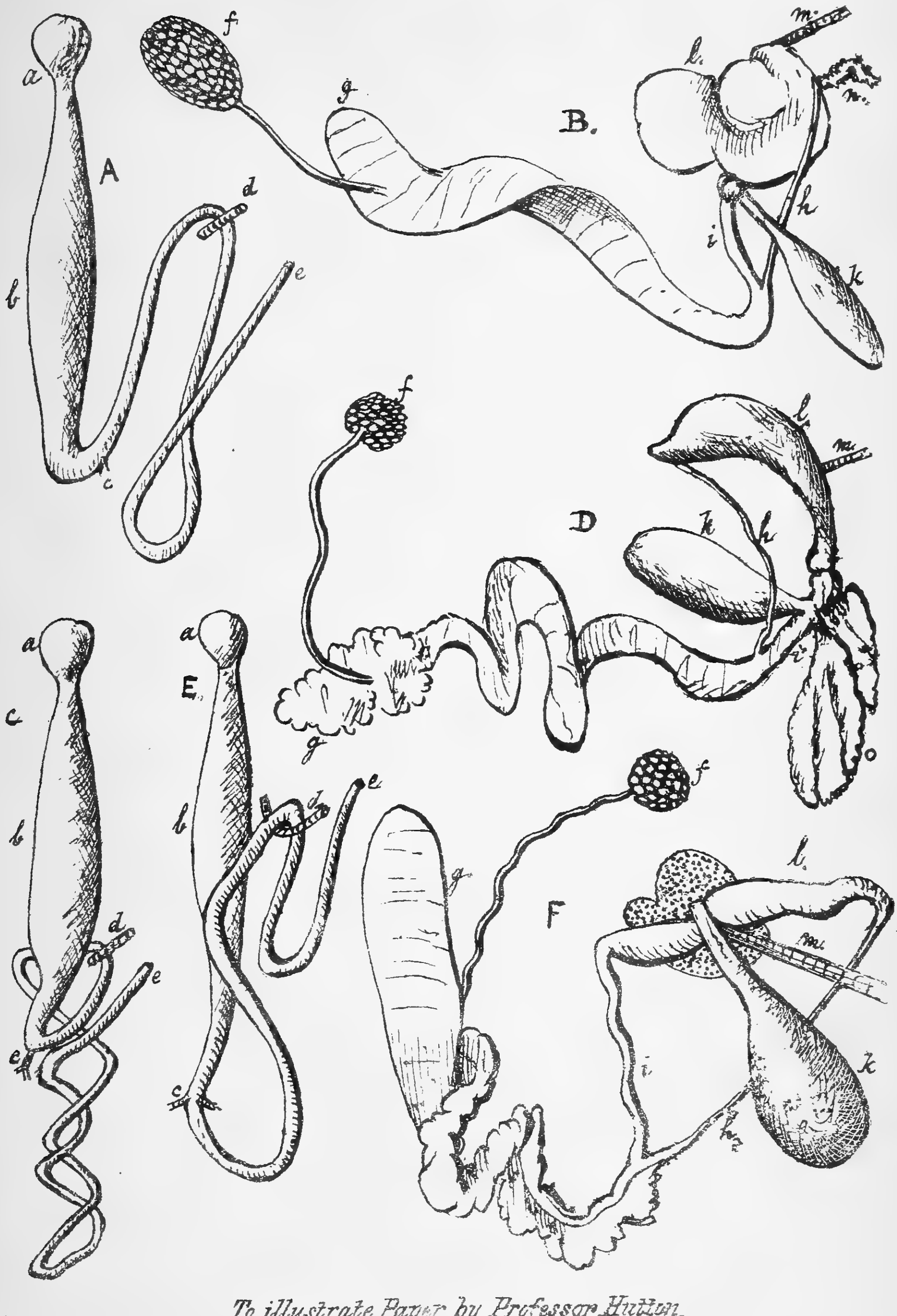
Limax molestus. *Alimentary canal.* The intestine turns forward and to the right before receiving the hepatic duct, and turns to the right again, and backward, round the aorta. It then passes to the posterior end of the body, makes a single bend to the left, and passes straight to the anus. (Pl. VI. f.a.)

Reproductive organs. The ovo-testis is large, oval, and purple in colour; it lays over the liver and intestine in an oblique position sloping backward and to the left. The albumen gland is moderate and smooth. The penis-sac lies to the right of the buccal mass; it is broad and inflated, and the retractor muscle is attached to the middle. There is a white prostate (?) gland opening into the penis with the vas deferens. The spermatheca is narrow, with a long neck. (Pl. VI., f.b.)

Milax antipodum. *Alimentary canal.* The intestine turns forward and to the right soon after leaving the stomach, receiving the hepatic duct at the bend; it then turns to the left, over the aorta, and crosses to the left side below the stomach. It then passes to the posterior end of the body cavity by two spiral curves, made with the sun, and passes forward again by two more curves in the opposite direction until it reaches the first turn of the duodenum, whence it passes straight to the anus. (Pl. VI., f.c.)

Reproductive organs. The ovotestis is small, round, pale purple, and hidden under the liver. The albumen gland is rather large, with crenated margins. The penis sac is long and narrow; the retractor muscle is attached to the middle. The spermatheca is oval, with a short neck. There is no prostate, but a large two-lobed accessory gland opens into the common genital opening by numerous small convoluted tubes. (Pl. VI., f.d.)

Arion incommodus. *Alimentary canal.* The intestine passes backward from the stomach and then, some distance from the hepatic ducts, turns



To illustrate Paper by Professor Hutton.

F. W. H. Del.

forward and to the right. It then passes diagonally over the stomach to the left, and then diagonally to the right round the aorta. It then proceeds backward for a short distance, as far as the pylorus, and turns sharply to the right and forward to the anus. (Pl. VI., f.E.)

Reproductive organs. The ovotestis is small, round, and dark purple. It lies on the liver behind the last turn of the intestine. The albumen gland is very large, with a smooth outline. The spermatheca is pinkish, oval, and with a long neck. The oviduct swells out before opening into the common genital orifice. The penis sac is long and narrow, and lies just under the pulmonary chamber, the retractor muscle is attached at the anterior end. There is no prostate gland.

Onchidella nigricans. The lingual teeth are arranged in transverse rows which form an acute angle in the middle, pointing forwards. They are acute, and very numerous, more than 200 in a transverse row. Adams gives it as a character of the family that the teeth are in straight transverse rows.

Auricula quoyi, *Adams.* Described by Sowerby in the "Conchologia Iconica," fig. 39, and stated to come from New Zealand. I very much doubt the correctness of the locality.

Tralia costellaris. This is figured by Sowerby in the "Conchologia Iconica," fig. 42.

Ophicardelus australis. This is figured by Sowerby in the "Conchologia Iconica," fig. 34.

Siphonaria obliquata. Lingual teeth about 80 in a transverse row.

Siphonaria sipho. Lingual teeth about 60 in a transverse row. Animal yellowish ochre, spotted with dark purple ; foot yellow.

Gadinia nivea. Lingual teeth arranged in transverse rows which form an obtuse angle in the middle, very minute, about 100 in a transverse row. Absent from the median line.

Defranchia luteo-fasciata. 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, approximated; the eyes at their outer bases. Siphon curved. Foot expanded in front, nicked on each side. No operculum.

Not uncommon on seaweed in Port Lyttleton.

Neptunea nodosa. Quoy figures the animal with a long recurved siphon. This should put it into the *Buccinidæ.* It will probably form a new genus.

Euthria lineata, *variety D.* Animal pale yellow ochre. Eyes half-way up the tentacles. Siphon short. Foot emarginate in front. The animal resembles that of *Neptunea.*

Euthria lineata, *variety C.* Animal like the last, but white.

Polytropa striata. Animal white. Siphon short, open below. Foot expanded anteriorly.

Turbo smaragdus. Animal a dark rich brownish black; tentacles and filaments lighter in the young. Filaments three on each side.

Rotella. The animal of this genus is described by Gray in the "Annals of Natural History," Series 2, Vol. 12, p. 179; and by Adams in the same periodical, Series 3, Vol. 6, pp. 109 and 288.

Anthora tiarata. Body white; head purplish brown, with a broad white longitudinal median band widening backward; head lobes purplish brown, margined with white; proboscis purplish brown, tipped with a white band, within which is a very dark band; foot sooty brown, speckled with white; the posterior upper surface, behind the operculum, white, with two rows of oblique black lines; tentacles light purple; eye peduncles white or purplish; side lappets transparent white, with opaque white spots. Filaments four on each side, retractile into sheaths; behind and below each filament is a second shorter one. Tentacles and filaments fringed with small retractile papillæ, which are larger on the filaments. Sides of the foot raised into a sharp margin.

Diloma æthiops. Foot black, margined with black and white transverse lines, inside of which is a band of yellow dotted with black. Proboscis black, margined with yellow; head black, the inner head-lobes margined with yellow below; lower surface of eye peduncles yellow; tentacles longitudinally striped above with black and white. Filaments three on each side, bluish. Body and sole of foot white. Mantle margined with green.

Zizyphinus punctulatus. Foot rich brown, speckled with white, the sides deepening into dark brown, generally with some white spots; a row of about six small white spots on each side of the anterior portion of the foot; side lobes the same as the foot. Top of the head rich brown; proboscis dark rich brown, tipped with white. Eye peduncles rich brown; tentacles pale brown. Side filaments four on each side, rich brown. Foot with a raised margin on each side behind the operculum, emarginate in front.

Cantharidus pupillus. Foot black, or dark brown variegated with white. Head white with a black mark on the vertex, or black. Tentacles white, or purple, or purple margined with white, or with three purplish longitudinal stripes. Proboscis black, margined with yellow. Filaments three on each side, white, or purplish; both they and the tentacles fringed. Foot fringed in front; a pectinated side lobe between the tentacles and the anterior filaments. Shell umbilicated or not umbilicated.

This very variable species is abundant on seaweed in Lyttelton harbour. It may perhaps be divided into three varieties; but they run one into the other.

A. Ribs of shell narrower than the grooves; five above the periphery. Foot black; tentacles black.

B. Ribs of shell narrower than the grooves; seven above the periphery. Foot black; tentacles margined with white.

C. Ribs of shell broader than the grooves; five or six above the periphery. Foot variegated.

PARMOPHORUS UNGUIS. Mantle ample, covering the whole foot and head, expanded on each side, with a simple margin, fissured in front. Tentacles two; eyes at their outer bases. A row of short cirri on each side of the neck and foot. Gills two, symmetrical, outside the shell, under the mantle; a round white renal organ at their apices. The whole body dark blue-black; mantle paler below; sole of the foot white. Habits nocturnal.

PATELLA INCONSPICUA. Animal yellowish white; head dark purple; tentacles with the outer half purple, very broad at the base and tapering.

DORIS LONGULA? Body oval, depressed; mantle large, expanded all round, with a smooth margin, finely granular; rhinophores conical, short, thick, and ringed; branchiæ six, each double; length 1·5 inch; breadth ·8 inch. Foot bright orange, showing the dark-coloured liver through it; mantle orange-yellow, freckled with small round white spots which form a more or less reticulated pattern; branchiæ yellow-orange; rhinophores orange.

This description applies to two specimens that I found in Lyttleton harbour, and which I think must be *D. longula.* The specimens are now in the Canterbury Museum.

PHIDIANA LONGICAUDA. Although Quoy describes the tentacles as clavate, he figures them as tapering. The generic position therefore of the animal must remain uncertain until it is re-discovered.

MONTAGUA CORFEI, *sp. nov.*

Last September Mr. C. C. Corfe of Christ's College brought me two living specimens of a beautiful little Nudibranch which he had collected at Governor's Bay in Port Cooper. As the species has not yet been described I have much pleasure in dedicating it to its discoverer. It belongs to the genus *Montagua* of Gray.

Tentacles approximated, tapering, standing erect at some distance behind the oral tentacles; a minute eye at their outer bases. Oral tentacles distant, tapering, half as long again as the tentacles. Body prolonged posteriorly into a long tapering tail. Branchiæ in four or five rows on each side of the back; crowded, linear, pointed, unequal. Foot grooved along the centre, the margin thin; contracted anteriorly and then produced on each side into a curved tapering fold directed backward.

Foot, back, tentacles, and oral tentacles translucent white; a dead white longitudinal line down the centre of the tail. Head pale pink. Branchiæ bright red, tipped with dead white.

Length about an inch, of which the tail is more than one-fourth.

Chamostræa. The animal is described by Hancock in the "Annals of Natural History," series 2, vol. II., p. 106; and by Deshayes in the "Proceedings of the Zoological Society," 1853, p. 67.

Mactra æquilateralis. When alive the young shell is rosy purple, but the colour fades after death.

Mesodesma spissa. The siphons are divergent and thick; the branchial is much thicker than the anal, and fringed. The anal siphon is tapering.

Artemis australis. The siphons are more than half the length of the animal, and slightly curved dorsally; the anal siphon is narrower and tapering.

Chione stuchburyi. The siphons are united throughout the whole length.

Mytilus ater. This appears to be the same as *M. crassus*, T. Woods, from Tasmania.

EXPLANATION OF PLATE VI.

A.	*Limax molestus.*	Alimentary canal.
B.	,, ,,	Reproductive organs.
C.	*Milax antipodum.*	Alimentary canal.
D.	,, ,,	Reproductive organs.
E.	*Arion incommodus.*	Alimentary canal.
F.	,, ,,	Reproductive organs.

a. Buccal mass.
b. Stomach.
c. Hepatic ducts.
d. Aorta.
e. Anus.
f. Ovotestis.
g. Albumen gland.
h. Vas deferens.
i. Oviduct.
k. Spermatheca.
l. Penis sac.
m. Retractor muscle of penis.
n. Prostate gland.
o. Accessory gland.

Art. XXIII.—*Recent Additions to and Notes on New Zealand* Crustacea.

By G. M. Thomson, F.L.S.

[*Read before the Otago Institute, 11th May, 1880.*]

Plates VII. and VIII.

The following notes and descriptions of new species have been made during the past two years, and supplement the papers read by me before this

Institute during the session of 1878.* As generic descriptions of Crustacea are not accessible to most of the readers of our "Transactions," I have thought it advisable to supply these in all cases where the genera are new to this country. The various species are mentioned in the following order, viz., Schizopoda, Isopoda, Amphipoda, and Phyllopoda.

Schizopoda.

Fam. MYSIDÆ.

Thorax covered by a carapace, which extends to the base of the ocular peduncles, and is produced into a rudimentary rostrum. Mouth situated near the base of the antennæ. Six pairs of thoracic feet, provided with a well-developed palp. Tail of five plates, forming a swimmeret, as in *Macroura decapoda.*

Genus **Mysis,** Latreille.

External antennæ beneath the eyes, bearing two terminal filaments. Internal antennæ beneath the external; first joint furnished with an elongated laminar appendage; two succeeding joints slender and cylindrical, terminated by a long, filiform, multi-articulate flagellum. Pedipalps two pairs, entirely pediform; first pair three-branched; second pair two-branched. Six pairs of thoracic feet, consisting each of two branches, decreasing in length from before backwards, and formed for swimming; last two pairs furnished with a flabelliform appendage. In the female these acquire a great development, and constitute two large semi-circular plates, folded below so as to form an oviferous pouch, in which the young pass through their first stage of development. Abdomen very slender, tapering, elongated, nearly cylindrical.

1. *M. denticulata,* G. M. Thomson, (Ann. & Mag. N.H., ser. V., Vol. VI., p. 1.) Fig. 1.

Female.—Carapace rather slender and short, with a short, triangular, acute rostrum. Peduncle of the internal (upper) antennæ extending to the extremity of the scale of the external antennæ; second joint very short; third the widest. Scale of external antennæ somewhat broad, with a tooth at the outer angle, and long ciliæ on its inner side, and at its extremity. Middle lamella of the tail entire, toothed on each side, and with two strong teeth at the apex. Lateral laminæ exceeding the central one; the inner narrow-lanceolate, acute, and furnished with long hairs on each side; the outer obtuse, with the apical half narrowing, ciliated only at the extremity and on the inside, and with a few stout teeth about the middle of its outer margin. Length ·5 inch.

Hab.—Dredged in Dunedin harbour, 4–5 fathoms.

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* See "Trans. N. Z. Inst." Vol. XI., p. 230, *et seq.*

Isopoda Normalia.

Fam. ARCTURIDÆ.

Genus **Arcturus,** Latreille.

Body slender and cylindrical, fourth segment greatly elongated. Antero-lateral margins of the head produced forward. Eyes large, semi-globose. Superior antennæ very short. Inferior antennæ long. Four anterior pairs of legs slender and ciliated ; abdominal legs short and very robust. Terminal segment of abdomen large, scutiform, and furnished below with two large opercular plates (somewhat similar to *Idotea.*)

1. *A. tuberculatus*, G. M. Thomson (Ann. & Mag. N.H., ser. V., vol. IV., p. 416). Fig. 2.

Male.—Body rather robust. Head very indistinctly separated from first thoracic segment, and together with the two succeeding segments produced upwards into acute tubercles. Fourth segment smooth, bearing a single stout spine at each extremity, the posterior one being bifid. Superior antennæ reaching beyond extremity of second joint of inferior; basal joint stout, second and third short, fourth as long as the two preceding, and bearing several articulated processes, consisting each of a basal joint, and a long lamellar appendage. (From want of sufficient specimens, I have not been able to investigate the function of these appendages). Inferior antennæ rather longer than four anterior segments of the body, not ciliated, but with rows of minute tubercles on the lower margin ; first and second joints rather short ; third and fourth long ; flagellum three-jointed, finely serrated on its inner margin, and furnished with a few cilia. The inferior antennæ are the chief organs of progression in the animals of this genus, and also serve to catch the prey and bring it to the mouth ; in this species they are apparently well-fitted for their functions.

The *female* differs from the above in having the whole body (except the margins of the lower antennæ) more or less tuberculate. The head and three posterior segments bear a row of tubercles on each side. The fourth segment is flattened on its posterior lateral margins ; it bears on the median line at its anterior extremity a large three-pointed tubercle, behind which are three smaller tubercles placed transversely, the middle one being the smallest ; on each side of the anterior margin are two tubercles, the lower of which is the largest. The oviferous pouch extends along three-fourths of the lower surface of this segment. The fifth segment of the body is extended downwards as if to form a supplementary pouch.

Length ·2 inch, exclusive of the inferior antennæ.

Hab. Dredged in Dunedin harbour, 4–5 fathoms.

(This may be *Leachia nodosa*, Dana.)

Isopoda Aberrantia.

Fam. TANAIDÆ.

Body narrow and elongated. First pair of gnathopoda (anterior feet) large, and furnished with a didactyle hand ; second pair approximating to the pereiopoda. Eggs borne in a sub-pectoral pouch beneath the five central segments of the body. Abdomen terminated by two setaceous articulated appendages.

Genus **Tanais,** Audouin and M.-Edwards.

Cephalon and first segment of pereion confluent. Antennæ short, sub-equal. First pair of gnathopoda very large, didactyle ; second pair slender and simple. Pleon five-jointed, fourth joint short, fifth terminated by a pair of *single-branched*, filamentary uropoda.

1. *T. novæ-zealandiæ*, G. M. Thomson (Ann. & Mag. N.H., ser. V., vol. IV., p. 418).

Fig. 3.

Body broader than deep, with transverse fascicles of rough (furry) hairs on the three anterior segments of the pleon. Eye very small, black, and circular, placed on a prominent lateral lobe of the anterior margin of the head. Superior antennæ three-jointed, setose at the extremity ; first joint longer than the two succeeding. Inferior antennæ rather shorter than superior. First gnathopoda very stout, the immobile finger of the hand smooth on its inner margin, or only slightly denticulated. Second gnathopoda very slender. Posterior pleopoda bearing a smooth—not denticulated—sickle-shaped finger, with a few long cilia at its base. Terminal uropoda almost as long as antennæ, five-jointed, and with numerous setæ. Length ·18 inch.

Hab. Dredged in Dunedin harbour, 4–5 fathoms.

Genus **Paratanais,** Dana.

Cephalon fused with first segment of pereion. Eyes shortly pedunculated. Antennæ without a flagellum, (with rudimentary flagella, *Bell*) ; inferior pair more slender than the superior. Gnathopoda as in *Tanais.* Pleon with six segments ; five anterior pairs of pleopoda, formed of ciliated swimming-plates ; sixth segment terminated by a pair of two-branched sub-styliform uropoda.

1. *P. tenuis*, G. M. Thomson (Ann. & Mag. N.H., ser. V., vol. VI., p. 2.)

Body slender. Head (when seen from above) narrowing anteriorly, front margin nearly straight. Eyes triangular ; peduncles so short as to be scarcely visible. Superior antennæ stout ; inferior pair about two-thirds as long as superior, and slender. First gnathopoda stout ; mobile finger smooth on the inner margin ; immobile finger terminated by two or three denticles, inner margin slightly convex and furnished with a few stout hairs. Second gnathopoda long and very slender, terminating in a filiform claw. Two anterior pairs of pereiopoda, comparatively slender, but little stouter than the second gnathopoda; succeeding pairs stronger. Last segment of abdomen somewhat triangular, with a truncate apex, terminated by two minute setæ. Terminal uropoda with the inner branch four-jointed, and more than half as long as abdomen; outer branch one-jointed, as long as first joint of inner.

Length .065 inch. A very minute species.

Hab. Dredged in Dunedin harbour. Also dredged in Paterson Inlet, Stewart Island, in ten fathoms.

Amphipoda Normalia.

Fam. ORCHESTIDÆ.

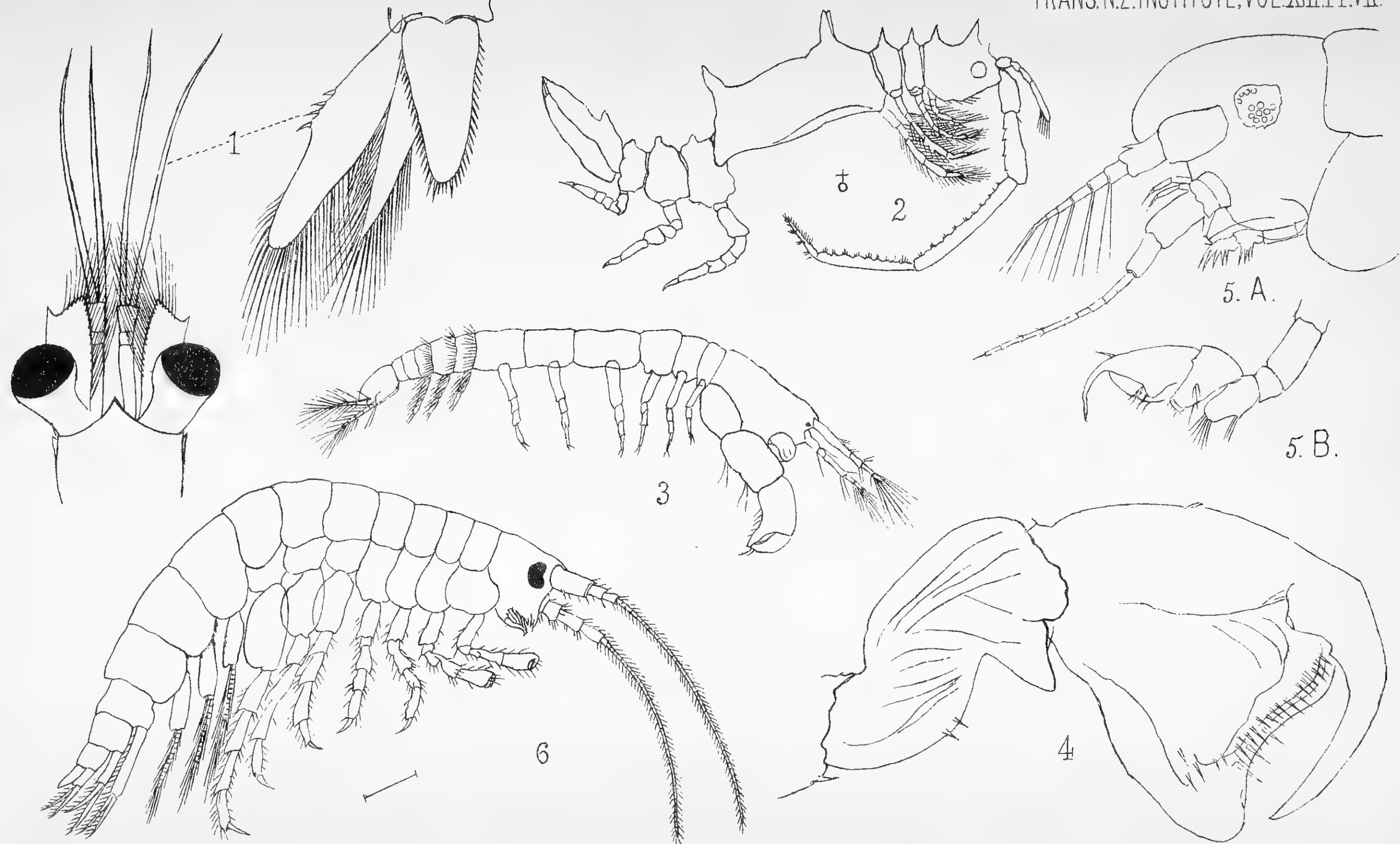
Genus **Orchestia.**

In Miers' Catalogue of New Zealand Crustacea seven species of this genus are mentioned, the descriptions being chiefly reproduced from Sp. Bate's Catalogue of Amphipoda in the British Museum. The first thing that strikes one on reference to this list is that of some species only females are described. They are as follows:—*O. aucklandiæ*, male and female; *O. novæ-zealandiæ*, female only; *O. telluris*, male and female; *O. sylvicola*, male and female (Sp. Bate only describes the male, but Miers has the description of the female also, though he does not say where or from what specimens he got it); *O. tenuis*, female only; *O. chilensis*, male and female; and *O. serrulata*, male and a doubtful female. As I have collected these animals for some years, it may prove of interest if I record my experiences here, though I feel that my observations are still in many respects very imperfect.

(1.) *O. aucklandiæ*, Sp. Bate. This is a very common littoral species in Stewart Island, where I have taken it in great numbers under stones between tide-marks. It is extremely active, running and jumping vigorously when pursued. The males are nearly an inch long, and have the first five segments of the pereion corrugated more or less, the anterior and posterior margins of the segments being strongly ridged.

(2.) *O. novæ-zealandiæ*, Sp. Bate. The description of this species in the Brit. Mus. Cat., and which has been transferred without material change to Miers' Cat. of N.Z. Crust., appears to have been drawn up from a single specimen, and its habitat is given very widely as "New Zealand, presented by Captain Bolton." I am inclined to think that this is a form of a polymorphic species, which also includes *O. sylvicola* and *O. tenuis*, and shall therefore refer to it again further on.

(3.) *O. telluris*, Sp. Bate. In the Brit. Mus. Cat., p. 21, the following note is appended to the description of this species:—"The specimens of



NEW ZEALAND CRUSTACEA. See Art. XXIII.

C. M. Thomson, del.

this species were taken under dead leaves in the woods by Mr. Hook during the voyage of the Erebus and Terror, and presented to the British Museum." As this is a littoral species, it is probable that the dead leaves were on the extreme edge of the bush, close to high water-mark. I have taken it in such localities myself in great abundance, both at Otago heads and at many spots in Stewart Island, but always within a few yards of the beach, and just where the sea and bush soil meet. In "Facts for Darwin," p. 27, Fritz Müller—somewhat led astray by the habitat given by Sp. Bate—says:—"I cannot refrain from taking this opportunity of remarking that (so far as appears from Spence Bate's catalogue), for two different kinds of males (*Orchestia telluris* and *sylvicola*) which live together in the forests of New Zealand, only one form of female is known, and hazarding the supposition that we have here a similar case.* It does not seem to me to be probable that two nearly-allied species of these social Amphipoda should occur mixed together under the same conditions of life."

This passage is unintentionally misleading, for *O. telluris* is by no means a terrestrial species. It lives in burrows in the sand just above tide-marks, and in the localities where it occurs may be seen hopping about in countless numbers. It certainly does not occur in the bush, strictly so called, but only on the very margin of it, where it joins the beach. Both male and female of this species are very distinct in form, in the former particularly the squamiform plate on the carpus of the fifth pair of pereiopoda, is a very characteristic mark.

(4.) *O. chilensis*, M.-Edw., is another very distinct species. It is the most strictly littoral of all the species, living under stones and in little pools between tide-marks, and never coming out on dry sand. It occurs in great abundance round our coasts, and is the commonest form in Otago harbour.

(5.) *O. serrulata*, Dana. While in Stewart Island in January last, I got four males and one female of this species under stones between tide-marks in Paterson Inlet. These agreed in all respects except size (they were under half an inch long) with the description in the Brit. Mus. Cat.

(6 and 7.) *O. sylvicola*, Dana, and *O. tenuis*, Dana.

In regard to the last of these species, the habitat given in the Brit. Mus. Cat. is "Bay of Islands, New Zealand, Dana." This would lead one to believe that the species was marine or littoral. I have collected *Orchestiæ* in great numbers for some years past from many localities, and have never found any answering to this species among either marine or littoral forms. In the bush, however, I have frequently gathered specimens which I have referred to it, though somewhat doubtfully. The same remark applies to

* Alluding to the two forms of male of *Orchestia darwinii.*

O. novæ-zealandiæ, which I believe I have gathered in the bush but never on the coast. *O. sylvicola* is recorded by Dana as having been obtained "from moist soil in the bottom of the extinct volcano of Taiamai, twenty miles from the sea, and about the joints of succulent plants." The Brit. Mus. specimen was obtained in the voyage of the Erebus and Terror, and "was found associated with *O. telluris*." As I have already said, this was probably on the edge of the bush near high-tide mark.

It is singular that Prof. Dana should have described the male only of *O. sylvicola*, for it has been frequently noticed, both by Professor Hutton and myself, that males are extremely rare. The examination of a large number of specimens of terrestrial *Orchestiæ* gathered in the bush and at the roots of plants in many localities distant from the sea, leads me to the conclusion that varying forms of the same species have been described under three names, namely, *O. novæ-zealandiæ*, fem., *O. sylvicola*, fem., and *O. tenuis*, fem. The principal characters employed in the identification of these species are :—

(1) the length of the superior antennæ ; (2) the length of the inferior antennæ, together with the relative length of the flagellum to the peduncle, and the relative lengths of the ultimate and penultimate joints of the peduncle ; (3) the sizes and shapes of the gnathopoda, and particularly of their terminal joints; and (4) the relative lengths of the three posterior pairs of pereiopoda. If the characters of the three species are arranged in tabular form it will be found that there is very little to choose between them.

Female.	*O. sylvicola.*	*O. novæ-zealandiæ.*	*O. tenuis.*
Upper antennæ ..	Reaching beyond the extremity of penultimate joint of lower	Reaching beyond extremity of penultimate joint of lower	About as long as base of inferior
Inferior antennæ ..	More than half as long as body	More than half as long as animal	About half as long as body
Flagellum	As long as peduncle	Longer than peduncle and spinous	Much longer than base
Ultimate joint of peduncle ..	Twice as long as penultimate	Slightly longer than penultimate	
Posterior pereiopoda	Third pair nearly as long as fourth	Third pair as long as fourth and fifth	Very unequal; increasing regularly in length; fifth pair nearly twice longer than third.

I have not compared in the table the characters of the gnathopoda, but if these are examined and the wording of the descriptions rendered uniform, it will be found that there is little to choose among them. Further, the distinctive points in the foregoing table are in organs liable to great modification, particularly at varying ages.

In the specimens gathered by me there was considerable diversity on the first point, even among specimens gathered from the same spot; there were great differences in the structure of the inferior antennæ; while there was considerable uniformity on the fourth and fifth points.

The specimens were from a number of different localities, and it is remarkable fact that, with few exceptions, females only were found. The commonest colour was a clear red-brown, but some were yellowish-red, others marbled reddish and pink, and others dark muddy brown.

(1.) From Otago Peninsula, among ferns, &c., in the bush. Thirty-one specimens of all sizes, all females, answering to description of *O. sylvicola*, female.

(2.) From Dunedin, among the roots of cocksfoot and other grasses on the town belt, about a mile from the bay. Thirty-nine specimens. These showed an extraordinary diversity: twelve were females agreeing with *O. sylvicola*, female; twenty-four were females much more similar to *O. tenuis*, female; while three were males. These last do not agree with the descriptions of the males of *O. sylvicola* having very remarkable propoda (fig. 4) to the second pair of gnathopoda. These resemble the corresponding organs of *O. aucklandiæ* more than any other species. The upper antennæ are as long as the peduncles of the lower, and in this and other characters they approximate most to the description of *O. tenuis*.

(3.) From Flagstaff hill near Dunedin, among bush, at an elevation of about 1,300 feet. Twenty-one specimens, all females, answering to *O. sylvicola*, female.

(4.) From Preservation Inlet, in the bush. Three specimens, females, corresponding most nearly to *O. tenuis*, female.

(5.) From Port Pegasus, Stewart Island, in the bush. Nineteen specimens, all females. Of these, nine approximated pretty well to *O. sylvicola*, female, while the other ten came nearer to *O. novæ-zealandiæ*, female, in all but the length of the third pair of pereiopoda which was in every case much shorter than the fourth and fifth pairs.

(6.) From Copper Island (Paterson Inlet) Stewart Island, in the bush. Thirty specimens, of which twenty-nine were females and one male, all agreeing well with the description of *O. sylvicola*.

(7.) From bush in the neighbourhood of Dunedin. Twenty specimens, of these nineteen were females and one male. The latter, while agreeing generally with *O. sylvicola*, male, differed in having the inferior antennæ very short, being little over a third of the length of the body; and in having the third pair of pereiopoda much shorter than the fourth pair.

The females were very variable, so that I am unable to refer them with certainty to any species. The antennæ vary greatly in length: thus the superior pair in some extend only as far as the extremity of the penultimate joint of the peduncle of the lower, while in others they extend as far as the extremity of the ultimate. In some cases the inferior pair are not one-third as long as the animal; in others they are more than half as long. Some exhibit a regular gradation in length of the 3rd, 4th, and 5th pereiopoda; others have the 4th and 5th equal, and the 3rd very short; while others again have the 3rd and 4th subequal and short, and the 5th very long.

From the examination of the foregoing specimens, numbering in all 163, I am strongly of opinion that they all belong to one variable species, the males of which have at least two forms of gnathopoda, and the females of which differ considerably in those very characters which have hitherto had specific importance attached to them. At present, our knowledge of this genus leads us to reduce the New Zealand species to five, namely:—

(1). *O. aucklandiæ*, Sp. Bate. Auckland, (Coll. Par. Mus.); Auckland Islands; Stewart Island. Littoral.

(2). *O. telluris*, Sp. Bate. New Zealand (Coll. Brit. Mus.) Common on sandy shores.

(3). *O. chilensis*, M.-Edw. Akaroa (M.Jacquinot). A common littoral form.

(4). *O. serrulata*, Dana. A littoral species. Bay of Islands, (Dana);—Stewart Island.

(5). *O. sylvicola*, Dana, (including *O. novæ-zealandiæ*, Sp. Bate, and *O. tenuis*, Dana). A strictly terrestrial form, always occurring among dank vegetation, bush soil, etc., and drowning very rapidly in water. Extremely common.

Fam. GAMMARIDÆ.

Sub-fam. Stegocephalides. (Brit. Mus. Cat. Amph. Crust., p. 54).

Superior and inferior antennæ subequal. Coxæ of second pair of gnathopoda, and of the first and second pairs of pereiopoda, monstrously developed; second pair broader than the preceding. Pereiopoda subequal. Last three pairs of pleopoda styliform. Telson single.

Genus **Panoplæa**, G. M. Thomson.

(Ann. & Mag. N. H. ser. V., Vol. VI., p. 2).

In the course of dredgings during the last two summers, I have frequently obtained specimens of an Amphipod which at first I took to be a species of *Pleustes*, an Arctic genus, particularly as Mr. T. W. Kirk recorded *P. panoplus*, Kröyer, as having been collected on our coasts. Closer examination, however, convinced me that not only was the local species different from either of the described species of *Pleustes*, but that it also differed in generic character, though only to a small extent. Later on I obtained a second form allied to the first, and to include both these I have formed the genus *Panoplœa*, so named from the coat-of-mail which envelopes the first-discovered form. The genus differs from *Pleustes*, in having a well-developed squamiform plate on the ischium of the maxillipeds, and in the gnathopoda being slender, and more or less chelate. The general appearance of the animals comprising this genus is also very different.

The following is the generic character :—

" Coxæ of the four anterior segments well developed, those of the second pair excavated on the upper part of the posterior margin. Antennæ subequal, without a secondary appendage. Mandibles with an appendage. Maxillipeds with a squamiform process on the ischium. Gnathopoda feeble, almost chelate. Three posterior pairs of pleopoda double-branched. Telson simple, squamiform."

1. *P. spinosa*. G. M. Thomson (loc. cit., p. 3, pl. I., fig. 2).

Cephalon produced into an acute rostrum. Pereion broad, smooth, the dorsal margins of the last segment and of the first two of the pleon produced posteriorly into two spines. Coxæ of the gnathopoda narrow, but deep. Eyes reniform, pale reddish in colour. Superior antennæ longer than the inferior. Both pairs of gnathopoda very slender: first chelate, ischium and carpus long, propodos with a mobile finger articulating at some distance from the setose extremity ; second pair nearly chelate, basos very long, propodos fringed with simple hairs on its inferior margin, dactylos articulating almost as in first pair. Pereiopoda increasing somewhat in size posteriorly, squamiform plates of the base of the last three pairs toothed on their posterior margins. Three posterior pairs of pleopoda subequal ; rami of the penultimate pair unequal. Telson subquadrate; extremity slightly excavate.

Colour varying from light to dark brown, thickly covered with black stellate markings. Length 0·45 inch.

Hab. Taken abundantly with the dredge in Dunedin harbour in 4–5 fathoms, among kelp and sertularians.

2. *P. debilis*, G. M. Thomson (loc. cit., p. 3, pl. I., fig. 3).

Coxæ less developed than in *P. spinosa*. Pereion tumid ; pleon slender, its first two segments and last of pereion produced on their postero-dorsal margins into spines. Cephalon produced into a very short rostrum. Eyes circular, black. Superior antennæ nearly as long as the body, rather longer than the inferior; peduncle very short. Gnathopoda feeble, sub-chelate; first pair small, basos long, fringed with a row of short spines on the anterior margin, propodos long, dactylos small, transverse; second pair similar in form, but very long and slender. Pereiopoda as in *P. spinosa*, but with the margins of the squamiform plates smooth. Telson rounded at the extremity. Colour uniformly light brown (when examined under a low power of the microscope the whole body is seen to be dotted with reddish-brown star-like marks). Length 0·35 inch.

Hab. Taken along with the preceding species in Dunedin harbour.

Sub-fam. PHOXIDES. (Brit. Mus. Cat. Amphip. Crust., p. 79.)

"The cephalon is produced in advance, more like a hood than a rostrum. The superior antennæ are situated considerably in advance of the inferior. The integumentary structure is generally thin and semi-transparent; and I am inclined to think that most of the genera are burrowers, for which purpose the hood-like cephalon affords an efficient protection. The three posterior pairs of pleopoda are double-branched."

Genus **Amphilochus,** Spence Bate.

(Brit. Mus. Cat., p. 107.)

Cephalon anteriorly depressed. Eyes two, posterior to the superior antennæ. Superior antennæ without an appendage. Gnathopoda sub-chelate; in both pairs the carpus is produced along the inferior margin of the propodos. Pereiopoda subequal; coxæ of the third pair not so deep as the preceding. Telson single.

(Mandibles with an appendage, terminal joints of the maxillipeds spinous, not clawed.)

1. *A. squamosus,* G. M. Thomson (loc. cit., p. 4, pl. I., fig. 4).

Fig. 5A & B.

Body broad and thick anteriorly, slender posteriorly. When seen under a medium power of the microscope the integument—which is very thin—is seen to be covered with minute scale-like marks and spines, hence the specific name. The cephalon (fig. 5A) is depressed anteriorly between the bases of the superior antennæ. Eyes large, deep red in colour, but not easily made out owing to the numerous and dense reddish-black spots with which the greater part of the body is coloured. Superior antennæ shorter than inferior; peduncle shorter than flagellum, which is seven-jointed and carries two long setæ at the extremity of each joint. (The last joint of the peduncle bears a minute one-jointed appendage.) Inferior antennæ not one-fourth as long as body; flagellum slender, longer than the peduncle, smooth. Gnathopoda (fig. 5B) subequal and similar in form; meros and carpus produced into obtuse lobes, which are spinous at the extremity; propodos with a rounded palm, and a few spines at the point of impingement of the slender, falcate dactylos. Pereiopoda slender and subequal. Ante-penultimate pleopoda reaching almost to the extremity of the ultimate, smooth; penultimate much shorter, and together with the posterior (ultimate) pair, having somewhat unequal rami. Length, 0·15 inch; colour, brown, covered with reddish-black round spots, chiefly on the pleon.

Hab. Dredged in Dunedin harbour, 4–5 fathoms, on sandy bottom.

Sub-fam. Gammarides.

Genus **Amphithonotus,** Costa.

(Brit. Mus. Cat. Amphip. Crust., p. 150.)

Body not laterally compressed. Cephalon produced into a rostrum. Antennæ slender, without secondary appendage. Mandibles having an appendage. Squamiform plates to the maxillipeds not largely developed. Gnathopoda similarly formed, subequal, having the carpi inferiorly produced. Pereiopoda subequal. Posterior pair of pleopoda double-branched. Telson single, cleft at the apex.

1. *A. levis*, G. M. Thomson (Ann. & Mag. N.H., ser. V., vol. IV., p. 330). Fig. 6.

Animal quite smooth and not carinated on the back. Cephalon produced into a small falcate rostrum, which projects between the bases of the antennæ. Eyes large, subreniform. Superior antennæ slightly exceeding the inferior, about half as long as the animal; peduncle very short; flagellum long, slender, and multi-articulate. Peduncle of inferior antennæ longer than peduncle of superior. Appendage of the mandibles long, middle joint exceeding the other two. Maxillipeds having the appendages longer than their respective joints. Gnathopoda small, subequal, abundantly ciliated; propodos with a well-defined, nearly transverse, palm, against which the dactylos impinges closely. Pereiopoda subequal, posterior pair the longest. Pleopoda subequal; rami lanceolate, those of the penultimate and ante-penultimate pairs unequal in length. Telson tubular, notched at the apex. Length ·3 inch.

Hab. Dredged in Dunedin harbour in 4–5 fathoms.

Though agreeing closely in generic characters, this species is very distinct in appearance from *A. edwardsii*, as figured in the Brit. Mus. Cat., and also apparently from *A. spiniventris*, Costa.

Genus **Eusirus,** Kröyer.

(Brit. Mus. Cat., p. 154.)*

" Cephalon not rostrated. Pereion and pleon compressed. Superior antennæ long and slender, having a secondary appendage; inferior antennæ

* The species described by me, though too near *E. cuspidatus*, Kröyer, to be separated from it except as a variety, differs from the generic character in the following points:—The maxillipeds are certainly not unguiculate, the propodos being obtusely pointed and densely clothed at the extremity with hairs, and the dactylos being obsolete; the cephalon also has a small rostrum.

having the peduncle longer than the peduncle of the superior. Mandibles having an appendage. Maxillipeds unguiculate, having a small squamous plate to the coxa, basos, and ischium. Gnathopoda uniform, each having the propodos large, with the postero-inferior margin posteriorly produced; carpus attached to the propodos near the centre of its superior margin; infero-anterior margin produced along the inferior margin of the propodos. Pereiopoda slender, subequal. Posterior pair of pleopoda biramous. Telson long, narrow, cleft at the apex."

1. *E. cuspidatus*, Kröyer, var. *antarcticus*, G. M. Thomson (Ann. & Mag. N.H., ser. V., vol. VI., p. 4).

Pleon having the first two segments produced backwards on their postero-dorsal margins into teeth; fourth segment with a central dorsal sinus. (Two posterior segments of the pereion smooth, not produced into teeth.) Eyes reniform. Superior antennæ scarcely half as long as the animal; peduncle shorter than flagellum; flagellum minutely articulated, every third articulation produced downwards into a tubercle and furnished with a tuft of cilia; secondary appendage uni-articulate, almost obsolete. Inferior antennæ scarcely as long as the superior, having the peduncle much longer than the peduncle of the superior; flagellum scarcely longer than the last joint of the peduncle. Both pairs of gnathopoda having the carpus attached near the centre of the superior margin of the propodos, and produced along the inferior margin as far as the palm; propodos subquadrate; palm defined by a double row of hairs, which are alternately very short, point of impingement of the dactylos defined by a fascicle of short stout spines. Penultimate pair of pleopoda shorter than the preceding; ultimate reaching rather beyond the ante-penultimate. Telson long, narrow, grooved longitudinally, and cleft at the apex.

Length, ·35 inches. (The Greenland species is 1·25 inches long.)

Genus **Aora**, Kröyer.

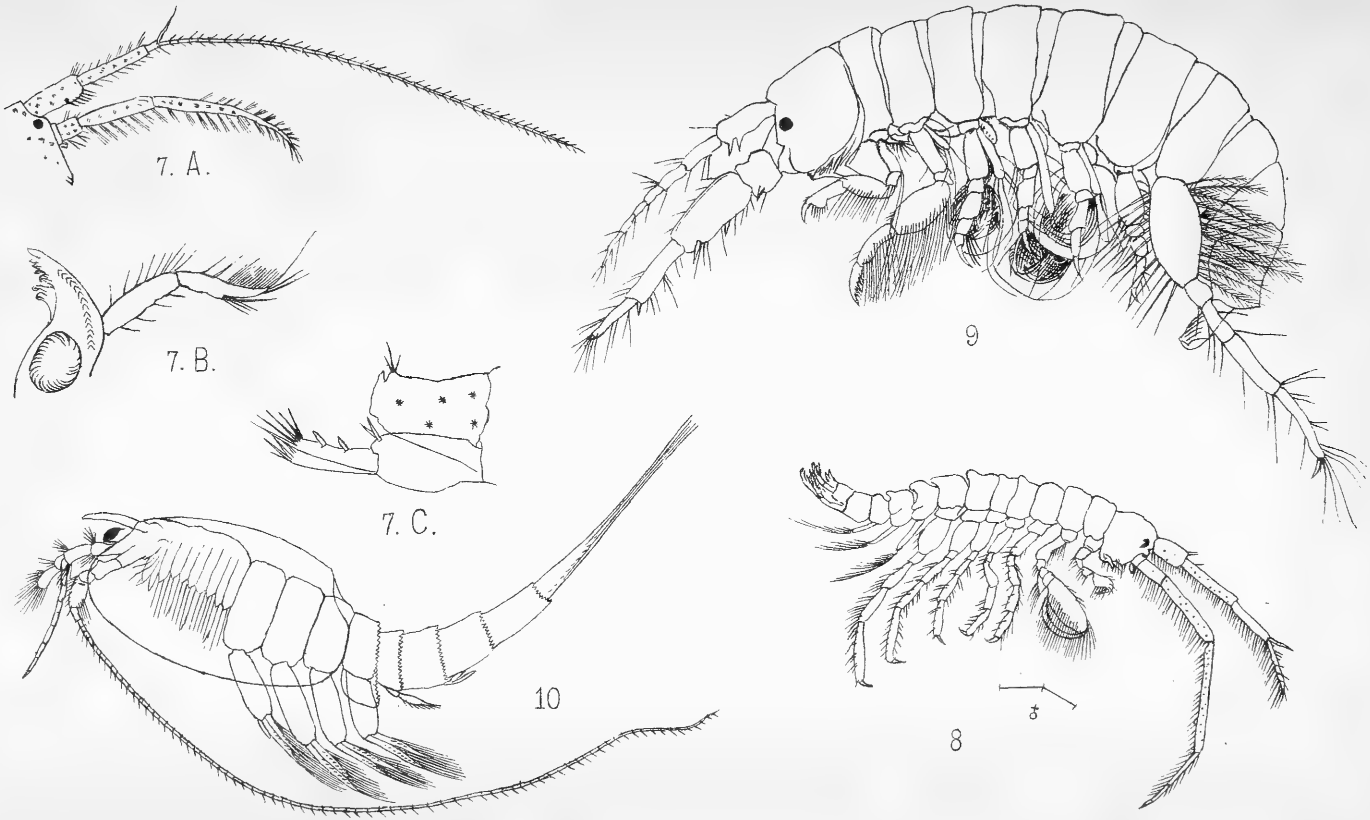
(Brit. Mus. Cat. Amphip. Crust., p. 160.)

Superior antennæ longer than the inferior, and carrying a secondary appendage. Inferior antennæ having the peduncle much longer than the flagellum. First pair of gnathopoda much longer than the second, and having the meros produced inferiorly into a long tooth. Third pair of pereiopoda shorter than the first two, fourth much longer than the third, fifth much longer than the fourth. Posterior pair of pleopoda biramous. Telson tubular.

1. *A. typica*, Kröyer.

Lalaria longitarsis, Nicolet, Gay's Hist. de Chile.

Body smooth, eye small, black, and round. Superior antennæ nearly as long as animal; flagellum twice as long as peduncle; secondary



NEW ZEALAND CRUSTACEA.

See Art. XXIII.

G. M. Thomson, del.

appendage very short and five-jointed. Inferior antennæ sparingly setose on the under surface; peduncle much longer than peduncle of superior; flagellum five-jointed, rather shorter than last joint of peduncle. Basos of first gnathopoda very long, produced into a tooth on its anterior margin; meros produced inferiorly as long as the carpus; carpus rather longer than the propodos; propodos enlarged anteriorly, with a single small tooth on its inferior margin, and covered with long hairs, which form a bunch at the articulation of the dactylos; dactylos slender, half as long as propodos. Second pair of gnathopoda not longer than succeeding pereiopoda, and very hairy. Third pair of pereiopoda short; fourth and fifth pairs much longer. Pleopoda subequal; telson quite smooth. Colour yellowish, with small black spots, chiefly on the lower parts of the body and appendages. Length ·3 inch.

Hab. A single specimen dredged in Otago harbour, in 4–5 fathoms.

The species was described originally from Chile (Valparaiso), but the description given in the Brit. Mus. Cat., p. 161, is meagre, and has accordingly been amplified.

Genus **Microdentopus**, Costa.

(Brit. Mus. Cat. Amphip. Crust. p. 163.)

Body long and slender. Superior pair of antennæ longer than the inferior, and carrying a secondary appendage. Mandibles furnished with an appendage. Gnathopoda subchelate, first pair larger than the second. Third pair of pereiopoda not longer than the two preceding; fourth pair much, and fifth pair very much longer than the others. Posterior pair of pleopoda biramous. Telson tubular, conical, and tipped with a double vertical apex.

1. *M. maculatus*, G. M. Thomson (Ann. & Mag. N. H. ser. V., vol. IV., p. 331). Fig. 7A., B. & C.

Animal smooth, slender. Coxæ rather small. Superior antennæ considerably longer than inferior, two-thirds as long as body; second joint of peduncle long and slender; third short and furnished with a 5–6-jointed appendage; flagellum very slender, multi-articulate, sparingly ciliated. Inferior antennæ strong, subpediform, with a stout olfactory denticle, and furnished with numerous cilia; third joint of peduncle short, fourth and fifth very long; flagellum short, indistinctly 6–7-jointed.

Mandibular appendage (fig. 7B.) 2-jointed. Maxillipeds with strongly-toothed appendages. Gnathopoda moderate, covered with strong cilia; first pair rather the largest, carpus rounded on its inferior margin; propodos oblong, with a very oblique, curved palm, defined by a strong spine; dactylos strong and curved, finely toothed on the inner margin; second pair similar, but with the palm transverse, and without the defining spine. Third pereiopoda shorter than preceding pair; posterior pair very long. Ante-penultimate pleopoda reaching to extremity of ultimate pair; base of the rami with a stout spine. Telson (fig. 7c.) when seen from above, with a broad apical notch, each side bearing a slender spinule. Lower part of body and appendages abundantly furnished with black star-like markings.

Length ·35 inch.

Hab. Dunedin harbour, not uncommon in 4–5 fathoms.

(Though dissimilar in many respects from *Aora typica*, there is such a strong resemblance in other points, that I should not be surprised if they prove to be male and female of the same species, in which case the generic character of *Aora* will require modification. Can it be a case of protective resemblance?)

Melita tenuicornis, Dana.

Mæra tenuicornis, Sp. Bate.
Paramæra tenuicornis, Miers.

This species is not uncommon in the rock-pools along the coast. The animals are dark slaty-grey in colour, very slender and compressed in form, and swim very rapidly. The females are remarkable for possessing a hook-like process on the coxal lamellæ of the fourth pair of pereiopoda, almost exactly similar to that figured and described by Fr. Müller ("Facts for Darwin," p. 27) as occurring in *M. insatiabilis*, and which enables them to be readily seized by the gnathopoda of the males.

Genus **Megamæra**, Sp. Bate.

(Brit. Mus. Cat., p. 224.)

Dorsal segments of the pleon without fasciculi of spines. Eyes round. Superior antennæ long; inferior about half the length of the superior. Gnathopoda subchelate, the second pair being the larger. Posterior pair of pleopoda biramous. Telson double.

1. *M. fasciculata*, G. M. Thomson (Ann. & Mag. of Nat. Hist., ser. V., vol. VI., p. 5, pl. I. fig. 5).

Dorsal surface of the animal quite smooth. Eyes reniform. Superior antennæ nearly one-third as long as the animal; first and second joints of peduncle rather short, subequal, third joint very short; flagellum long, very-many-jointed, joints transverse and setose; secondary appendage very minute, one-jointed, and terminated by two or three setæ. Inferior antennæ shorter than superior, very similar in the form of the joints of the flagellum. First pair of gnathopoda with carpus and propodos subequal, and *fringed on their lower margin with fascicles of serrated or barbed hairs*; propodos broader at distal extremity than at the base, with a rounded projection at the extremity of the lower margin; palm quite transverse; dactylos not quite as long as palm. Second gnathopoda larger; carpus increasing in width, with numerous fascicles of barbed hairs; propodos longer, lower margin with barbed hairs, upper with several transverse rows of simple hairs; palm rounded; dactylos curved. Pereiopoda somewhat increasing in length posteriorly, and with short spines. Posterior pleopoda considerably exceeding the preceding pair. Telson double. Length 0·5 inch.

Hab. Common along the coast; Sumner (near Christchurch), Dunedin, Stewart Island.

Fam. COROPHIIDÆ.

Sub-fam. Corophiides.

Cephalon and pereion broader than deep. Inferior antennæ sub-pediform, longer and more powerful than the superior. Coxæ small. Posterior pair of pleopoda simply sub-foliaceous or styliform, not armed with hook-like spines. Telson squamiform, unarmed.

Genus **Cyrtophium**, Dana.

(Brit. Mus. Cat. Amphip. Crust., p. 273.)

Pereion narrow, elliptical. Pleon inflexed beneath the pereion. Cephalon subquadrate. Eyes situated at the exterior angles, and a little prominent. Antennæ pediform, with very short flagella or none; the inferior pair a little the longer. Gnathopoda sub-chelate; second pair much the stouter. Posterior pair of pleopoda minute, simple, partly concealed by the telson; ante-penultimate and penultimate pairs with the rami unequal, not specially curved upon the outer side.

1. *C. cristatum*, G. M. Thomson (Ann. and Mag. N.H., ser. V., vol. IV., p. 331). Fig. 8.

Male.—Eyes prominent. Pereion wider than deep, transversely ribbed, and tuberculate. Last segment of pereion and three anterior segments of pleon elevated dorsally into prominent crests. Antennæ with long cilia on their inferior margins; superior pair shorter than inferior; peduncle reaching the extremity of penultimate joint of peduncle of inferior, bearing a one-jointed appendage; flagellum very indistinctly 7–8-jointed; inferior pair very strong, about as long as body; second and third joints with spines on their anterior margins; fourth and fifth joints long; flagellum indistinctly three-jointed, the first joint being equal to the two succeeding. Mandibles with an appendage, the basal joint of which is much the shortest. Maxillipeds with appendages to the basos and ischium; dactylos spathulate. First gnathopoda with simple cilia on their inferior margins; carpus produced inferiorly into a rounded lobe; propodos narrowing anteriorly, palm very oblique, defined by three or four stout spines; dactylos strong, curved, and acutely toothed on its inner margin. Second gnathopoda large and powerful, furnished with numerous plumose hairs, which are particularly abundant in two rows on each side of the palm; basos hollowed out in front, so as to receive the upper side of the propodos; meros acutely produced on its infero-posterior margin; propodos articulating on the upper margin of the carpus, oblong, that of the left side slightly the larger, and having the teeth more prominent on its upper margin; palm extending along the whole under-surface, with two or three denticulations; dactylos long, curved and smooth. Pereiopoda sub-equal, fifth pair the longest; setæ numerous and strong, not exceeding the diameter of the articulations to which they are attached. Telson conical, tipped with a few slender setæ.

The *female* differs from the male only in the greater width of the pereion, and in having the second gnathopoda relatively smaller, rounder, and wanting the plumose cilia. Length ·25 inch.

Hab. Dredged in Dunedin harbour in 4–5 fathoms, among Sertulariæ and seaweeds.

Genus **Corophium**, Latreille.

" Superior antennæ small, situated close together in advance of and above the inferior, having a multi-articulate flagellum. Inferior antennæ very large and powerful, subpediform; flagellum not multi-articulate. First pair of gnathopoda subchelate; second pair not subcheliform. Posterior pair of pleopoda very short, single-branched. Telson squamiform, simple." (Brit. Mus. Cat. p. 279.)

1. *C. contractum*, Stimpson.

Fig. 9.

" Antennæ equal in length, which is one-fourth that of the body; superior antennæ with four-articulate flagella; inferior antennæ very thick, with minute terminal articuli. Posterior pair of pereiopoda rather long, with long plumose setæ along the edges of the basa. Colour yellowish. Eyes black. Length ¼ of an inch.

Hab. " Japan."

The above description is taken from the Brit. Mus. Catalogue, p. 282, where it is quoted from the Proceedings of the Academy of Nat. Science, Philadelphia, for 1855. Meagre as it is, there is little doubt that it is identical with the species obtained by me. I have therefore given a figure of the animal, and a supplementary description, which applies only to the females.

Body much broader than deep. Eyes small. Superior antennæ with the first joint stout, produced on its inferior inner margin into two stout teeth; second joint equal to it in length, slender; third much shorter and hardly distinguishable from the flagellum, which is five-jointed, and terminated by a bunch of setæ. Inferior antennæ very strong, with a few strong teeth on its inferior margin on the inside. First gnathopoda small; basos with two long setæ; ischium, meros and carpus fringed with long setæ; propodos rounded towards the extremity, with a convex palm fringed with short hairs; dactylos curved, as long as the palm. Second gnathopoda larger than first; carpus widely convex on its inferior margin, and together with the more slender propodos bearing fringes of long setæ; dactylos four-toothed at the extremity of its lower margin. Four anterior pairs of pereiopoda diminishing in length posteriorly, but with basa progressively widening. Fifth pair very long; only the setæ on its posterior margin plumose, those on the anterior being simple. Posterior pair of pleopoda reaching slightly beyond the telson, flattened, rounded, thickly covered with short hairs, and bearing a few long setæ. Telson broadly triangular, notched at the apex. Length ·14 in.

Hab. Dredged in Dunedin harbour, 4–5 fathoms.

ENTOMOSTRACA.

Phyllopoda (?).

Genus **Nebalia**, Leach.

Antennæ two pairs, large and ramiform; eyes two, pedunculated; feet twelve pairs, eight branchial and four natatory; carapace large, enclosing head, thorax and part of abdomen, almost as in a bivalve shell. (Baird's Brit. Entomostraca, p. 31.)

1. *N. longicornis*, G. M. Thomson (Ann. & Mag. N. H., ser. V., vol. IV., p. 418). Fig. 10.

Carapace extending back to about the third abdominal segment on the sides, but with a wide dorsal sinus. Beak large and well-developed. Eyes situated on moveable peduncles, and formed of numerous crystalline bodies under a common cornea. The antennæ furnished with numerous hairs on their peduncles; superior pair with a peduncle of two joints, the last of which bears two appendages, consisting of (1) a short, triangular joint with spines on its outer margin, and an oval ciliated plate, and (2) a slender flagellum of several articulations, the number of which were not made out; inferior pair with a peduncle of three stout joints,—the second bearing a large tooth on its upper margin, the third furnished with rows of spines and hairs on its outer margin, and a bunch of hairs at its extremity,—and a slender flagellum, almost equal in length to the whole body, and consisting of between seventy and eighty articulations. Branchial feet completely concealed beneath the carapace. The third to the seventh (inclusive) abdominal segments with their posterior margins finely dentated. Peduncles of the natatory feet largely developed, their branches with a row of spines on each outer margin. Caudal appendages with a row of spines on each side, and terminated by several long and minutely plumose filaments. Carapace semi-transparent, whole body pale-yellow in colour. Length ·35 inch.

Hab. Dunedin harbour, 4–5 fathoms. Stewart Island, 10 fathoms.

Art. XXIV.—*On some new Species of Nudibranchiate* Mollusca.

By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 19th July*, 1880.]

1. Doris rubicunda, n.sp.

Body $\frac{1}{3}$–1 inch in length, oblong, blunt at both ends, sides nearly parallel, back elevated. Mantle not much larger than the foot, densely covered with minute, closely-packed, narrow, erect tubercles; colour bright scarlet, sometimes with a darker line down the centre, and with a few scattered blackish specks. Dorsal tentacles (rhinophores) clavate, short, stout, completely retractile; lower part cylindrical, whitish; central part much broader, furnished with about twelve broad laminæ that run obliquely upwards; apex a small projecting flat-topped style. The tubercles round the base of the tentacles are rather larger than elsewhere, and of a paler colour. Branchiæ completely retractile, eight in number, small, erect, oblong, bipinnate. Oval tentacles free, narrow linear. Head rounded, fleshy. Foot the same colour as the mantle or slightly darker, obtuse, and slightly notched in front, behind pointed and extending beyond the mantle when the animal is crawling. Odontophore broad, of very numerous rows of teeth, central tooth wanting, lateral about 50 on each side, those nearest the centre short and hooked, those on the outside much longer and more slender, strongly arched.

This species belongs to the same section of the genus as the British *D. coccinea*, Forbes, to which it comes very near indeed; principally differing in the fewer bipinnate branchiæ. *D. granulosa* and *D. longula*, two new species from New Zealand, described by Mr. Abraham in the Proceedings of the Zoological Society (1877, p. 253), are also near allies. It is abundant in Auckland harbour and elsewhere on the coast.

2. Doris (?) flabellifera, n.sp.

Body $\frac{3}{4}$–$1\frac{1}{4}$ in. long, elliptical oblong, equally rounded at both ends, back moderately elevated. Colour pale yellowish orange, sometimes sprinkled with a few minute blackish specks. Mantle not much larger than the foot, minutely rugose, and covered with small low rounded tubercles; margin thin, undulate. Dorsal tentacles somewhat conical, retractile within cavities that have slightly tuberculate edges, upper part strongly laminate, laminæ usually 15. Branchiæ placed in a transverse slit on the hinder part of the back, all spreading in the same plane, usually 22 in number, but varying from 18 to 26, simply pinnate, or occasionally forked at the ends, connected together at the base, and completely retractile within the slit, the anterior flap-like margin of which falls down and closes the cavity. Head produced into a broad two-lobed veil. Foot rounded in front, pointed behind, and often protruded beyond the mantle when the animal is crawling. Odontophore broad, of 35 rows of teeth; central teeth none, laterals from 40 to 45 on each side, all similar in form but the inner the smallest, stout, smooth, strongly hooked. Mantle spicules very numerous, straight or slightly bent, thickest in the middle and tapering gradually to the extremities.

Not uncommon between tide-marks in Auckland harbour, feeding on sponges and corallines. The position of the branchiæ, which instead of forming a more or less complete circle round the anus are placed in a single flat row in front of it, would appear to remove this species from *Doris* proper; and I have little doubt but that it will ultimately form the type of a new genus.

3. Chromodoris aureo-marginata, n.sp.

Body ½–1¼ inch long, linear-oblong, much depressed, expanded and rounded in front, then contracted, and gradually tapering to a point behind. Colour pellucid white, with a narrow bright golden line just within the margin of the mantle on both surfaces. Mantle quite smooth and even, greatly expanded in front and forming a broad and thin veil that extends far beyond the head, abbreviated posteriorly, and not nearly concealing the foot, sometimes deeply notched on the right side; margins thin, even. Dorsal tentacles rather long, retractile within simple-edged sheaths, linear, tapering a little upwards, laminæ about twenty. Branchial plumes nine (seven in one specimen), simply pinnate, erect or incurved at the tips, retractile within a common cavity. Foot much longer than the mantle, narrow, pointed behind, very thin and flexible.

This is a very handsome and delicate species. I have only seen four specimens, three of which were obtained in Auckland harbour, and the fourth on the coast near Waiwera.

4. Doridopsis citrina, n.sp.

Body 2–3 inches long, a little depressed, elliptic oblong, equally rounded at both ends. Mantle very large, margin thin and almost translucent, wavy; upper surface roughened with indistinct low and broad irregularly shaped pustules; under-surface smooth. Colour usually a pale lemon yellow, but varying from nearly white to a dark orange, always more or less freckled with minute superficial opaque-white specks. Dorsal tentacles clavate, upper two-thirds strongly laminated, laminæ 19–20, retractile within simple-edged sheaths. Branchiæ five, large, ramose, tripinnate, set round the anus in a circle that is interrupted behind, the two posterior the largest and the most branched, the whole retractile within a common cavity. Foot oblong, rounded in front and behind, margin thin, even. There is a slight transverse marginal groove in front through which passes the tubular proboscis. No oral tentacles or veil, and no odontophore or buccal armature of any description.

This is the commonest Nudibranch in Auckland harbour, and is particularly abundant in the winter and spring months. It is usually found in sheltered rocky places, in tide-pools, or under stones. The spawn is deposited in the form of a few-coiled spiral, and is generally seen in the months of June, July, and August.

Art. XXV.—*On a new Genus of Opisthobranchiate* Mollusca.

By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 16th August,* 1880.]

In some tide-pools near the Tamaki heads, in Auckland harbour, I have repeatedly obtained specimens of a curious little Opisthobranch, that appears to me to be not only undescribed, but also to form the type of a new genus. The following is a description.

Melanochlamys cylindrica, nov. gen.

Body elongated, almost cylindrical, 1–1¼ in. long; colour a deep rich velvetty black. Cephalic disc narrow oblong-quadrate, slightly expanded in front, so as to project over the foot and mouth, truncate behind. Mantle small, entirely concealing the shell, at its posterior end 2-lobed and with a large gaping orifice. Foot large, with ample side-lobes, which are folded up to the sides of the head-disc and mantle, leaving, however, the back exposed. Shell quite internal, triangular, spire minute, inner lip with a small spoon-shaped projection. Branchiæ minute, situated far back on the right side under the mantle. Gizzard very large and muscnlar, without calcareous plates. Odontophore apparently wanting.

I assume that the proper position of this animal is with the Philinidæ, with which it agrees in most of its characters. It differs, however, in having no odontophore, and in the gizzard not being strengthened with calcareous plates. *Aglaia* (of Renier), appears to be its nearest ally ; but I am unable to place it in that genus, as it differs from the species figured in Adams' "Genera" in being much more elongated, in the cephalic disc being larger and projecting beyond the foot, in the branchiæ being smaller and always concealed by the mantle, and in the side-lobes of the foot being closely appressed to the sides of the animal, and not spreading.

In addition to the specimens collected by myself I have examined some obtained by Mr. G. M. Thomson near Dunedin, and kindly forwarded to me by Prof. Hutton. Very probably it will be found to be common in suitable localities all round our shores.

Art. XXVI.—*An Analysis of Moa Eggshell.* By Prof. Liversidge, F.C.S., University of Sydney. Communicated by Prof. von Haast, F.R.S.

[*Read before the Philosophical Institute of Canterbury 5th August,* 1880.]

I am indebted to the kindness of Dr. Julius von Haast, F.R.S., director of the Canterbury Museum, New Zealand, for the specimen which is the subject of this note. The little packet of fragments was labelled "Moa-hunter kitchen-midden, Sandhills near Moa Cave Point, Sumner."

All the fragments appeared to be more or less weathered, and the edges, except where freshly fractured, were smooth and rounded, and their general appearance seemed to indicate that they had been subjected either to the action of blown sand or to that of water charged with carbonic acid gas; both influences may, of course, have been at work together.

The fragments were all very brittle, the fractured edges plainly showing, without the aid of a lens, the presence of two distinct layers. In most of the fragments the inner or concave layer, *i.e.* the one facing the interior of the shell, possessed a pale brown colour, the middle portion being quite white whilst the outer surface of the shell presented a pale tint of brown. Judging from the different depths of tints, the varying thicknesses and appearance, the pieces were apparently fragments of several different shells.

It is unnecessary for me to give any account of the microscopical structure of the shell, since that has been so ably done by Prof. F. W. Hutton, of Canterbury College, New Zealand.*

The pores are readily seen to penetrate right through the substance of the shell, on account of the brown-coloured matter which most of them contain; some appear to penetrate only to a certain limited distance, but this is because the direction of the pores is not straight and a portion of their length is cut off in the section; their apertures can easily be seen on the inside of the shell as well as on the outside, the outer openings, however, are considerably larger and are funnel-shaped,—many of these pores can be seen to pass through from side to side by the unassisted eye.

The middle portions of the eggshell are shown to be of softer material than the two surfaces, since most of the weathered pieces show a groove running along the edges.

On ignition all the pieces of shell experimented upon blackened and emitted an ammoniacal odour, thus plainly showing that they had by no means lost the whole of their organic matter, and on dissolving portions in acetic acid flocculent particles of organic matter were left floating in the solution. This organic residue was collected and found to be a readily com-

* *Vide* "Trans. N.Z. Inst.," Vol. IV., p. 166.

bustible nitrogenous body; under the microscope it presented traces of an organized structure.

A careful qualitative analysis was made of a portion of the shell, and, in addition to calcium carbonate, alumina (with traces of iron), phosphoric acid, magnesia, sulphur, potash, and soda, were found to be present; the latter three were in very small quantity, and no estimation of the amounts was attempted.

ANALYSIS.

Moisture driven off at 100° C	·20
Carbonic acid	40·05
Phosphate of alumina, with traces of iron	·29
Lime	53·65
Phosphate of magnesia	·17
Phosphoric acid	·59
Organic matter	4·90
Undetermined, including traces of sulphur, potash, and soda	·15
	100·00

The above results calculated out to the proximate constituents give the following:—

Calcium carbonate	91·02
" phosphate	1·29
Magnesium phosphate ($Mg_3(Po_4)_2$)	·17
Aluminium phosphate, with traces of iron ($Al_2(Po_4)_2$)	·29
Lime	1·98
Organic matter	4·90
Traces of sulphur, soda, and potash, undetermined	·15
Moisture driven off at 100° C	·20
	100·00

The amount of organic matter was determined by the loss on ignition, after deducting the carbonic acid and moisture present, thus,—

Loss on ignition (carbonic acid, moisture, and organic matter) = 45·15 per cent.
Less carbonic acid 40·05 per cent., and moisture ·20 per cent. = 40·25 "

∴ Organic matter = 4·90 "

This organic matter probably in part consisted of albumen, since both sulphur and soda were present; the acetic acid solution also, from which the flocculent organic matter had been filtered, became turbid on boiling, thus affording an additional confirmatory reaction for albumen. I much regret that the small quantity of shell at my disposal did not permit me to prosecute this part of the enquiry further.

The phosphates of magnesia and of alumina were determined by dissolving out the phosphate of magnesia, by means of acetic acid, from the precipitate containing the mixed phosphates thrown down by ammonia; the amount of iron present was so small that it was disregarded.

It will be noticed that 1·98 per cent. of lime in the above results is uncombined with any acid; it therefore probably existed as an organic compound, perhaps as an albuminate. The amount of carbonic acid found in the shell itself was 40·05 per cent., but on treating the ignited residue (of quick lime) with ammonium carbonate and again determining the carbonic acid 41·48 per cent. was found, or an excess of 1·43 per cent. over and above that furnished by the original shell itself; this 1·43 per cent. of carbonic acid would, by calculation, require 1·82 per cent. of lime, whilst the actual excess of lime found was 1·98; the difference, ·18 per cent., between the calculated amount and that found is quite within the range of experimental error.

It was thought that perhaps it was just possible, although not very probable, that the shell had been subjected to the action of fire, and that part of the lime might still be in the caustic state, but nothing was found to confirm this momentary idea; the powdered shell turned red litmus blue paper, but not to a greater extent than does powdered marble; and, moreover, the presence of the organic matter found in all the fragments examined completely negatived the supposition that they had lost part of their carbonic acid by the action of fire.

The specific gravity of the shell was found to be 2·706 when taken in the form of powder; the uncrushed shell, after long soaking in water, gave a specific gravity of 2·530, and after warming until air-bubbles ceased to be expelled it was found to be 2·610. The difference between the first and second determinations gives a rough estimate of the amount of air-space in the substance of the shell.

On comparing the results of the analyses of the moa eggshell with the analyses of recent eggshells, it will at once be apparent that the composition of the moa eggshell differs but little from them; hence it has, in all probability, undergone but a slight amount of change.

The following analysis of the eggshell of the domestic fowl, made by Vauquelin, is quoted in Watts' Dictionary of Chemistry, vol. II., p. 363:—

Calcium carbonate	89·6
,, phosphate with a little magnesium phosphate ..	5·7
Animal matter containing sulphur	4·7
	100·0

In the Supplement to Watts' Dictionary, p. 549, the following analyses by W. Wicke, are also cited:

	Heron.	Gull.	Pheasant.	Goose.	Hen.	Duck.
Calcium carbonate	94·60	91·96	93·33	95·26	93·70	94·42
Magnesium ..	·69	·76	·66	·72	1·39	·50
Phosphates ..	·42	·83	1·37	·47	·76	·84
Organic substances	4·30	6·45	4·64	3·55	4·15	4·24

Art. XXVII.—*Descriptions of the Larva and Pupa of* Lasiorhynchus barbicornis. By Capt. T. Broun.

[*Read before the Auckland Institute, 21st June,* 1880.]

Larva.

Colour: testaceous, more or less infuscate, head constantly castaneous, with piceous mandibles. Its *form* somewhat cylindrical, ordinarily compressed laterally, distended in front and behind. Composed of thirteen *segments,* the first forming the head, the penultimate and terminal with distinct dorsal sutures, but interrupted laterally and nearly obliterated below; all the segments with deep transverse furrows, their sides (except the anterior four and anal one) limited by a deep irregular groove, so that the rather flat inferior surface is very obviously separated from the sides. *Head:* much narrower than the second segment, sub-conical, rugulose in front, almost smooth behind, bearing several elongate fulvous bristles; *epistome* well marked, strongly transversal, its basal suture curved; *labrum* broader than long; *mandibles* robust, slightly notched at apex, uneven; *eyes* represented by small rounded elevations situated some little distance from the base of the jaws; maxillary *palpi* greatly developed, as long as the lower surface of the head, second articulation excessively short; third small, aciculate; the labial very small, connate, appearing to form the apical portion of the mentum; second joint small, cylindric, terminal needle-shaped; devoid of *antennæ.* The second *segment* broad, very finely rugose, with a large spiracle at each side, and a dorsal fold at its base; third broader than the preceding, broadly emarginate in front, with a large semicircular basal lobe, and a small chestnut-coloured elevation near each side; fourth equalling the former in width, obtusely rounded apically, its anterior portion separated from the basal by a deep transverse furrow; fifth to tenth with two dorsal grooves, the last-mentioned feebly impressed. The *legs* proceed from the second, third and fourth segments, are very short, and apparently only bi-articulate; they are setose. The *spiracles,* sixteen in number, are placed at the sides of the superior surface, on the second, fifth, sixth, seventh, eighth, ninth, tenth and eleventh segments. The whole surface is almost destitute of *clothing,* there being only a few scattered hair-like bristles, those on the underside shortest. The *size* is subject to considerable variation; the example before me, a small one, measures nine lines in length with both extremities incurved, and three in breadth, the middle parts, however, being much narrower.

Pupa.

Male measures nineteen lines in length, but with the rostrum projecting four lines beyond the last ventral segment. The *head* and rostrum attain a length of twenty-three lines, are bent below the body, finely grooved superficially as far as the antennal insertion (not far from the apex), are without other distinct sculpture, though at uncertain intervals seeming slightly constricted; the *antennæ* repose at each side, extend forwards as far as the intermediate coxæ, in one specimen the external filmy covering has been removed, thus displaying the five terminal joints in perfection; the position of the *eyes*, identical with that of the imago, is clearly indicated by the lateral dilatation of the head. The *prothorax* is neither quite conical nor cylindrical but just intermediate in form, is armed at its apex with two pairs of horn-like, sometimes wrinkled, protuberances, two other but much smaller ones behind these, and two larger ones at its base; the front pair of legs attached thereto are obliquely folded below. The *mesothorax* is short, divided from the preceding by a deep frontal suture, is impressed with two longitudinal grooves; from it issue the elytra which lie obliquely along the sides, and the middle pair of legs. The *metathorax* is longer than the latter, very uneven, and bears the membranous wings and posterior legs; the tarsal claw envelopes of these latter reach the extremity of the body, and are perceptibly marked off from the covering of the tarsi. The *abdomen* consists of eight free segments, all of which, except the last, are distinctly separated from one another, the terminal ends with two large protuberances having a spine-like process at the extremity; their upper and lower surfaces are closely, finely, and irregularly wrinkled; the basal and two apical segments are more or less spiniferous above, the others are considerably raised behind, and on the summit of each elevation are placed eight short corneous, almost bi-articulate, spine-like processes forming a transverse row, whilst two or more less evident ones may be noticed on the depressed frontal portion.

The *female* differs in several respects; the *rostrum* extends but little beyond the metasternum; the *antennæ*, inserted nearer the base than the middle of the beak, are directed forwards and then sideways, thus embracing the surface just behind the basal tubercles of the prothorax; it is only half the bulk of the other sex.

Habits of the Insect.

This paper would be held to be incomplete without some account of the habits of the insect. I shall not, however, inflict on the members of the Institute an elaborate series of details, which, indeed, could not be done without long and close observation under favourable conditions, but will content myself with the mere recital of facts, from which you may draw your own conclusions.

The perfect female gnaws a hole but little broader than a pin's-head, and in the cavity deposits the eggs. If the tree or log be visited some years afterwards, the following will be found to correspond with what usually occurs. On one occasion, when examining the forest north of Whangarei harbour, I noticed a *karaka*-tree which had been pierced by insects. I cut it down, and on opening it up found it tenanted by *Lasiorhynchus barbicornis* in all its stages. The larvæ were engaged in the formation of cylindrical drills running in different directions; the pupæ reposed in the attitude described above, *i.e.*, with the head and rostrum (the two conjointly, it will be borne in mind, longer than the body itself) bent along the lower part of the body, in a hole just broad enough to contain the insect, and without external orifice to permit its subsequent egress. I also cut out a few perfect specimens of both sexes; sometimes these had so nearly effected their exit that the extremity of the beak protruded. Of course there can be no doubt that these beetles had themselves eaten their way through, but what filled me with wonder was, how the pupa, on arriving at maturity, had managed to straighten its rostrum so that the mandibles might be employed to effect its release?

The description of the imago appears in my "Manual of the New Zealand Coleoptera."* Specimens are preserved in the Museum. I now add alcoholic examples of the larvæ and pupæ. With these before him, the student may proceed to the investigation of the question propounded, and if he can solve the problem without acknowledging the wonderful designs of the Almighty, he must be hard indeed to convince.

Art. XXVIII.—*On the Larva and Pupa of* Ceratognathus irroratus. By Captain T. Broun.

[*Read before the Auckland Institute, 19th July, 1880.*]

Larva.

Testaceous, head reddish, mandibles black. In *form* cylindrical, medially narrowed, underside nearly plane. The head and three following segments, as well as the three ventral ones, are nearly smooth, the others studded with minute spines and numerous hair-like bristles, the legs thickly clothed with shorter rufous bristles.

Composed of thirteen *segments*; the terminal large, flabby, and uneven, appearing to possess a supplementary anal one, not, however, distinctly defined by any well-marked suture; the *head* ovate, deflexed, not so broad in its widest part as the next segment, longitudinally impressed on the

* "Manual of the New Zealand Coleoptera" (Wellington, 1880), p. 543.

vertex, obsoletely punctate in front; epistome transversal, with five or six transverse impressions; *labrum* narrowed at the base, ciliated at apex; *mandibles* stout, dentate at the extremity; the *antennæ* implanted at the sides near the base of the jaws, tri-articulate, exclusive of the socket, first joint equalling the next two in length, cylindric, the apical almost aciculate; *palpi* four-jointed, basal articulation very large, the others decrease; *eyes* indicated by a small lunate black spot behind each antenna; legs rather long and robust, their three joints becoming smaller, the last terminating in a stout claw.

The three *segments* bearing the legs are, conjointly, scarcely longer than the eleventh, all are more or less perceptibly impressed from side to side, the anterior thoracic segments being considerably wrinkled and uneven. The *spiracles*, though present, cannot be distinguished with accuracy.

Length 6 lines; breadth 1½ (maximum).

Pupa.

Length, 6 lines; breadth, 2–2½; colour, infuscate testaceous.

Head large, bearing two spine-like protuberances on the vertex, a pair of smaller ones before each eye; *mandibles* large, their form not well defined; the antennæ enveloped in a large lunate sac extending backwards to the middle of the prothorax. *Prothorax* transversal, a little uneven, with incrassated lateral margins; a sharp protuberant process forms the posterior angle, another is placed rather in front of the middle at each side; its disc is bi-impressed longitudinally, but obsoletely on the middle, and at each side of the depressions, at base and apex, are placed two tubercle-like spines smaller than those on the head. *Mesothorax* short, obtusely pointed behind, with two protuberances. *Metathorax* canaliculate, bi-tuberculate posteriorly. *Abdomen* composed of eight segments, all finely and irregularly wrinkled; the basal with a transverse row of six tubercles; the others armed at each side with a tubercular process having two claw-like spines at the extremity; each bears a transverse row of small tubercles, the apical segment ending in two robust spines. The *limbs* repose in the usual manner.

I cut my specimens out of a *Coriaria sarmentosa* which they had destroyed. The insect does not, however, restrict itself to that shrub. The imago is described at page 253 of the "Manual of the New Zealand Coleoptera."

Art. XXIX.—*On* Harpagornis (third paper).

By Professor Julius von Haast, Ph.D., F.R.S.

[*Read before the Philosophical Institute of Canterbury, 1st July*, 1880.]

Plate IX.

In two former papers published in the Transactions,* I have described those portions of the bones of a large diurnal bird of prey, *contemporaneous with the Dinornithidæ*, named by me *Harpagornis*, which were obtained from the turbary and loess deposits of Glenmark and from a rock-shelter of Otago. Since then Mr. B. S. Booth, of Hyde (Otago), has made very interesting excavations in some turbary beds situated at Hamilton, in Otago, of which he has given us an exhaustive account in Vols. VII.† and IX. of our Transactions. A great quantity of moa bones was obtained, belonging to half a dozen different species, and to birds of all ages. In addition to these bones, a considerable number of *Cnemiornis* remains were discovered, of which the turbary deposits of Glenmark did not contain a single specimen, and a few bones of *Harpagornis*. Of the two latter I was fortunate enough to obtain a portion from Mr. Booth, which are now in the Canterbury Museum. The bones of *Harpagornis*, although few in number, are nevertheless of considerable interest, containing amongst them the mandible, or lower jaw-bone, hitherto unknown to us, and which doubtless, as I shall show in the sequel, belonged to the tibia, the smaller of the two ulnas, and the metacarpus, found with it in the same locality. The bird to which the mandible belonged was, as the measurements will show, of somewhat smaller dimensions than *Harpagornis assimilis*, from Glenmark. Although designating the latter by a specific name, I am inclined, as previously observed, to think that it was only the smaller male form of *Harpagornis moorei*, which in that case may be regarded as the female.

Prof. R. Owen, upon receiving the casts of the *Harpagornis* bones from Glenmark, has confirmed my views, that they belonged to a gigantic extinct harrier, and a study of the mandible in question has strengthened to my mind this hypothesis considerably. However, before offering a description of these bones under review, I wish to point out that we have proof that two specimens of *H. assimilis* were imbedded in the Hamilton peat beds.

If we admit Mr. Booth's theory about the formation of these deposits, viz., that they were formed in lagoons, obtaining their supply of water from springs only, it is difficult to understand how the bones of the two birds could have been brought there, unless we admit that by feeding upon the carcasses of those moas perishing in the springs from some cause or other, they were

* "Trans. N.Z. Inst.," Vol. IV., p. 192, and Vol. VI., p. 62.

† And not Vol. VIII., p. 12, as stated in a foot note to Mr. Booth's article in Vol. IX., p. 365.

MANDIBLE OF HARPAGORNIS ASSIMILIS, von Haast.

killed or drowned during that operation, because we know from experience that all birds, if possible, retire to most inaccessible or hidden spots to die.

This mode may also account for the extreme rarity of the remains of *Harpagornis*, which I am sure flourished in considerable numbers during the Moa Age.

Mandible of HARPAGORNIS ASSIMILIS.

Total length measured from point of symphysis along the ramus to posterior end of articular process 4·75 inches, greatest distance between articular processes, measured from the outward sides, 3 inches.

From a comparison of the general form of this mandible with that of the New Zealand harrier *(Circus assimilis)* it will be seen that it is somewhat narrower in proportion than that of the latter. In this respect it resembles the mandible of the condor *(Sarcorhamphus gryphus)* and griffin vulture *(Gyps fulvus)*. However, as several others of the vultures have a broad mandible, this character is not of any generic value. But when comparing the shape and size of the articular portion of *Harpagornis* with that of *Circus*, the striking resemblance between both becomes at once manifest. The articular part of the mandible in both is well excavated for the mandibular end of the tympanic bone.

The articular process has the same form in both. A pneumatic canal perforates the surface of this articular process at its base. The articular depressions for the insertion of the pterygoid muscles and for the two strong ligaments uniting the tympanic and squamosal with the articular part of the mandible are well excavated. The three portions of which the ramus consists when extending forward from the articular end are well cemented together, having a long and well defined articular surface for the insertion of the temporal muscle in the central portion.

The dentary portion is so well united on the right ramus that its junction with the posterior portion is not well visible, whilst on the left side the separation can be easily traced. From here the dentary curves gradually down to the symphysis, which is well channelled, measuring ·68 inch across the upper portion. Total length of symphysis, ·98 inch. A number of nervo-vascular tracts are seen on the anterior part of the symphysis, together with a series of canals on the lower side.

Right tibia.

This bone evidently belonged to a full-grown bird, although not aged. The intermuscular ridges, as well as the fibular ridge, are well developed, and all the characters described in my former paper, as observed on the tibia of *H. assimilis* of Glenmark, are well exhibited.

Although somewhat shorter than the latter, both the proximal and distal extremities are a little larger.

TABLE OF MEASUREMENTS.

	Hamilton Specimen.	Corresponding bone of *H. assimilis* from Glenmark.
	Inches.	Inches.
Right tibia, length	8·30	8·92
Circumference of shaft where thinnest ..	1·90	1·91
Circumference of proximal end	4·10	4·06
,, ,, distal end	3·85	3·80

Ulna.

There are two ulnas, both of the right wing, of which No. 1 doubtless belongs to the tibia whose measurements are given above.

	Hamilton Specimen. No. 1.	Hamilton Specimen. No. 2.	Corresponding Bone of Glenmark.
Total length	9·30	9·60	9·35
Circumference at proximal end	2·90	..	3·00
,, ,, distal end ..	2·24	..	2·32
Shaft where thinnest	1·50	1·62	1·48

No. 1.—This bone is also somewhat more slender in its proportions than the corresponding bone obtained at Glenmark, but it has at the same time the characteristic features of the bones belonging to a full-grown bird.

No. 2.—This evidently belonged to a larger specimen of the *H. assimilis* size. It is a shade stouter than the corresponding Glenmark bone. Both extremities are partly broken off.

Metacarpus.

Among the bones from Hamilton is also a right metacarpus, agreeing in all its proportions with the tibia and ulna No. 1.

Total length, 4·27 inches, or ·21 inch less than the corresponding bone from Glenmark, the total length of which is 4·48 inches. The latter is also a *little* stouter in all its proportions. Amongst the smaller bones there are a few ribs and some phalanges, all of which are similar to the corresponding bones of Glenmark, with the exception that they are all a little smaller. The last specimen to which I wish to draw your attention is the distal end of a femur (right leg) of *Harpagornis moorei*, obtained, according to Mr. Booth, in a gully a mile away from the turbary deposits of Hamilton. It was evidently extracted from a loess bed. It accords so closely in size and other distinctive features with the femur of *H. moorei* from Glenmark, that I need not offer a description of it.

DESCRIPTION OF PLATE IX.

1. Upper view of mandible of *Harpagornis assimilis*, von Haast.
2. Lower ,, ,, ,, ,, ,,
3. Outside ,, ,, ,, ,, ,,
4. Inside ,, ,, ,, ,, ,,

All natural size.

Art. XXX.—*Notes on some Additions to the Collection of Birds in the Colonial Museum.* By T. W. Kirk, Assistant in the Colonial Museum.

[*Read before the Wellington Philosophical Society, 11th February,* 1881.]

By permission of Dr. Hector, I have the pleasure of bringing before the notice of the Society several interesting birds lately received at the Museum.

1. *Porphyrio melanotus.*—Pukeko.

Porphyrio melanotus, Temm.

Several examples of abnormal colouring in this species have been recorded, but no instance of a pure albino has yet been noticed, unless we accept Dr. Buller's suggestion that *Porphyrio stanleyi*, described in Rowley's "Ornithological Miscellany," Vol. I., p. 37, is merely an albino of *P. melanotus*. It is, therefore, with great pleasure that I now draw your attention to an undoubted albino, obtained at Lake Grassmere by Mr. Liardet.

Description:—The whole of the plumage is quite white; the frontal plate is small, and nearly square; total length, 19 inches; wing, from flexure, 10·5; tail, 4·4; frontal plate, across the top, ·5; from posterior edge of frontal plate to tip of superior mandible, 2·75; along the edge of inferior mandible, 1·6; bare portion of tibia, 1·2; tarsus, 3·5; middle toe, 3·5, and claw, ·5; inner toe, 2·3, and claw, ·6; outer toe, 2·9, and claw, ·5; hind toe, 1·2, and claw, ·5.

The bird is somewhat small, but, as will be seen, agrees in the proportion of its measurements with the common "swamp hen," and may perhaps afford *slight* evidence in support of the specific distinction of *P. stanleyi*, the wing of which is shorter, and the legs and feet apparently stouter than in the specimen under consideration.

2. *Anas chlorotis.*—Brown duck.

In a paper read before this Society in 1878, Dr. Buller mentioned that an albino specimen of the common "brown duck" was shot on the Horowhenua lake, the whole plumage being of a dull cream colour, with obsolete markings. The specimen now before you is a partial albino, shot at the Wairarapa lake in April last.

Face and a band across the forehead white with numerous brown spots; back and abdomen irregularly marked with grey and white feathers; wings white with irregular black patches, the coverts being of the usual colour but with many of the feathers either entirely white or deeply margined with the same; bill and feet bluish black.

3. In passing through Featherston in May last, I observed a man carrying several ducks, one of which immediately attracted my attention, both by

its large size and the peculiarity of its plumage. The possessor would not part with his prize, but willingly allowed me to examine and measure it.

In general appearance it resembled the specimen described by Dr. Buller* as a variety of the common grey duck *(Anas superciliosa)*.

There was a broad band of white across the breast; the wings were quite white, the coverts being of the usual grey, but with a few white feathers interspersed; the head and face were white as far as the posterior margin of the eye, remainder of head dark brown with green reflections; bill black; feet and legs yellow; total length, 28·5 inches; wing from flexure, 11 inches; tarsus, 2·2; middle toe, 2·7.

Is it possible that this bird can have been the result of hybridization, say of the paradise and the grey duck, or the former and the domestic variety!

Art. XXXI.—*Notice of New Crustaceans.*

By T. W. Kirk, Assistant in the Colonial Museum.

[*Read before the Wellington Philosophical Society, 11th February,* 1881.]

Halimus rubiginosus.

The Colonial Museum has for some years past possessed a specimen of *Halimus* bearing the name "*Halimus rubiginosus*, Hutton, MS." In 1877 Dr. Hector submitted a drawing of this specimen to Mr. Miers of the British Museum, who replied, "It is evidently closely allied to *H. hectori*, Miers, the tubercles occupying the same positions, but being in some places replaced by spines, also the rostral spines are longer and more acute; these differences may be due to age or sex." Having had the opportunity of examining a series of seven specimens, both male and female, I feel convinced that the differences are not "due to age or sex," and therefore have but little hesitation in distinguishing it from *H. hectori*, Miers, and adopting the name so long ago applied.

Description :—Rostral spines long, acute and depressed. Anterior legs moderate, armed with acute spines, hand smooth. A single row of very stout hairs arranged alternately, one long and one short, along both margins of the second and third pairs of legs. A few scattered hairs of the same character on the fourth and fifth pairs of legs.

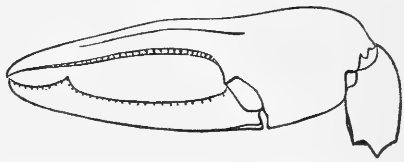
Hab. Cape Campbell, Wellington, Napier.

Gelasimus thomsoni.—Fighting Crab.

Two males and one female of this singular and pugnacious-looking crab, were brought to me some time ago by one of the local fishermen.

* See "Trans. N.Z. Inst.," Vol. VII., p. 225,

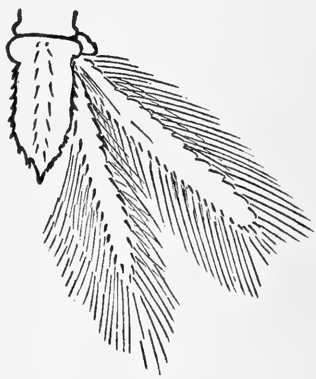
The carapace is smooth, convex, broader in front than behind, anterior margin sinuate, with a small depressed rostrum, grooved along the middle. Anterior-lateral angles produced into a point. Ophthalmic peduncles reaching to the angles of the carapace; the grooves which protect them have the margins finely crenated. As in all the members of the genus, the right hand is very large, being nearly twice as long as the greatest width of the carapace, or just four times the length of the ophthalmic peduncle. External surface of hand and wrist coarsely granulate; fingers two-thirds total length of hand. External face of immobile finger with a groove running the whole length. The fingers, when closed, leave a considerable interspace; the inner margin of each finger furnished with very coarse granules. Fingers meeting at the tips for one-fourth of their length. Abdomen of male and female seven-jointed.



Hab. Wellington.

Mysis meinertzhageni.

Carapace of moderate length, very slender, rostrum short and obtuse. Middle plate of tail short, not more than half the length of the laterals, broad and entire, apex obtuse, margins serrated. Lateral plates narrow, lanceolate, margins furnished with very long hairs.



Hab. Waimarama.

ART. XXXII.—*Notes on some Species of Diurnal Moths.* By PERCY BULLER. Communicated by W. L. Buller, C.M.G., ScD., F.R.S., Vice-president.

[*Read before the Wellington Philosophical Society, 11th February,* 1881.]

Bronze-wing Moth. (*Plusia eriosoma.*)

This moth is very plentiful in the Auckland district, but less so in other parts of the North Island. It is both diurnal and nocturnal in its habits, and is especially abundant on the flowering French clover and lucerne. When at rest it presents a somewhat singular appearance, from the pointed shape of its closed wings.

Appears in February and lasts till April.

Description of caterpillar: (Looper.) Back green, slightly tinged with yellow; under-surface green, with white spots; a clear white stripe from head to tail on each side; six minute black spots along this line, with a small black hair springing from the centre of each; white longitudinal stripes down the back, with small white papillæ enclosed by a ring of green.

Length, one inch.

Feeds on scarlet *Geranium*, the introduced nettle, etc.

Spins a slight web, always on the under surface of a leaf.

Chrysalis: Under-surface and sides, light green; back, marked with irregular dark blotches.

The presence of the chrysalis is always betrayed by the crumpled form of the leaf under which it conceals itself. Remains in the pupa state for five weeks.

Magpie Moth. *(Nyctmera annulata.)*

This familiar moth occurs plentifully during the summer months in all parts of the colony. It often rises to a great height in the air, although its general flight is weak and feeble. The house-sparrow, strange to say, does not wage war against this moth or its caterpillar (probably from their having a bitter taste); so it appears to increase and multiply every year, while many of the other common moths are becoming extinct. Professor Hutton describes the larva and pupa of this moth in "Trans. N.Z. Inst.," Vol. IX., p. 335. There are I believe, two broods in the year, and the caterpillar feeds on groundsel, Irish ivy, and other particular plants. The moth appears in October and lasts till April.

Dwarf Magpie Moth.

I believe this moth inhabits only the Auckland district, as I have never met with it anywhere else. The markings on its wings very closely resemble those of *Nyctmera annulata*, but the bands on the body are white instead of yellow. The antennæ are not feathered. Frequents grass and flower-beds. Appears in February.

Rare Tiger Moth *(Fidona ? crephosata.)*

This little moth is met with on the mountain-tops and table-lands in the Patea and Taupo districts, about two or three thousand feet above the level of the sea. It is by no means plentiful, and is very difficult to catch owing to its fitful and jerky flight. It may be mentioned that this moth does not habitually frequent herbage, but seems to prefer the dry and bare ground of the mountain paths, rising before the traveller, and alighting a few yards ahead, only to be again disturbed by his advancing footsteps. In 1877 my father obtained several specimens in the above localities, and these are now in my collection. In the following year, towards the end of March, I captured one in Wellington. This was resting on a shrub of white *Escallonia* in full flower.

Common Tiger Moth.

This species is not uncommon during the months of November and December, and frequents hill sides and grassy slopes. Unlike the mountain species, it keeps to the grass and stunted vegetation, chiefly "*tauhinu.*" It is not easy to distinguish when at rest, for the markings on the under-surface of the wings very closely resemble dried grass blades and stalks. No doubt this is for a protective purpose. It is very shy and wary, and to catch a specimen means a long chase with the net.

Hab. Wellington.

Common Grass Moth.

Frequents grass, *Escallonia*, and flowering shrubs in general. It shows a preference, however, for the common Scotch thistle when in flower. It is very plentiful in all parts of the North Island, and may be found in any grassy lane or meadow. It has a bold and swift flight, and a curious habit of vibrating its wings very rapidly for a few seconds after settling. It is both diurnal and nocturnal in its habits.

Appears in February, and lasts till April.

III.—BOTANY.

Art. XXXIII.—*On the Fertilization, etc., of New Zealand Flowering Plants.*

By George M. Thomson, F.L.S.

[*Read before the Otago Institute, 11th May*, 1880.]

Plate X.

The collection and examination of the flowering plants of this colony have occupied a good deal of my spare time during the last four or five years, and have enabled me to accumulate some materials for working out the various modes of fertilization which are to be found among them. These materials, even when made the most of, are however only sufficient to show how little is really known of this most interesting subject. In giving, then, the results of my imperfect observations, I do so in the form of a preliminary notice, which I trust will pave the way for fuller and more detailed work in the future. This subject of the fertilization of our flowering plants is necessarily so mixed up with the question of our insect fauna that I am led to unite the two to a certain extent, and show the relationship which exists between them.

At the risk of repeating to many here information which they already possess, I will—for the benefit of the uninitiated—shortly explain the phenomena of fertilization of flowering plants, as far as external manifestations are concerned. The sexual organs of such plants are contained in those parts of the flower termed, respectively, *stamens* and *pistil*. A stamen consists essentially of a 1-, 2-, or 4-celled cavity, called the *anther* (which may or may not be mounted on a stalk, or *filament)*, and which contains, usually, a vast number of small, variously-shaped, cellular bodies, the *pollen-grains*, which either are themselves, or contain, the male fertilizing element. The pistil consists of a 1- or more-celled cavity, the *ovary*, containing *ovules*, in which the female element occurs. External to the ovary is a glandular portion (of extremely various shapes in various plants), termed the *stigma*, which at a certain stage of the development of the flower becomes viscid, and so fitted to catch and retain the pollen-grains. In some cases the stigma is on a stalk, the *style*, in others it is sessile. The pollen-grains, when in contact with and apparently excited by the viscid secretion of the stigma, produce very slender tubes which grow down and penetrate the ovary, and finding their way to the *micropyles* (or apertures) of the ovules, bring about fertilization. Into this part of the subject I do not propose to enter, but will confine myself to the modes in which the pollen is transferred to the stigma. In a very large number of species, both stamens and pistil occur in the same flower, which is then said to be *hermaphrodite.* In other species, the stamens and pistil are in separate flowers, which are then *unisexual.* Unisexual plants are *monœcious* when the staminate and pistillate flowers are on the same plant, as in *Carex*, etc., and *diœcious* when they are on different plants, as in *Coprosma.* Lastly, some plants, as manuka *(Leptospermum scoparium)*, produce both hermaphrodite and unisexual flowers, and are then said to be *polygamous.*

At first sight it would seeem as if all hermaphrodite flowers were self-fertilized, *i. e.* that the pollen from the anthers became transferred to the stigma of the same flower, and so brought about fertilization. On examination, however, it is found that this is not always the case; in fact it would seem not to be the case in a majority of instances. By a multiplicity of means and contrivances it happens that many hermaphrodite flowers cannot be self-fertilized, but are dependent upon the pollen of other flowers, which may be brought to them in various ways. Unisexual flowers of course are always dependent on other flowers for their fertilization. The two great agents which carry out this cross-fertilizing process are insects and the wind, and plants are termed *entomophilous* or *anemophilous*, according as they are dependent on one or the other agency. Some birds (chiefly tuis and honey-birds in New Zealand) aid in the process, but only seven or eight species of Otago flowers are fertilized by them. (The following are the species with which I am acquainted, which are thus visited and aided:—*Clianthus puniceus*, *Sophora tetraptera*, *Metrosideros lucida*, *Fuchsia excorticata*, etc. *Loranthus colensoi (?)*, *Dracophyllum longifolium* occasionally, and *Phormium tenax.* Probably there are others.)

It is hardly worth while to discuss here and now the *pros* and *cons* of the theory first enunciated by Sprengel, but only fully explained by Darwin and his followers—that the characteristic features of each species of plant and animal have been acquired during a long "struggle for existence," and are the result of the adaptation of the species to its environments. It is sufficient to affirm that it is now held by most biologists that the colour, odour, and honey of flowers are designed to attract insects, and have been produced in accordance with the law of the survival and accumulation of favourable variations. Other flowers not furnished with these means of attraction have been developed into their present forms by the gradual production of certain other characters favouring their fertilization by wind, until they have become strictly anemophilous. In New Zealand we seem to see the transition stage to this state of things taking place among some species.

In whatever manner flowers may be fertilized, it is now known that pollen from a flower on a different plant seems to produce more and larger seeds, from which spring finer and stronger plants, than result from fertilization by pollen of the same flower applied to its own pistil. Hence probably, to a certain extent at least, the advantages of, and tendency to, separation of the sexual organs, which is so common a phenomenon among New Zealand flowers.

A point worthy of notice among entomophilous flowers is this,—that not only have flowers become modified for fertilization by insects, but even by certain insects only. Thus some are suited for fertilization by Lepidoptera alone, others by Diptera, Hymenoptera, or Coleoptera only, while some are actually dependent on certain species of insects. This seems to be the case with several species of the long-nectaried orchids of the subtropical genus *Angræcum*, and with *Trifolium pratense* (the common red clover), which is apparently only fertilized by long-trunked bees of the genus *Bombus*. But even the converse probably holds good, viz., that many insects have become modified in certain respects by their becoming to some extent dependent on certain species of flowers. Thus it can only be moths or butterflies with an extremely long proboscis which can obtain honey from the whip-like nectary of *Angræcum sesquipedale*, which attains a length of eleven inches (though no species has yet been found which accomplishes this); and we can understand how completely dependent the flowers of this plant are upon such moths, and how the insects themselves must be advantaged in that no others can compete with them for this supply of food.

Among hermaphrodite flowers in which no special arrangement or contrivance exists for preventing self-fertilization, it does not follow that the pistils are always pollinated by the stamens which are included in the same perianth with them. Darwin* has pointed out that in very many plants the flowers of which are quite fertile with their own pollen, the pollen from other flowers is found to have a greater fertilizing power, and to produce fertilization of the ovules even after their own pollen has been scattered on the stigmas; so that the visits of pollen-carrying insects to such flowers are sure to be advantageous, even although not absolutely necessary for the production of seed. Hermaphrodite flowers show every gradation between perfect self-fertility, such as prevails in various species of Cruciferous and Caryophyllaceous plants, and absolute self-sterility, as in *Oxalis magellanica*, in which no seed is produced even after the stigma has been abundantly smeared with pollen from the adjacent anthers. This latter state of self-sterility is, however, attained in a variety of ways. Thus in some flowers, the anthers dehisce and scatter all their pollen before the stigmas are ready

* "Cross- and Self-Fertilization of Plants," p. 391.

to receive any—this occurs in *Wahlenbergia*, *Gentiana*, etc., and such flowers are functionally unisexual, and are said to be *proterandrous*. But all have not this character so fully developed, and every gradation may be noticed from complete proterandry to the opposite extreme. Thus in buttercups, the outer anthers commence to dehisce first, and the process extends from without inwards; but considerably before the inner anthers have dehisced the stigmas have become viscid. In *Epilobium* again, at least among New Zealand species, I have never been able to notice any difference of time between the maturing of the anthers and stigmas. Here cross-fertilization, when it takes place, will be chiefly accomplished through the prepotency of the pollen brought from other flowers by insect visitants. But this functional separation of the sexes is equally well accomplished by the opposite arrangement, viz., the maturing of the stigmas first, and the protrusion and dehiscence of the anthers only after the former have been pollinated and are withered up. This is very well exemplified in the various species of *Coriaria* (tutu). Such flowers are called *proterogynous*, while the term *dichogamy* is applied generally to the maturing of the sexual whorls at different times.

Another means of accomplishing the same end, viz., cross-fertilization, is attained by the occurrence of two or more forms of flowers in the same species *(heterostylism)*. Thus some species of *Primula* are *dimorphic*, having two forms, one with long style and short stamens, the other with short style and long stamens. Some few flowers are even *trimorphic*. For a more complete description of these forms I must refer to Darwin's work already quoted. I have not detected distinct heterostylism in any New Zealand plant as yet, though in some *Pimeleas*, *Asperula*, etc., I have found something very like it. Special structures of the perianth, or of the sexual whorls, serve to prevent self-fertilization among certain flowers, and to ensure their proper pollination, but these are so numerous and varied as to obtain only a passing notice here. I have detailed in the body of this paper the most conspicuous of these modes, as they are exemplified among New Zealand plants.

It is worthy of notice that entomophilous plants are usually furnished with flowers possessing, more or less markedly, the following characters:—(1.) *Conspicuous appearance*, attained in a variety of ways, viz., by individual size as in *Clematis indivisa*; aggregation into more or less dense clusters as in *Rubus australis*, and many of the Compositæ, etc.; or, brilliancy of colour as in our iron-wood, *(Metrosideros lucida)*. (2) *Fragrance*. (3) *Honey*. Sometimes all three characteristics are present, as in certain of the wild roses of Europe, but as a general rule a principle of economy prevails, so that if any one attraction is present to a great extent, the others are usually wanting. Thus *Clematis indivisa* has very conspicuous flowers, but they lack both scent and honey. *Clematis fœtida* is overpoweringly fragrant, but is not strikingly conspicuous and has no honey. *Fuchsia excorticata* and *Phormium tenax* are only partially conspicuous (as far as colour is concerned), have no scent, but produce great quantities of honey. *Tupeia antarctica* is very fragrant, and produces a comparative abundance of honey, but is extremely inconspicuous. Besides these three characteristics of attraction, we may note that entomophilous plants usually have comparatively small stigmas, and produce relatively a small quantity of pollen, and that both stigmas and anthers are so placed that it becomes difficult for insects to enter the flower without coming into contact with one or other. In some flowers there are also irritable organs, as in the lamellate stigmas of *Mimulus*, the stamens of *Berberis*, etc. Very few such contrivances have, however, been noticed among our local flowers.

Before leaving this part of the subject, it is interesting to note that several species produce both entomophilous and also strictly self-fertilized flowers. These latter are usually very inconspicuous (hence called *cleistogamic*), and are produced after the ordinary conspicuous flowers. I have already recorded their occurrence in the genus *Viola*,* and believe they also occur in *Hypericum japonicum*. I have not investigated the subject, but I think that all the winter-produced flowers of *Trifolium minus*, a very common introduced plant, are cleistogamic. Flowers of this kind have been recorded as occurring in the following genera, which are represented in New Zealand, though I have never found them in our species, viz.:—*Oxalis*, *Drosera*, *Campanula (Wahlenbergia)*, *Cuscuta*, *Thelymitra*, *Juncus*, and *Danthonia*. Probably others have been recorded, which I have not noticed.

Among anemophilous plants, the following characteristics usually prevail:—(1) flowers usually inconspicuous and destitute of honey and fragrance, these being of no use to them; (2) the pollen usually light and powdery, and produced in great quantity in anthers which are generally so constructed as to be easily shaken; and (3) the stigmas of comparatively large size, greatly protruded and very papillose,—all characters favourable to the dispersion of the pollen by wind, and its transportation to and retention by the pistils.

Having noted shortly the means of fertilization among flowering plants, it may be asked,—How is the prevalent imperfection of our New Zealand flowers to be accounted for? That they are imperfect to a great degree (if separation of the sexes constitutes imperfection) is a fact well-known to botanists; perhaps in no other part of the world is this found to such an extent. Species, genera, and orders which are *characterized* by hermaphrodite flowers in other parts are frequently unisexual here. I am afraid

* "Trans. N.Z. Inst.," Vol. XI., p. 415.

the question cannot be satisfactorily answered yet; our knowledge of the subject is of too fragmentary and incomplete a nature. Mr. A. R. Wallace, who may be considered one of the most leading authorities on such a question, concludes that the poverty of insect life here is one of the chief causes. He says*—and I must be pardoned for quoting his opinion at some length—"In New Zealand, where insects are so strikingly deficient in variety, the flora is almost as strikingly deficient in gaily-coloured blossoms. Of course there are some exceptions, but, as a whole, green, inconspicuous, and imperfect flowers prevail to an extent not to be equalled in any other part of the globe, and affording a marvellous contrast to the general brilliancy of Australian flowers, combined with the abundance and variety of its insect-life. We must remember, too, that the few gay or conspicuous flowering-plants possessed by New Zealand are almost all of Australian, South American, or European genera; the peculiar New Zealand or Antarctic genera being almost wholly without conspicuous flowers.† * * * The poverty of insect-life in New Zealand must, therefore, be a very ancient feature of the country; and it furnishes an additional argument against the theory of land-connection with, or even any near approach to, either Australia, South Africa, or South America. For in that case numbers of winged insects would certainly have entered, and the flowers would then, as in every other part of the world, have been rendered attractive by the development of coloured petals; and this character once acquired would long maintain itself, even if the insects had from some unknown cause subsequently disappeared." "After the preceding paragraphs were written, it occurred to me that, if this reasoning were correct, New Zealand plants ought to be also deficient in scented flowers, because it is a part of the same theory that the odours of flowers have, like their colours, been developed to attract the insects required to aid in their fertilization. I therefore at once applied to my friend, Dr. Hooker, as the highest authority on New Zealand botany; simply asking whether there was any such observed deficiency. His reply was,—'New Zealand plants are remarkably scentless, both in regard to the rarity of scented flowers, of leaves with immersed glands containing essential oils, and of glandular hairs.' There are a few exceptional cases, but these seem even more rare than might be expected, so that the

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* "The Geographical Distribution of Animals," Vol. I., pp. 457-464.

† The following exclusively New Zealand or Antarctic genera are surely exceptions: *Notothlaspi* (white), *Hectorella* (white), *Hoheria* (white), *Entelea* (white), *Pennantia* (white), *Notospartium* (pink), *Ixerba* (white), *Stilbocarpa* (yellowish), *Corokia* (yellow), *Pleurophyllum* (purple), *Raoulia* (white), *Helophyllum* (white), *Colensoa* (blue), *Myosotidium* blue), *Rhabdothamnus* (reddish), *Earina* (white and yellow), and *Phormium* (reddish). All these are more or less entomophilous.

confirmation of the theory is very complete. The circumstance that aromatic leaves are also very scarce, suggests the idea that these, too, serve as an attraction to insects. Aromatic plants abound most in arid countries and on alpine heights; both localities where winged insects are comparatively scarce, and where it may be necessary to attract them in every possible way.* Dr. Hooker also informs me, that since his 'Introduction to the New Zealand Flora' was written, many plants with handsome flowers have been discovered, especially among the *Ranunculi*, shrubby *Veronicas*, and herbaceous Compositæ. The two former, however, are genera of wide range, which may have originated in New Zealand by the introduction of plants with handsome flowers, which the few indigenous insects would be attracted by, and thus prevent the loss of their gay corollas; so that these discoveries will not much affect the general character of the flora, and its very curious bearing on the past history of the islands through the relations of flowers and insects."

It is impossible to differ from this reasoning *in toto*, because the statements and facts on which it is founded are to a great extent correct, though in the light of more recent knowledge they require considerable modification. I do not see, however, that the imperfection alluded to, viz., the great tendency among our plants to sexual separation, is yet explained. It may help to solve the question if the proportions of the various kinds, forms, colours, etc., of our flowers be examined. The following numbers may be taken as approximately correct; they are drawn up from those species only which I have personally examined and noted:—

TOTAL OF SPECIES EXAMINED, 433.

(1). Flowers conspicuous by themselves .. .. .. 131; over 30 per cent.
" " " association† .. .. .. 91; " 21 "
" " " inconspicuous‡ .. .. 211; nearly 49 "

(2). If we take, now, the colours of the whole we find—White (142 sp.), nearly 33 per cent.; yellow (48 sp.), over 11 per cent.; red, of all shades (21 sp.), abou 5 per cent.; blue or purple (11 sp.), or about 2½ per cent.; the remainder being greenish, or inconspicuous.‡

(3). In regard to the possession of fragrance, the numbers are—

Sweet scented	95 species;	or nearly 22 per cent.
No scent perceptible	338 "	" " 78 "

(4). Those noted as being melliferous, or not

Possessing honey	189 species;	over 43 "
Not having honey	244 "	" 56 "

* Anyone who has botanized on our mountains must have been struck with the number and brilliancy of the flowers, mostly white (*Celmisias*, *Raoulias*, *Ranunculi*, *Veronicas*, etc.), which grow in such localities. Many fine insects are also confined to the mountains, however.

† Includes all the (conspicuous) Compositæ.

‡ Includes most of the lower Monocotyledons (Junceæ, Cyperaceæ, Gramineæ, etc.)

(5). Always hermaphrodite, were noted ..	235	species;	or	54	per cent.
,, more or less unisexual* ..	198	,,	nearly	46	,,
(6). Apparently self-fertile	208	,,	,,	48	,,
(This is a very doubtful approximation.)					
Certainly entomophilous	102	species;	or over	23	,,
,, anemophilous†	123	,,	nearly	29	,,

(7). Of the 235 hermaphrodite species, 87 sp., or 37 per cent., are proterandrous;* 18 sp., or nearly 8 per cent., are proterogynous; while 130 sp., or 55 per cent., are not decidedly one or other.

If we take out the most prominent of these figures we shall see that a very large proportion of our plants are dependent on insect aid, more or less. While 23 and 29 per cent. respectively are solely dependent on insects and wind, the remaining 48 per cent. are put down as more or less self-fertile. But even of these it is probable that a large proportion have their fertilization aided if not exclusively effected by insects. Again, no less than 51 per cent. have conspicuous flowers, while had I excluded from these results the large, inconspicuously-flowered orders of Gramineæ, Cyperaceæ, etc., the average of this class would have stood very much higher. Of course it is a good deal a matter of private judgment and opinion as to how large a flower or flower-cluster must be before it merits the term conspicuous. I have included under this head such flowers as *Cardamine*, *Oxalis*, *Geranium*, etc., because, though small, they are very readily seen; but I have excluded the large solitary *Pterostylis*, and the dull clusters of *Fagus*, *Griselinia*, etc., which are of too green a hue to be readily distinguished. But again it must be remembered that a flower may be conspicuous enough to an insect, even if not so to us. The fragrant-flowered plants only amount to 22 per cent., and the honey-producing to 43 per cent. of the whole, but here it is to be said that flowers do not produce honey and are not fragrant *at all stages of their development*. It is probable that the secretions which serve to attract insects are only produced under centain conditions of weather, temperature, etc., which we are at present ignorant of; and when the various sexual whorls are at a proper condition to receive or benefit by the visits of insects. My numbers, therefore, in these two last items are probably considerably under the mark. Here, again, it may be noted that a flower may be possessed of a kind or an amount of fragrance which is not appreciable to our olfactory nerves, though it may be to those of an insect. This remark applies particularly to the Diptera, which, as an order, have probably attained the greatest perfection in this respect. Everyone must be aware of the marvellous power of scent possessed by the ordinary blue-flies, for example, and the faculty is, no doubt, fairly well developed in the flower-visiting species also.

* Includes all the (conspicuous) Compositæ.

† Includes most of the lower Monocotyledons (Junceæ, Cyperaceæ, Gramineæ, etc.)

It may also be pointed out that with regard to the two hundred and thirty-five species of hermaphrodite flowers examined, there are several (*Oxalis magellanica* being a good example) which appear quite capable of self-fertilization, but are in reality self-sterile.

Having now considered the flowering plants, I would shortly draw attention to what is known as to the relations of our insects to them. As far as I can make out, this amounts to very little. One thing is clear, however, viz., that the prevalent impression as to the poverty of insect life here (as it is expressed in Wallace's work), is not quite correct. Certain prominent classes of insects are very poorly represented, both in species and individuals, but others almost make up for them. Mr. Wallace's figures are in this respect misleading, not from error on his part, but owing to the immense number of new forms which have been described since his work was published. I give shortly the approximate number of species of the various orders of insects, as far as they are known at present. I am indebted for this part of my subject—and I would thankfully acknowledge it here—to Capt. Broun, Prof. Hutton, and Messrs. W. Colenso and R. Fereday, who have given me valuable information regarding those orders which they have respectively examined. Mr. Wallace's figures are subjoined for comparison.

Of butterflies, Lepidoptera, only 18 species (A. R. W., 11 sp.) are known, but of moths (not mentioned by Wallace) several hundreds are described in numerous publications, while probably half as many more are undescribed. These latter insects are also extremely numerous in individuals, and many of our flowers (as *Leucopogon*, etc.) appear to be exclusively fertilized by them. Of Coleoptera about 1300 species are now described (A.R.W., 300). Of these a great number are not flower-visitants, but others again are greatly concerned in this work of flower-fertilization. I quote with pleasure here some extracts from a memorandum on the subject which Captain Broun kindly furnished me with:—" Of the family Palpicornes, two genera—*Hydrobius* and *Philhydrus*—consist of water-loving species as is usual in other countries ; but one peculiar New Zealand genus, *Rygmodus*, of six species, is of quite abnormal habits. One, *R. modestus*, which is commonly found on the inflorescence of *Brachyglottis repanda*, *Cordyline banksii*, etc., has finely spinous legs, and, though somewhat metallic above, is hairy underneath. It undoubtedly plays an important part in the fertilization of flowers, a remarkable trait in the case of an insect belonging to that family—I think the only instance known to science. Most of the others are rare, and though described by me were found by other collectors, so that I cannot speak authoritatively as to their habits ; I suspect, however, that all frequent plants. * * * Of the Melolonthidæ, the pretty *Pyronota festiva*, metallic above, hairy below, is found in profusion on the inflorescence of *Leptospermums*. * * * The Buprestidæ (A.R.W., 1 sp.) and Elateridæ (A.R.W., about 12 species) about 80 species, are wood-feeders in the larval state, but when perfect insects occasionally visit flowers. Nearly all the Dascillidæ do so too, and must, being hairy, render important services. * * * All the Melandryadæ and Mordelliæ frequent flowering shrubs ; one insect—*Selenopalpus cyaneus*—is never found away from them, chiefly ti-tree *(Cordyline australis)*; but I oncé noticed numbers of this species on grass when in blossom. The Curculionidæ, an extensive family, in most cases having scaly or hairy clothing, to a great extent aid the seeding of flowers. The species of *Eugnomus* are very partial to the lawyer *(Rubus australis)* when in bloom. Altogether about 40 species of the Erirhinidæ may be found on most of the indigenous flowering shrubs. *Apion metrosideros* confines itself almost exclusively to the pohutukawa *(Metrosideros tomentosa)*. *Oropterus coniger* lives entirely on the native fuchsia *(F. excorticata)*. The Longicornia are wood-feeders, but often visit flowers. *Zorion minutum* confines itself almost exclusively to flowers. Some, but not all the Phytophaga, are found on flowering plants. *Arnomus brouni*, though very rare, is generally found on *Leptospermum* ; 11 species of the genus *Colaspis* (A.R.W., 2 sp.), usually found in abundance, frequent the inflorescence of many shrubs." It will be noticed from these quotations that Captain Broun's observations are made on North Island plants. Had we similar observations continuously made on the flora of other parts, and particularly of mountain districts, we should soon be able to solve many problems which are very obscure at present. Hymenoptera (A.R.W., only a score of species) are very poorly represented, the only flower-visitants being 10 species of bees. The Orthoptera probably do not visit flowers ; but many of the Hemiptera-Heteroptera do, only as no attempt has been systematically made to catalogue them yet, I am in utter ignorance as to the number of species. Prof. Hutton informs me that the following flower-visiting species are very abundant in individuals, viz., *Anubis vittatus*, *Rhopalimorpha obscura*, *Nysius huttoni*, and *N. zealandicus*. The most important flower-visiting order in New Zealand is probably, however, the Diptera (not noticed by Wallace). Only about 100 species have been described, but this, Prof. Hutton informs me, is probably only about one-tenth of the whole number. As far as I can make out, the Diptera depend chiefly on scent in their search for food, and certainly this would explain the fact of their being the sole fertilizers of many inconspicuous or green flowers, as *Tupeia antarctica* and various species of *Pterostylis*, etc. I was formerly of opinion that the part apparently taken by the New Zealand Diptera in this work of fertilization was quite an exceptional case, and that here they performed the work done by bees and butterflies in other countries; but a short and suggestive letter by H. Müller in "Nature" (Vol. XXI., p. 275) shows that among alpine (European) flowers generally Diptera come next in importance to Lepidoptera as flower-visitants, while among lowland flowers they are only exceeded by the Hymenoptera. In the absence of any more definite information on the subject, I would only advance it as a suggestion that here Diptera will be found to be by far the most numerous class of flower-fertilizers. In concluding this introductory portion of my paper, I would point out that my observations do not extend to many of our purely mountain forms, among which are to be found some of the finest flowers in New Zealand.

I now give in detail the results of my investigations on a number of our flowering plants. These deal chiefly with their mode of fertilization, but include some other points which have been noted as well.

Nat. Ord. Ranunculaceæ.

Of this order only two genera are represented in this part of Otago, and these by a few species.

All the New Zealand species of *Clematis* are hermaphrodite or unisexual in structure, but all are diœcious in function. The male flowers are furnished with stamens only, without any trace of carpels, while the female flowers have a row of stamens surrounding the mass of carpels, but these have abortive anthers which never appear to produce pollen.

Clematis indivisa and *hexasepala* depend solely on the size and brilliancy of their large white flowers, which are always displayed in most conspicuous situations. They appear to be destitute of scent and honey, and though apparently suited only for insect-fertilization, I have never seen them regularly visited. As is usually the case in entomophilous diœcious plants, the male flowers are larger and brighter than the female, which have more or less of a greenish hue. While the former are usually two to three inches in diameter, the latter seldom exceed one inch and a half.

Clematis fœtida, grossly misnamed by Raoul. This is a much lower-growing, altogether humbler, plant than the first-named, and its flowers are only a little over half an inch in diameter. They are greenish-yellow in colour, and tolerably conspicuous from their number; but their chief attraction lies in their overpoweringly strong perfume. I have never found honey in them.

Of the genus *Ranunculus* I have observed six species, viz., *R. sinclairii*, *R. plebeius*, *R. lappaceus*, *R. macropus*, *R. rivularis*, and *R. acaulis*. These species are all hermaphrodite, nor have I detected a trace of abortion in their parts. All appear also to be more or less proterandrous, and to be furnished with a scale-like nectary on the petals. This is better developed in the larger and brighter flowered species such as *R. lappaceus*, than in such as *R. acaulis*, while in some forms of *R. plebeius*, in which the petals are much reduced both in size and number, it shares the same fate, and is nearly rudimentary. I believe all these species are self-fertile, but as they are frequently visited by insects they will often be crossed by pollen of other flowers. Specimens of *R. plebeius* grown by me under bell-jars, and carefully excluded from the visits of insects and from currents of air, have produced abundance of large and fine capsules.

Nat. Ord. Magnoliaceæ.

Drimys axillaris, the common form of pepper-tree in this part, is certainly not *D. colorata*, Raoul, as described in the appendix to the "Handbook of the Flora of New Zealand," p. 724, but agrees completely with the description of *D. axillaris* as given at p. 10 of that work.

I have never been able to make out satisfactorily its mode of fertilization. The flowers are hermaphrodite and quite inconspicuous, being small and greenish-coloured, and almost solitary on the branches, where they occur nearly hidden on the under-side. They do not seem fitted in any way for insect-fertilization, and yet, from the sparingness with which they produce fruit, I can hardly think them self-fertilized. They are destitute of scent and honey, but produce a considerable amount of pollen.

Nat. Ord. Cruciferæ.

I have examined the following—*Nasturtium palustre, Sisymbrium novæ-zealandiæ*, and *Cardamine hirsuta*—and find nothing which would lead me to think them only cross-fertilized. The last named is perfectly self-fertile, isolated plants under bell-jars producing abundance of good seed, and the same probably applies to the other New Zealand species, these being all occasionally crossed by insects.

Nat. Ord. Violarieæ.

Two species of *Viola* are common, viz., *V. filicaulis* and *V. cunninghamii* but the structure of their flowers is similar. As has been already pointed out,* these produce two kinds of flowers, the ordinary showy form, and —later on in the season—an inconspicuous (cleistogamic) form. The ordinary flowers are white, more or less streaked with blue or purple, and these streaks act as guiding lines to the few insects which visit the flowers, being all on the large lower petal, and converging towards its base. The anthers are connate, and the contained pollen, being of a rather dry or mealy consistence, falls out of the nodding flowers very easily. The short spur contains a little honey, which could not be well reached by an insect without disturbing the anthers; and the stigma is so placed as to be in the way of any insect entering the flower. In his

* "Trans. N. Z. Inst." Vol. XI., p. 415.

work on "British Wild Flowers in relation to Insects," Sir John Lubbock gives a memorandum of Mr. Darwin's on the fertilization of *V. tricolor*, the common heartsease or wild pansy, which is applicable, to a great extent, to the whole genus. He remarks how rare it is to see any insect visiting the flowers, and how he watched many times daily in a fortnight before he saw a single bee visiting a certain clump of heartsease. I have myself repeatedly watched patches of our violets, and have never seen them visited by any insect.

Species of thrips are to be found in these flowers—as, indeed, in most flowers—and Mr. Bennett considers that the fertilization of *V. tricolor* is due to this insect. It seems to me, however, that this view must be erroneous. Thrips is an insect which lives *in* the flower it frequents, feeding probably on the pollen, and only flying to other flowers to lay its eggs in them. In the course of its running about inside a flower, it probably frequently carries pollen from the anthers to the stigma, but this would only bring about self-fertilization, whereas the flowers are specially constructed to avoid this. Even where several flowers are crowded together in the same inflorescence, if the pollen of each was distributed to others, the fertilization—if it took place—would not be that of a true cross.

I have not verified, experimentally, whether the ordinary flowers of both our violets are self-fertile, but from the fact of frequently finding withered flowers in which the ovaries showed no signs of enlargement, I think it improbable that they are. I have never been able to detect any scent in the flowers of either *V. filicaulis* or *V. cunninghamii.*

The genus *Melicytus* contains four New Zealand species, all of which occur in Otago, but I have only examined two of them. The name of the genus—literally, *honey-cavity*—suggests the occurrence of abundant nectar. This is secreted by the so-called scale at the back of each anther. This is a thick succulent club-shaped organ, on the apex of which a bead of honey is produced. The flowers are polygamous, ranging from perfect unisexuality to complete hermaphroditism. The male flowers occasionally have imperfect pistils, though the total want of the pistil is commoner. The female flowers, on the contrary, seem always to be furnished with stamens, though the anthers are frequently abortive, and the reason of this may be the adaptation of part of the anther for the secretion of honey.

M. ramiflorus produces enormous numbers of flowers of a greenish-yellow hue, conspicuous by their mass, fragrant and abundantly supplied with nectar. These cannot be wind-fertilized growing as they do in dense bush where the wind can hardly affect them, and having somewhat waxy pollen.

M. lanceolatus has relatively larger flowers, and they are individually more conspicuous, being yellowish in their lower part, and having the recurved portion of their petals purplish. Like those of the preceding species, they are crowded chiefly along the under-sides of the branches, but are even more hidden by the foliage. They are sweet-scented, and contain abundant nectar.

Nat. Ord. Pittosporeæ.

About twelve species of *Pittosporum* occur in New Zealand, and two of these are common in the east of Otago.

P. tenuifolium, belonging to the section of the genus having solitary flowers, is a very handsome little tree. Its flowers are a good deal hidden by the foliage, but are tolerably conspicuous, the petals being bright purple when first expanded, and gradually deepening in colour as they begin to wither. As soon as the flower opens the stigma is seen to be viscid, and it remains so long after the pollen is shed. The base of the ovary is hairy, and between it and the filaments small beads of honey are secreted. The object of the hairs is probably to prevent any insects reaching the honey except those which are furnished with a proboscis. The pollen is very coherent, and not easily shaken from the anthers. The flowers have no perceptible fragrance.

P. eugenioides, according to Hooker, is more or less diœcious, though the numerous specimens I have examined were invariably hermaphrodite. The flowers are produced in large corymbs, which are very conspicuous, and they are extremely fragrant, and secrete a quantity of honey between the bases of the ovary and filaments. In many cases, when opening, the anthers are found dehiscing almost on the viscid stigma, to which some of the pollen-grains adhere. In this way probably the flowers are often fertilized, while their attractions to insects are so numerous as almost to ensure cross-fertilization.

Nat. Ord. Caryophylleæ.

The order is represented by four genera—*Gypsophila*, *Stellaria*, *Colobanthus*, and *Spergularia*. Our species are probably all self-fertilized, the only doubtful one being *Stellaria roughii*, a mountain form with large green flowers. The others have small, and, in some cases (*Colobanthus*), perfectly inconspicuous flowers, destitute of colour, scent, or honey.

Nat. Ord. Portulaceæ.

Claytonia australasica has small, white flowers, which are, however, relatively very large when compared with the size of the whole plant. They are tolerably conspicuous, have a little honey at their base, and are distinctly proterandrous, the divisions of the style being stigmatic on their inner faces only, and these remaining closed until the pollen is scattered.

Nat. Ord. Hypericineæ.

Two species of *Hypericum* are found in New Zealand, and both occur in Otago.

H. gramineum has very bright, golden-yellow flowers, which are, however, destitute of smell, and also, I believe, of honey. The numerous stamens do not dehisce all at once, but one after another, and they produce a great quantity of pollen. *H. japonicum* has its fully-formed flowers very similar to the other species, but much smaller. It is remarkable, however, for producing besides a set of flowers in which the capacity for self-fertilization is so complete that they have almost become cleistogamic. There is no true abortion, but only great diminution of the corolla and stamens, and the flowers produce seed without having ever opened. It appears to me that we have here a case of variation going on. Probably the examination of a large series of specimens would show that some had acquired complete cleistogamy. I think both species of *Hypericum* are self-fertilized by the withering and curling-in of the petals, which thus smear the stigmas with pollen, if they have not previously been crossed by insects.

Nat. Ord. Malvaceæ.

This order is represented by three genera—*Plagianthus*, *Hoheria*, and *Hibiscus*, but only the first two occur in Otago.

Plagianthus divaricatus is a low shrub, occurring abundantly on the muddy shores at the head of Otago harbour. It is strictly diœcious, the male flowers having no trace of a pistil, and the female being furnished with rudimentary stamens, which produce no pollen. The former are much more numerously produced, and are, therefore, more conspicuous than the latter. They produce little or no honey, but to make up for their small size they are extremely fragrant.

P. betulinus is also strictly diœcious. The male flowers are produced in dense panicles, which are whitish-yellow in colour, and are thus very conspicuous; they have no trace of a pistil. The pistillate flowers are in lax panicles, are much more sparingly produced, and, from their greenish colour, are rather inconspicuous. The style is surrounded at its base by a ring of abortive stamens, and the stigma is a wide flattened expansion, proportionally large to the rest of the flower. Both kinds of flowers are very fragrant, and produce honey, the female in this latter respect being better provided than the male.

I have not had an opportunity for years of examining *P. lyallii*, the flowers of which are very large and white.

Hoheria populnea produces great masses of pure white flowers. These are quite hermaphrodite, and appear to depend for their crossing almost entirely on their conspicuousness. They have neither scent nor honey, nor do they appear to be at all dichogamous.

Nat. Ord. Tiliaceæ.

There are three genera of this order in New Zealand: viz., *Entelea* (not found in Otago), *Aristotelia* and *Elæocarpus*.

Aristotelia racemosa is very abundant, and is interesting from the perfect gradation which it exhibits between true male flowers having no trace of a pistil and true female flowers quite destitute of even the rudiments of stamens, and between these and true hermaphrodite flowers having the full complement of both stamens and carpels. The flowers are produced in great numbers, the male particularly, so that the bushes are bright red with them. They have no perceptible fragrance, and no honey, and the pollen is of so light and friable a nature that I think they must be almost entirely anemophilous, though perhaps assisted in their fertilization by insects. They grow, also, on the edges, or in more open parts of the bush, where they are not shut off from access of wind.

Aristotelia fruticosa is one of those extremely variable species which I think are at the present time undergoing rapid modification into distinct forms. Sir J. D. Hooker states, in the "Handbook of the New Zealand Flora," that he has made four varieties, "but they seem to be states determined by age and exposure, rather than hereditary races." I have, however, gathered three very distinct forms growing all together, which makes me consider them as incipient species. As in *A. racemosa*, the flowers of this species are polygamous, but being much smaller and more sparingly produced it is difficult to say how they are fertilized. I could detect neither scent nor honey. At the same time the flowers have not the loosely-hung anthers, nor the very prominent stigmas, which characterize the majority of wind-fertilized plants.

Elæocarpus hookerianus seems to be fitted for insect-fertilization. The flowers are greenish-white and drooping, but very conspicuous by their abundance. They appear to be strictly hermaphrodite, but are proterandrous. Though destitute of fragrance they produce a great deal of honey, which is probably secreted by the circle of glands surrounding the base of the stamens.

Nat. Ord. Linaceæ.

Linum monogynum is the commonest representative, and is a very variable plant as to the size of its leaves and flowers. I have not been able, however, to detect distinct dimorphism, which is so characteristic of some European forms, nor have I seen the minute honey-glands, such as occur in *L. usitatissimum*. The flowers are pure white, scentless, but, as far as I can make out, sterile with their own pollen. Examination of more specimens, and cultivation, would throw more light on this plant. I have not been able to examine *L. marginale*, which occurs sparingly in the neighbourhood of Dunedin.

Nat. Ord. Geraniaceæ.

Of the genus *Geranium*, four species are common, but I have only examined two, viz., *G. microphyllum*, and *G. molle*. The latter has been described in Lubbock's work already quoted, and the former agrees well with it in its fertilization. The outer anthers commence to open first while the stigmas are still immature and closely pressed together. But before the pollen is all discharged the stigmatic surfaces expand, though they only reach maturity after the anthers are emptied.

Pelargonium I have not examined.

Oxalis is represented by two common species, which differ very much in their habitat, *O. magellanica* being found in damp woods, and mountain bogs and streams, while *O. corniculata* affects dry, sunny localities. *O. magellanica* has white scentless flowers. Of its ten stamens, five are long, equalling the style in height, and five are considerably shorter. The anthers of the latter dehisce first, usually a couple of days before those of the long stamens. The flowers when first open stand nearly erect, but the peduncle gradually bends down, until by the time the petals are withering they are completely pendulous. By this time the petals gradually cohere together and close into a kind of cylinder, which in falling off smears the stigmas with pollen. I was at first of opinion that the flowers were thus self-fertilized, in the event of their not being crossed, but having cultivated a large number of plants under glass, I found that *all the flowers produced* were sterile, not a single capsule having set.

The closely allied European wood-sorrel (*O. acetosella*) produces cleistogamic flowers, but I have never found any on our New Zealand species.

O. corniculata. The brilliant little yellow flowers of this species contain a good deal of honey, and only display themselves on sunny days, which makes me conclude that they are dependent on insects for fertilization, but I have not been able to examine them minutely.

Nat. Ord. Rutaceæ.

Melicope simplex, the only representative of the order in Otago, is an abundant shrub. Its flowers are more or less unisexual, the male having no pistil, and the females having a full complement of stamens, but with abortive anthers. The flowers have little or no honey, but are sweet-scented. They are not, however, individually conspicuous, nor are they produced in large masses, and are therefore, I think, entirely dependent for fertilization upon the numerous small Diptera which so commonly frequent the edge of the bush.

Nat. Ord. Olacineæ.

Pennantia corymbosa is entirely dependent on insects for fertilization. The flowers are usually diœcious in function though hermaphrodite in structure; but in the male flowers the ovary is only represented by a rudiment, while in the female the anthers are abortive. They are pure white, produced in great quantity, and are very fragrant; I have seen no honey.

Nat. Ord. Rhamneæ.

Our only local representative is the abundant *Discaria toumatou.* The flowers of this plant are small, green, and hermaphrodite, and produced in considerable numbers along the under-side of the branches. Though inconspicuous, I believe they are chiefly or altogether insect-fertilized. Their fragrance is overpoweringly strong, and they produce a very large quantity of honey, besides which the stamens mature a little before the stigma.

Nat. Ord. Coriarieæ.

All three species of *Coriaria* are common in the neighbourhood of Dunedin (*C. angustissima* at elevations of about 2,000 feet), and their mode of fertilization is extremely interesting. According to the "Handbook of the N.Z. Flora," the flowers of the genus are hermaphrodite, but in at least two of our species they are polygamous. They are all anemophilous.

C. ruscifolia appears always to be hermaphrodite. The flowers are very markedly proterogynous, the stigmas withering completely before the anthers dehisce. The flowers are produced in great abundance, but are green, small, and destitute of honey or scent. (The green colour is to a considerable extent relieved by red in the first stage of flowering, when the stigmas are expanded). The stigmas are relatively large and very papillose, and protrude to a considerable extent. When the stamens are mature, the anthers dangle out at the end of very slender filaments, while the pollen is very light and incoherent.

C. thymifolia and *C. angustissima* agree almost exactly in their flowers. These are sometimes hermaphrodite in structure as in *C. ruscifolia*, in which case they are as distinctly proterogynous. But more frequently the parts are more or less wanting, so that we find truly male and truly female flowers, with every intermediate stage to complete hermaphroditism.

Altogether it seems unlikely that they are visited by insects, but everything points to their being fertilized by the wind.

Nat. Ord. Leguminosæ.

Out of the nine species of *Carmichælia*, described in the "Handbook of the N.Z. Flora," I have only examined *C. flagelliformis*. The flowers are very distinctly marked, but, being small and isolated, are not conspicuous. They are, however, very fragrant, and contain quite a considerable amount of honey. The anthers dehisce as soon as the flowers open.

Clianthus puniceus. This beautiful flower is only found in cultivation in the South Island, and seems to be chiefly fertilized by birds (*tuis*, *korimakos*, etc.) The extremity of the style generally protrudes from the flower before it fully expands; only the tip of it is stigmatic, and it is furnished on its lower (outer) side with a brush of hairs. The anthers dehisce before the flowers open, and, as the latter are pendulous, the pollen falls down towards the apex of the carina, and lodges on the hairs of the style. As soon as the vexillum opens, it curves completely backwards; an arrangement which tends to make the flower more prominent and conspicuous than it would otherwise be. The carina opens about the middle, the two petals diverging slightly at that part, opposite to the anthers of the shorter stamens; in their upper part they remain in contact with each other, their edges slightly folded together, so as to hold the style and enclosed pollen firmly. The flowers are scentless, but the cup-like calyx contains a large drop of honey. It is this delicacy which attracts the honey-birds, which search the flowers with great diligence. In inserting their heads into the flowers, they push back the carina with considerable force; this retains its hold of the style for a time, until the pressure is too great, when the latter is jerked forward by its own elasticity, and throws out the accumulated pollen on the intruder's head. The filaments of the stamens are normally so long as to exceed the carina, but many of them are bent completely back for part of their length. I am not aware what is the use or object of such an arrangement.

Sophora tetraptera. This is another species chiefly visited by honey-birds. It usually flowers very early with us—from July to September—at which time of year there are very few insects about. Like the last-named species, this has very conspicuous pendulous flowers, which are hardly papilionaceous however; they are not sweet-scented, but contain a quantity of honey in the cup of the calyx. The style projects a considerable distance beyond the stamens, and rather out of their line, while only the extreme point is stigmatic. I have no idea whether this species and *Clianthus puniceus* are self-fertile or not, but they are certainly well-fitted for cross-fertilization by the numerous birds which visit them.

Nat. Ord. Rosaceæ.

This order, like the last, is very poorly represented in these islands, being represented by only four genera and ten species, of which latter two are cosmopolitan. Some of its species, however, are remarkable for the contrivances which enable them to wage a very successful warfare with their neighbours,—the *Rubus* with its powerful recurved spines, and some species of *Acæna* with their singular barbed bristles developed from the calyx-lobes, being pre-eminent in this respect.

Rubus australis is invariably diœcious, a fact which Hooker, in the "Handbook of the N.Z. Flora," appears not to have noticed, or to have overlooked. I have examined great numbers of flowers for several years past, and have never found even a trace of hermaphroditism. I do not know whether this character holds throughout New Zealand; I have occasionally found that certain species of plants which produce hermaphrodite flowers in one locality, produce diœcious flowers in another part, where the conditions are different.

In the species under consideration the flowers are produced in great conspicuous panicles, and are not only powerfully sweet-scented, but also contain a quantity of honey. As in almost all such cases, the male flowers are much larger and whiter than the female, which have a greenish hue, and are more sparingly produced. They have also a much wider and flatter disc, so that insects lighting on them turn round and round, smearing the under surfaces of their bodies with pollen. In lighting on the female flowers the same process is repeated, the stigmas of the carpels being brushed over by the under-surfaces of their bodies. The stamens expand from without inwards, the outer anthers being often empty before the inner ones have commenced to dehisce, so that the supply of pollen is kept up for some days.

These flowers seem to be chiefly visited by hairy Diptera of the size and form of a common house-fly, but of which I do not know the species.

Potentilla anserina has very conspicuous bright yellow flowers, which, however, only expand fully in sunshine. Sir J. Lubbock states that the species of this genus have the stigma arriving at maturity before the stamens, so that cross-fertilization generally takes place. I have never been able to detect any difference of such a nature. The honey, as he further states, is secreted in a thin layer, not in drops. The flowers are faintly sweet-scented.

Geum urbanum is stated by Sir J. Lubbock to be melliferous. I have not examined it.

Acæna sanguisorbæ has its flowers clustered into small heads. They are distinctly protorogynous, and, when the stamens expand, they do so one after another. From their inconspicuousness, want of scent, and large papillose stigmas, I am inclined to think that they are wind-fertilized.

Nat. Ord. Saxifrageæ.

Carpodetus serratus, belonging to the tribe Escallonieæ, is apparently dependent altogether on insects. The flowers are conspicuous and very fragrant; they produce a large amount of honey, and are distinctly proterandrous.

Weinmannia racemosa, belonging to the tribe Cunonieæ, has also very conspicuous sweet-scented and melliferous flowers. I have not noticed whether they are also proterandrous.

Both these species are hermaphrodite.

Nat. Ord. Crassulaceæ.

This order is only represented in New Zealand by five species of *Tillæa*, three of which occur in this neighbourhood. Of these *T. sinclairii* and *T. verticillaris* have extremely minute flowers. *T. moschata* has also very small flowers, but they are apparently strongly sweet-scented, and secrete honey. The stamens dehisce before the stigma is matured, so that their fertilization is probably aided by insects.

Nat. Ord. Droseraceæ.

The extremely interesting genus *Drosera* is represented by six species in New Zealand, all of which occur in this island, and of which I have gathered four. I regret having been unable to get them in sufficiently good flower to notice their mode of fertilization. They do not seem to open their flowers very freely, which fact alone has often led me to think that they are chiefly self-fertilized.

All our species catch and digest insects, and in fact are known in some districts by the name of "Fly-catchers."

D. stenopetala, which I have gathered at Port Pegasus, Stewart Island, where it is abundant, seems to be remarkably well fitted for this work, the hairs on its spathulate leaves being unusually long, and bearing very large glands.

D. arcturi, which grows in bogs on the summit of Maungatua, seems in its native habitat seldom to catch insects, but this is attributed by me to the fact of its being often submerged in wet weather. The leaves are from one to three inches long, and rather narrow-spathulate; the marginal glands are on pedicels about ·05 inch long, those on the surface of the blade being much shorter, and interspersed with glandular papillæ. These glands all showed the aggregation of the protoplasm as mentioned in Darwin's "Carnivorous Plants," when acted on by dilute ammoniacal solutions.

I experimented on various leaves by supplying them with small fragments of raw meat and insects. I did not weigh the portions of meat, as I was not particular as to the exact results, but selected them of various sizes, from the size of a pin's-head to pieces as large as a full-sized grain of wheat. In each case the meat was seized by the tentacles (or marginal hairs) in from two to twenty-four hours, those nearest bending first towards it, and by the latter time the colour was generally bleached out of it. The process of absorption lasted from four days to as much as eight for the larger pieces, the meat all the time having a pearly-white appearance, and being bathed in clear liquid, which sometimes accumulated to such an extent as to run down the blade and petiole. In experimenting with insects I placed four full-sized rose *Aphides* on each leaf, and found that on an average they were completely disposed of in about three days, usually not a trace of them remaining. Only those glands in the immediate vicinity of the insects appeared to be concerned in the process. These results were obtained on strong, healthy leaves. Very young leaves seemed easily sickened by an overdose of meat, while older ones sometimes did not begin to act for two or three days.

Drosera spathulata, like the last, is a very low-growing plant, and in wet weather is frequently submerged. In dry weather, however, it is often seen to have insects adhering to its leaves, the bright red colour probably attracting them. The leaves are very small, and have not such powerful tentacles as *D. arcturi*, but the blades are broader, and when bent form a more perfect cup than the trough-like shape assumed by those of the other species. These gave similar results to the last recorded, being of course supplied with proportionally small supplies of food.

D. binata, as well as the last-mentioned species, is referred to in Darwin's work already alluded to. Its leaves are quite different in form to the spathulate-leaved species, but they are equally active in their power of absorbing nitrogenous materials. In the native state this plant almost always has insects, seeds, etc., etc., adhering to its tentacles, and this may be chiefly due to its erect habit and bright-red colour.

Nat. Ord. Halorageæ.

My observations on the genus *Haloragis* are very imperfect. The flowers are mostly unisexual, and from their inconspicuous appearance and want of scent are apparently anemophilous. In the smaller species, *H. depressa* and *H. micrantha*, the relatively large plumose stigmas point to the same conclusion.

Myriophyllum is also apparently anemophilous. The plants are usually monœcious, having female flowers in the axils of the lower leaves, and male flowers higher up. This is the case in all the specimens of *M. variæfolium* and *M. pedunculatum* examined by me.

Gunnera monoica and *G. densiflora* are certainly anemophilous. The male flowers are produced on erect peduncles which stand usually well up from the leaves; the female flowers on the contrary, which are very inconspicuous, are in almost sessile clusters and are greatly buried by the leaves.

Callitriche verna also has monœcious (or diœcious) very imperfect flowers, and is probably similarly fertilized. All the species named of this order have powdery pollen.

Nat. Ord. Myrtaceæ.

This order is fairly well represented in New Zealand, which possesses four genera, including some seventeen species; of these only a few occur in Otago.

Leptospermum scoparium is remarkable for the polygamous character of the flowers, and is the only plant, as far as I know, which departs from the normal hermaphroditism of the order. It would be of interest to ascertain whether it is truly hermaphrodite in Australia. The flowers are sweet-scented and secrete a quantity of honey. They are also very conspicuous, those which are only staminate in structure being both larger and whiter than hermaphrodite or female flowers. The most singular fact about the plants is that the same branch will produce different kinds of flowers, and that frequently the lower part of a branch will bear the previous year's capsules while the upper part is covered with male flowers only. All stages of hermaphroditism and polygamy occur in this species, which seems absolutely dependent on insect aid for its fertilization.

L. ericoides bears smaller flowers than the preceding, and all that I have observed were hermaphrodite. They are also fragrant and melliferous, and are probably aided in their fertilization by insects.

Metrosideros lucida, the rata or iron-wood of Otago, is one of the most gorgeous plants in New Zealand. Like most of the very conspicuous plants of the genus, it owes its brilliancy to the long tassels of crimson stamens in each flower. The flowers are destitute of scent, but secrete a quantity of honey. They are invariably hermaphrodite, but are probably aided in their fertilization by the numerous tuis and honey-birds which frequent them for the sake of their honey.

M. hypericifolia, a smaller species which climbs on the trunks of trees, is much less inconspicuous than the former. Its flowers are smaller, white, pink or crimson, with much shorter and less conspicuous stamens, but these disadvantages are counterbalanced by the abundance of honey produced, and its fragrance. It is sometimes visited by birds, but more probably by large Diptera.

Myrtus obcordata and *M. pedunculata* have nearly similar flowers, and are apparently dependent chiefly on insect-aid. Though not produced in great quantity, they are white and tolerably conspicuous, very fragrant, and distinctly proterandrous. I have not observed any honey in them.

Nat. Ord. Onagrarieæ.

The genus *Fuchsia* is usually considered to have three representative species in New Zealand, viz., *F. excorticata*, *F. colensoi*, and *F. procumbens*, but I should really consider them as two widely different forms, with a great many intermediate gradations. They all agree, however, in the peculiarity of their flowers which I am about to describe, and which I am rather astonished has not been noticed before. Each of these kinds is dimorphic, possessing two very distinct forms of flowers.

The larger form of flower is green and purple, an inch to an inch and a half long, stout, and with exserted anthers. These produce abundance of brilliant *blue* pollen, which is tied together in a remarkable manner by slender threads. These flowers are hermaphrodite in function as well as in structure, but the stigma matures before the anthers, so that cross-fertilization must often take place.

The other form of flower is much smaller, seldom exceeding five-eighths of an inch in length, pale green and pink in colour, and with very short stamens furnished with abortive anthers, which contain no pollen. These flowers, though hermaphrodite in structure, are pistillate in function, and may often be seen with their stigmas smeared with the blue pollen of the larger form.

In the "Handbook of the N.Z. Flora," p. 728, the length of the stamens has been taken as a character separating *F. procumbens* from the other two, the latter having the stamens as long as or longer than the calyx-lobes, and *F. procumbens* having them shorter. I have, however, repeatedly found true *F. excorticata* with both forms of flowers, and *F. procumbens* also with both, and this is one of my chief objections to admitting the validity of the three species.

Both forms of flowers are scentless, but produce a large quantity of honey within the calyx-tube. They appear to be fertilized only by tuis and honey-birds. As in the case of the other plants frequented by these birds, viz., *Clianthus*, *Sophora*, and *Metrosideros lucida*, the *Fuchsia* flowers are pendulous, affording no resting place for insects, while the great quantity of honey secreted would drown any but a large form furnished with a long trunk.

I believe that the dimorphism manifested by our *Fuchsias* is a modification tending in the direction of separation of the sexes, and which would ultimately lead to the production of diœcious plants. This is remarkable, as occurring in an order characterized among other marks by the hermaphroditism of its flowers. Probably the polygamy already noticed as occurring in *Leptospermum scoparium* among the Myrtaceæ is a further development of the same tendency.

The genus *Epilobium* is credited in the "Handbook of the N.Z. Flora" with seventeen species (or, as they might more correctly be called, varieties of about ten or twelve tolerably distinct forms). It is one of those remarkable genera probably undergoing rapid modification and development at the present time, in which the variety of form is so great that it becomes impossible to define the species with any accuracy. The various forms range from minute-flowered like *E. nummularifolium* var. *brevipes* to the large handsome-flowered *E. pallidiflorum*. All are strictly hermaphrodite, and I have not been able to notice any very appreciable difference in time between the maturing of the stamens and pistil. They all seem to be self-fertilized, though the finer-flowered forms are probably largely aided and crossed by insects. I have grown *E. nummularifolium* and *E pubens*, and carefully isolated them under glasses when about to flower, so that all access of insects or of wind was prevented, and they have produced a vast number of capsules and seeds. From the great variety of intermediate forms which occur so commonly, I am inclined to think that hybridization goes on freely among the various so-called species.

Nat. Ord. Ficoideæ.

The flowers of *Mesembryanthemum australe* are stated to be unisexual, in which case they are probably entomophilous. All the specimens I have examined have been hermaphrodite however, and apparently self-fertilized. The flowers are very conspicuous, but destitute of scent or honey.

Tetragonia expansa has comparatively inconspicuous and solitary flowers, which are always hermaphrodite. It is probable, therefore, that they are self-fertile, but they are also rendered attractive to insects by the thin layer of honey they contain, while cross-fertilization must often be insured by the fact of their being slightly proterogynous. The stigma is always expanded some time before the anthers dehisce.

Nat. Ord. Umbelliferæ.

This large order, which is nearly always represented in other parts by hermaphrodite flowers, has unisexual forms in three of its New Zealand genera.

In the genera *Hydrocotyle*, *Pozoa*, and *Crantzia*, the flowers are very small and inconspicuous, and the plants themselves are small and low-growing. *Oreomyrrhis* has also small flowers, though more conspicuously placed, while the same remark applies to the smaller forms of *Ligusticum*. *Daucus brachiatus* has minute red flowers, which are somewhat conspicuous when abundantly produced. I am not aware whether the flowers of these different plants are visited by insects or not.

Apium, like the foregoing, has hermaphrodite flowers, which are conspicuous in *A. australe*, but much reduced in *A. filiforme*. The former secrete honey and are slightly fragrant. I have not noticed either peculiarity in the flowers of the latter.

Aciphylla squarrosa and *A. colensoi* have diœcious flowers, the male being furnished with an imperfect pistil. They produce abundance of honey, are very fragrant, and are produced in such mass (forming elongated panicles two to four feet long) as to be extremely conspicuous objects. They are entomophilous, and are frequently seen to be covered with various species of Coleoptera and Diptera. Professor Hutton informs me that *Lyperobius huttoni* and *Inophlœus innus*, two large weevils, are only found on plants of this genus, and that *Cyttalia griseipila* is much more abundant on them than anywhere else. He is of opinion, however, that *Lyperobius huttoni* lives on the juices of the leaves.

The larger species of *Ligusticum* which I have examined—namely, *L. intermedium* and *L. lyalli*, are also usually diœcious. The flowers are sweet-scented and produce honey, while the umbels are of large size, much flattened on the top, and very conspicuous.

Angelica gingidium produces very conspicuous umbels of white, sweet-scented, polygamous flowers, which contain honey. Some are hermaphrodite, some pistillate, and others only staminate.

Angelica geniculata, though a much less conspicuous species, and having its flowers in very small umbels, is also polygamous. Most of the flowers in each umbel are hermaphrodite, but a few of the outside ones have stamens only, and these are generally much the most prominent. All have honey on their disc, and are very fragrant. The hermaphrodite flowers of both species are also proterandrous, a character which is rather prevalent throughout the order. I believe that most of our flat-flowered, hermaphrodite Umbelliferæ are fertilized by Diptera (and perhaps minute Coleoptera). Sir J. Lubbock has pointed out that flowers which have their honey produced on a flat disc are rarely visited by Lepidoptera, whose long trunks are more suited to flowers with tubes.

Nat. Ord. Araliaceæ.

Stilbocarpa polaris, or a closely-allied species, occurs in Stewart Island, usually within or at the edge of the bush, but at no distance from the sea. The flowers are produced in very large loose umbels, and are tolerably conspicuous, but have no scent, and little or no honey. They are either hermaphrodite or unisexual. In the latter case, they can only—to judge from their habitat—be fertilized by insects. The Auckland and Campbell Islands plant appears to be somewhat different, growing in the open, "covering large tracts of ground with huge orbicular masses, very conspicuous from the yellowish-waxy flowers, and black shining fruit."

The genus *Panax* is represented by ten species, of which I have only examined three—*P. simplex*, *P. edgerleyi*, and *P. colensoi*. All have green flowers, which are only conspicuous by their umbellate arrangement. All are diœcious or hermaphrodite, but, when the latter, distinctly proterandrous. They are also fragrant, and produce a considerable amount of honey. I have frequently seen large, hairy, brown Diptera on the flowers of *P. colensoi*, and think that all the species are entomophilous.

In like manner *Schefflera digitata* produces great umbels of small green flowers, but these are fragrant, and secrete a quantity of honey, and are frequently visited by flies.

Nat. Ord. Corneæ.

This order contains two New Zealand genera, each with two species, but only one of each occurs in Otago.

Griselinia littoralis, the common *broadleaf*, has perfectly diœcious flowers, the male and female flowers showing no trace of the organs appertaining to the other sex. I judge from the following considerations that they are wind-fertilized :—viz., because they are produced in enormous numbers by each tree, they are very small, green and inconspicuous, and are destitute of either scent or honey.

Corokia cotoneaster produces numbers of golden yellow, very conspicuous flowers, which are all hermaphrodite. They are also very sweet-scented, and the bright orange-coloured pistil is covered with a scale or fringe of glandular hairs, which secrete a little honey. They are thus rendered very attractive to insects, which must aid in their fertilization.

Nat. Ord. Loranthaceæ.

The genus *Loranthus* has five species in New Zealand, which exhibit a steady gradation in size and conspicuousness. Thus *L. colensoi*, which occurs abundantly in the West Taieri bush, where it is chiefly parasitic on *Fagus menziesii*, has bunches of handsome scarlet flowers which are nearly two inches long. These are pendulous, have no scent, and apparently no honey. It is probable that this is developed at some time of their growth however, and that it attracts tuis and honey-birds.

L. tetrapetalus (which I have not seen), and *L. tenuiflorus* which occurs at Queenstown and other localities in the Lake district, have flowers about one inch long.

In *L. flavidus*, which is a common parasite on *Fagus solandri*, the flowers are tolerably conspicuous, yellow-coloured, and about half an inch long. Lastly, in *L. micranthus* they are minute and green. Though so inconspicuous in this last species, they are fairly sweet-scented, and are probably visited by small Diptera. All the flowers of this genus are hermaphrodite, and probably more or less self-fertile ; the largest forms being most dependent on external aid.

Tupeia antarctica. This species, though like the last bearing inconspicuous flowers, is diœcious and entomophilous. The separation of the sexes is complete. Both kinds of flower are very fragrant, and secrete a relatively large amount of honey. They are much frequented by numerous midge-like Diptera, which in sucking the nectar from the flat discs bring the lower part of their bodies into contact with the stamens or stigmas.

The mode of fertilization in both our species of *Viscum* has not been made out by me. In *V. lindsayi*, the flowers are whorled on minute peduncles, while in *V. salicornioides* are solitary on the tips of the joints of the branches. In both plants they are unisexual, and from the fact of their being so inconspicuous I suppose they are wind-fertilized. I have found them on a variety of shrubs, but always in comparatively open parts, or on the outside edges of the bush.

Nat. Ord. Rubiaceæ.

The chief genus of this very large order in New Zealand is *Coprosma*, of which over twenty-five species have been described in these islands. As is remarked in the "Handbook of the N.Z. Flora," "the species are most difficult of discrimination, owing to their extreme variability, their being diœcious, and their very small flowers." These latter points constitute, to my mind, a much greater difficulty than the former, for I think it will be found, after examination of a large series of specimens, that most of the forms are tolerably distinct and well-defined. The genus may be divided into two sections, in one of which the female flowers are collected into clusters, and in the other they are solitary. In the former they are, of course, more conspicuous than in the latter, but there seems no doubt that in both forms they are solely dependent on the wind for fertilization. They are dingy-green in colour, small, and quite destitute of scent or of honey. The male flowers have four stamens, the anthers of which dangle at the extremity of very slender, easily shaken, long filaments. The pollen is also extremely light and powdery, and the whole of it escapes on the dehiscing of the anther. The female flowers have a much smaller calyx and corolla than the male, these parts being reduced to the minimum size consistent with their function of covering the pistil while it is still immature. The ovaries are very small, but the styles are proportionally of immense size, and stigmatic over their whole length. Some idea of this may be gained from the drawings in Plate I., where figure 1 represents the female flower of *C. propinqua*, and figure 2 that of *C. rotundifolia* (both magnified). I have examined the flowers of fourteen species growing in this neighbourhood, and find that all possess the same character. The brightly-coloured drupes of these plants must aid greatly in their dispersion, as they are eaten and passed by birds. It would be interesting to ascertain what advantage is gained by the possession of the intensely fœtid odour which is so characteristic of some species.

The genus *Nertera* differs from *Coprosma* not only in its herbaceous habit, but—in the New Zealand species at least—in having hermaphrodite flowers. These are, however, perfectly diœcious in function. I have examined the flowers of three out of the four New Zealand species, viz., *N. depressa*, *N. dichondræfolia* and *N. setulosa*. All are very decidedly proterogynous, the stigmas being expanded fully while the stamens lie in the flower, and withering completely before the anthers dehisce. They must, therefore, be always cross-fertilized, and as the flowers agree in all respects (but that already mentioned) with those of *Coprosma*, they are also probably anemophilous.

The flowers of *Galium umbrosum* and *Asperula perpusilla* are very small, but they are white and secrete a minute trace of honey, and are therefore probably visited by insects. The latter plant, which is one of the smallest flowering plants we have, is remarkable for exhibiting distinct dimorphism. In one form the stigma is almost sessile on the ovary, in the other there is a well-developed style. I have not observed a corresponding difference in the stamens, which made me think at first that the difference was due solely to the varying age of the flowers examined. This, however, is not the case, as in young and old flowers alike the two forms are to be found.

Nat. Ord. Compositæ.

This very large and important order is represented in this part of New Zealand by about sixteen genera, out of the twenty-four occurring in the colony. The advantages possessed by flowers of this order by having their florets crowded together, have often been insisted on, the chief of these being the prominent appearance of the flowers when massed together, the facility with which honey is obtained rendering them attractive to insects, and the greater chance of cross-fertilization enjoyed by them, seeing that an insect lighting on a flower-head is likely to come into contact with several flowers at each visit. A further chance in favour of cross-fertilization arises from the polygamous nature of the florets in each head, those on the outside being usually pistillate only, while those within are hermaphrodite. In most of the sub-order Ligulifloræ, the ray-florets are pistillate, and it is worthy of notice that this is the reverse of what usually occurs in diœcious or polygamous plants, for it is usually the staminate or male flowers which are the most conspicuous. This will be found to be the case in almost all the genera mentioned in the earlier part of this paper in which separation of the sexes occurs. In those Composites which are frequented by insects—and possibly in others—*autogamy*,* or fertilization of a flower by the pollen from the stamens of the same flower, is usually avoided by a simple form of proterandry. The anthers, which cohere to form a tube round the style, dehisce a little before the flower expands ; the pollen, however, is retained in the tube, where it has no access to the stigmatic surfaces of the style, as these are in close contact. The style gradually lengthens up, however, through the staminal tube, which it bursts open at the top, and scatters the pollen out. After a time the stigmatic arms at its summit separate, and gradually recurve, in which position they protrude to some distance from the mouth of the floret. This peculiarity of Composites and

* "Flowers and their Unbidden Guests," by Dr. Kerner, (C. Kegan Paul & Co.) This author also proposes to use the terms *geitonogamy*, for the fertilization of a flower by pollen from other flowers on the same plant, and *xenogamy*, for the fertilization of a flower by pollen from other plants. Both terms to be classed under the name *allogamy*. He objects to the indefiniteness of the term "self-fertilization."

some other plants, is illustrated in Sir J. Lubbock's work already referred to, at p. 114, to which the reader is referred for details. I have observed it in the following New Zealand Composites: *Olearia ilicifolia* and *O. nitida*, *Celmisia longifolia*, *Lagenophora forsteri*, *Cotula coronopifolia* (though not so decidedly as in the other species named), *Cassinia fulvida*, *Senecio lautus* and *S. rotundifolius*, and in *Microseris forsteri*. It is probably the rule in all the bright-flowered species.

Of the genus *Olearia*, probably all are very attractive to insects—*O. nitida*, *O. dentata*, and *O. ilicifolia*, have their flowers arranged in large conspicuous corymbs, and are sweet-scented. I have not seen honey in them.

O virgata has small sweet-scented heads, which are much less conspicuous than the preceding, while *O. hectori* has its flowers most deliciously scented, like ripe peaches.

Of the genus *Celmisia*, the larger flowered species examined—namely, *C. coriacea* and *C. hectori*, though very conspicuous, have no fragrance and very little honey. The same remark applies to *C. sessiliflora*, in which the individual heads, though small, are produced in such immense numbers as to render the cushion-like masses in which the plant grows extremely conspicuous. In *C. longifolia* the flower-heads are solitary, but are slightly fragrant, and the tubes of the disc-florets contain a little honey.

In *Vittadinia australis* the flower-heads are also produced singly. They are not so conspicuous as the last-named, and, though slightly fragrant, are probably more commonly autogamous. The protrusion of the stigmas from the hermaphrodite florets of the disc is very slight, and they are frequently found smeared with the pollen of the same floret. The ray-florets, however, being pistillate only, require the visits of insects to bring pollen to them from other flowers.

Lagenophora forsteri and its small variety *L. petiolata* have small but conspicuous scentless flowers.

The genus *Cotula* I have hardly looked into. *C. coronopifolia* has very conspicuous yellow flower-heads, which are destitute of fragrance and produce little or no honey. The minuter flowered forms, as *C. dioica*, *C. minor*, etc., do not seem to possess any attractions for insects. The absolutely unisexual species are probably anemophilous.

The flower-heads of *Cassinia fulvida* are very conspicuous by association, and are sweet-scented.

Ozothamnus glomeratus has also sweet-scented florets, which are much less conspicuous than the last.

Gnaphalium bellidioides and *G. trinerve* are very conspicuous, owing to the large pure white involucral leaves which surround the flower-heads. These perform the function of the ray-florets in other Composites, acting as lures or flags of invitation to honey-loving insects. These flowers are also sweet-scented.

The genus *Erechtites* has inconspicuous greenish flower-heads, which never expand much. They have no scent, and no honey, and are probably self-fertilized.

The genus *Senecio* exhibits a great diversity in its flowers. *S. lautus* has yellowish, but by no means conspicuous flowers. These are scentless, but contain a little honey, and, as has been already remarked, are proterandrous.

S. lagopus and *S. bellidioides* (probably two extreme forms of the same variable species), and the beautiful *S. lyalli*, have very conspicuous flowers, which are also scentless, and produce very little honey. *S. rotundifolius*, which grows so abundantly round the coasts and in the bush of Stewart Island and the West Coast Sounds, has comparatively inconspicuous flowers, but these are of an overpowering fragrance, and the tubes of the florets almost overflow with honey.

Lastly, *Microseris forsteri* has solitary flower-heads destitute of scent, and with very little honey, but they are bright yellow, very conspicuous, and proterandrous.

Nat. Ord. Stylidieæ.

The flowers of this order are characterized *inter alia* by being *gynandrous*, *i.e.* having their style and stamens united into a column. Instead of aiding in self-fertilization, as might at first be supposed, this arrangement more commonly prevents it. The order is represented by three genera in New Zealand.

Phyllachne (Forstera) sedifolia has extremely variable flowers as to size, those which grow on the hills near Dunedin being seldom more than a fourth of an inch in diameter, while some gathered by me on Frazer Peaks, Stewart Island, were over three-fourths of an inch, and furnished with a very beautiful dark-purple eye. All I have gathered have been hermaphrodite, but according to Hooker they are sometimes unisexual. These flowers are scentless, but so strongly proterandrous as to be practically diœcious. The two stamens shed all their pollen, and wither completely, before the stigmas commence to expand and recurve. The flowers are furnished with two epigynous glands, whose function I have not made out; it may be to secrete honey, of which the flowers contain a little. They are manifestly entomophilous.

Stylidium subulatum is a very doubtful member of this genus. Its column is short and straight, and in no way irritable, whereas one of the characteristics of the genus is a bent, irritable column which springs up with considerable force on a touch, and throws the pollen out of the anthers. In this species the only contrivances for preventing self-fertilization appear to be the position of the transverse anthers under the stigmatic disc, their proterandry—which, however, is not very decided, and the rigidity of the short, erect column. They are probably, also, entomophilous as in the preceding species.

Donatia novæ-zealandiæ occurs tolerably abundantly on the summit of Maungatua (3000 feet), and in similar swampy country near sea-level in Stewart Island. The flowers are solitary, white, and quite sessile at the end of rigid branches, which are covered with very short, rigid leaves. They are destitute of scent and, as far as I have observed, of honey, but owing to the plants being aggregated into large tufts they are very conspicuous. The bases of the filaments and styles are connate, but the anthers diverge from the stigmas and dehisce outwards. I hardly think the flowers are self-fertilizable, but have not sufficiently definite information on the subject.

Nat. Ord. Campanulaceæ.

Two species of *Wahlenbergia* are abundant in this part of New Zealand, *W. gracilis* being found in dry spots at all elevations from the sea-level to 3000 feet (Maungatua), while *W. saxicola* is more commonly a hill-growing species. I have, however, found it at sea-level in some parts of Otago and in Stewart Island. The former is a branched plant, sometimes two feet high, and producing a solitary flower at the end of each branch. These are small but brightly coloured, white, lilac, or blue. *W. saxicola* is a much smaller plant, producing one much-larger bell, on a slender, erect peduncle, seldom more than six inches high, and conspicuous from its pure white or pale blue colour. Both species are hermaphrodite in structure, but diœcious in function, as they are very distinctly proterandrous. The anthers dehisce before the flowers open, and discharge all their pollen on to the outside of the style, which is furnished with hairs to which the grains adhere. The style, which bears two stigmatic branches at its upper part, lengthens upwards, carrying the pollen with it, in which state it is accessible to any insect visiting the flower. It cannot, however, get on the stigma, for the two faces of the style are in close contact. These ultimately open, displaying two convex surfaces thickly clothed with glandular papillæ, and finally curving back from one another stand right in the path of any insect entering the flower. The ovary is covered by the expanded and fringed bases of the filaments, and between these may be seen small beads of honey. Both species are evidently quite dependent on insect-aid for their fertilization.

Nat. Ord. Lobeliaceæ.

The only plant belonging to this order which I have been able to examine is *Pratia angulata*. It is almost universally admitted among botanists that irregular flowers are specially fitted for the visits of insects, and if this view is correct all the plants which belong to this order are more or less entomophilous.

The flowers of *Pratia* (with which those of *Lobelia* and *Colensoa* agree pretty closely), are extremely irregular. The corolla tube is split to the base at the back, while in front it stands somewhat horizontal, and affords a convenient landing stage for small insects. It is usually white in colour, with very bright blue or purple guiding lines converging to its base, where a considerable amount of honey is secreted. The style, which is two-lobed above, is surrounded by the connate anthers when the flower newly opens, and the column is thus bent forward at its summit, so as to slightly arch over the horizontal corolla-tube. The stamens are proterandrous, as in *Wahlenbergia*, and just as in those flowers, the style lengthens out of the staminal tube, carrying out the pollen with it, and then the two stigmatic faces, which up to this time have been in close contact, expand widely and expose a large papillose surface. These flowers are quite incapable of self-fertilization.

Nat. Ord. Goodeniaceæ.

The fertilization of *Selliera radicans* has been already fully and clearly described by Mr. T. F. Cheeseman.* This species is exclusively insect-fertilized.

Nat. Ord. Ericeæ.

There are really only two genera (*Gaultheria* and *Pernettya*) of this large order in New Zealand.

Gaultheria antipoda is remarkable for the tendency towards separation of the sexes which it exhibits; standing alone in this respect—as far as I am aware—in the order.

In some of its forms truly hermaphrodite flowers are found, and in these the stamens mature considerably before the stigmas. In others, the stamens occur in a more or less aborted form, until a stage is reached where the anthers are represented by small bent portions on the summit of a diminished filament. I have never found a purely pistillate form with no trace of anthers, nor have I found a male form showing a diminished pistil. In all those of course in which abortion of the stamens has taken place, cross-fertilization must take place to secure the production of seed, and from the nature of the flower this can only be accomplished by insect-agency. In the hermaphrodite flowers, even if not absolutely essential, it must frequently take place. The corolla always contains honey at its base.

Gaultheria rupestris, which is a much more conspicuously flowered plant

* "Trans. N. Z. Inst." Vol. IX. p. 542.

than the preceding, though probably connected with it by a complete gradation of intermediate forms, shows the same tendency to abortion and separation of the reproductive organs. Hermaphrodite and pistillate forms are both found, honey is also found in the flowers, and these are usually produced in such quantity as to be very readily seen.

Nat. Ord. Epacrideæ.

Six genera of this typically Australian order occur in New Zealand, and four of these grow in this neighbourhood.

Cyathodes acerosa has extremely minute, solitary flowers, difficult of detection by sight, and destitute of smell. They contain honey however, and are distinctly proterandrous, so that they must probably be visited by small insects.

Leucopogon frazeri is a most abundant plant on dry ground, and is apparently solely entomophilous. I have found its flowers invariably hermaphrodite, but yet so contrived as to require insect-aid to ensure fertilization. The corolla, which always stands quite erect, is in the form of a long cylindrical tube contracted at the throat; its lobes and most of the inner surface of the tube are thickly clothed with hairs. The style is very long and slender and bears a rounded stigmatic head, which projects a little above the throat of the corolla and is very viscid. Immediately below it are the five anthers, nearly filling up the whole of the tube. These are nearly sessile, and one-celled, and their pollen, after escaping from them, lies exposed on their inner side, and almost in contact with the top of the style. The pollen-grains are comparatively large and circular, and cohere readily together. The flowers are very sweet-scented, and the base of the corolla contains a large secretion of honey. It seems almost impossible that self-fertilization can take place, while the manifest attractions for insects lead us to the conclusion that their agency is necessary for the production of seed. The only insects which could reach the honey, however, are those furnished with a long slender proboscis, such as the Lepidoptera, for not only is the corolla-tube lined thickly with hairs, but the style itself is also furnished with these impediments. Between the walls of the corolla, however, and the style, are five minute apertures through which a moth's proboscis might be inserted to reach the honey, but, as these apertures lie right over the anthers, it would be almost impossible for the insect to reach the coveted sweets at the bottom of the flower without touching and removing some of the pollen. The position of the capitate stigma also, guarding the entrance of the flower, with its drop of viscid secretion is such that contact with anything adhering to the proboscis of an insect would almost certainly take place. I do not think insects with short trunks could reach the honey. I, on one occasion, found a minute beetle in the tube, but it was drowned in the honey at the bottom.

Pentachondra pumila is somewhat similarly furnished with a densely-bearded corolla-tube, and is probably fertilized in the same manner. In the summer of 1876 I had a plant of this in flower under glass, and, though it produced numerous blossoms, no fruit resulted. In each case, after the gradual withering of the corolla, it was found that the ovary had shrivelled also.

Dracophyllum longifolium has very conspicuous fragrant clusters of flowers. These contain a great deal of honey, and are therefore no doubt visited by insects. They are hermaphrodite, but I have not seen any special contrivance to render self-fertilization impossible. Birds occasionally visit the flowers.

Nat. Ord. Myrsineæ.

The only New Zealand genus is *Myrsine*, of which two species—*M. urvillei* and *M. divaricata*—are common in the neighbourhood of Dunedin. I have examined the flowers of the former, and find them mostly diœcious. The male flowers have an imperfect ovary, while the female flowers have stamens with small anthers, which, however, contain no pollen. This is morphologically so slight a remove from hermaphroditism that I think the latter must frequently occur. In all cases I have noticed they have, however, been functionally diœcious. The flowers are produced in great numbers, are small and rather inconspicuous, have no scent and no honey, while their pollen is light and very incoherent, all of which considerations lead me to consider them as always anemophilous.

Nat. Ord. Apocyneæ.

The only plant of this order found here—*Parsonia albiflora*—has puzzled me a good deal. It is a straggliug climber producing panicles of pendulous white flowers. These have a funnel-shaped corolla, the lobes of which bend back. The stamens are syngenesious—that is, their anthers are united together. These anthers are arrow-shaped, with very acute apices, and when joined together they form a sharply-pointed conical cap (not unlike some forms of metal drills) which fits closely on the summit of the stigma. Of each anther, one cell only produces pollen, which seems to me to be always applied directly on the stigma. In fact, this introrse dehiscence of the anther, and the application of the pollen on the stigma, is given by Le Maout and Decaisne* as a characteristic of the order. At first sight this would make us at once conclude that the flowers were self-fertile, in which case insect-aid would not be absolutely necessary. But what appears a still greater difficulty is that the pollen is all contained inside a cap, from which I have not seen it shed, and which does not readily open from any side. Yet the flowers are usually fragrant, and contain a large quantity of honey. I am inclined to think that, had I examined the flower at different stages of

* "Descriptive and Analytical Botany," by Le Maout and Decaisne, p. 550. Edited by Sir J. D. Hooker. (Longmans and Co.)

its maturity, I should have found a clue to this apparently contradictory arrangement. Meanwhile, I commend the case to other working botanists as one that will repay investigation.

Nat. Ord. Gentianeæ.

Of the five species of *Gentiana* described in the "Handbook of the N.Z. Flora," I have only examined the commonest form, viz., *G. montana*. The flowers are white and scentless, and produce very little honey. They are, however, very distinctly proterandrous, and can only be fertilized by pollen from another flower. The style is two-lobed above, and only the inner faces of these are stigmatic, as in *Wahlenbergia*. The anthers dehisce as soon as the flowers open, but the stigmas do not expand for two or three days after, when they separate pretty widely. Any adhering pollen is then on the outside of the style, but not on the stigmatic arms.

Nat. Ord. Convolvulaceæ.

Convolvulus tuguriorum and *C. soldanella* are both plants with very prominent and beautiful flowers; the former with large white blossoms, which often cover the shrubs over which the plant climbs; the latter growing only on the sand at the sea-shore, which it ornaments with its rose-coloured, purple-striped flowers.

C. tuguriorum remains open all night if the sky is bright, and often in wet weather too, and yet though thus flaunting its attraction before diurnal and nocturnal insects alike it does not seem to be much visited by them. Both the species named are self-fertilized; they are scentless also, and produce apparently no honey.

Dichondra repens is a very low-growing, humble plant, producing small, greenish-white or yellowish flowers, which are, however, extremely variable both in size and conspicuousness. The larger and brighter forms are perhaps visited by insects, but the smallest forms show a tendency towards cleistogamy. In some localities I have found them with large calyces (which hardly opened at all), greatly reduced corollas, and stunted anthers, and yet producing full round capsules.

Nat. Ord. Scrophularineæ.

This large order is represented in New Zealand by ten genera, the most characteristic and important of which is *Veronica*. All the flowers of the order are irregular, and we find numberless contrivances for the attraction of insects, and the consequent cross-fertilization which ensues. I have not, however, had opportunities of studying many flowers of this interesting class.

The fertilization of *Glossostigma elatinoides* has been remarkably well described by Mr. T. F. Cheeseman.* In this flower the flattened spoon-shaped stigma is sensitive to a touch, and lies over the top of the anthers,

* "Trans. N.Z. Inst.," Vol. X., p. 353.

ready to spring up when touched. I do not know whether similarly-sensitive stigmas are found in the two species of *Mimulus* which occur in this colony. In both our naturalized forms, *M. luteus* and *M. moschatus* (the common musk-plant), self-fertilization is prevented by such a contrivance. I have not seen any description of the fertilization of these flowers (though I believe they have been described), and therefore will record here my own observations on the former species, as they may be suggestive to anyone observing our indigenous species. I may mention that very beautiful hybrid forms of this species have gone wild in Ross Creek, in the neighbourhood of Dunedin. In their new habitat they have attained immense growth, forming thick succulent stems an inch and more in diameter and frequently three feet long. It was on the flowers of these plants that my observations were made. The style is a good deal longer than the longer pair of stamens, and ends in a two-lobed stigma, formed of two flat plates, which are viscid on their inner faces (fig. 3, pl. X.). The upper of these lobes stands against the corolla-tube, the lower hangs over, and is in the way of any large insect entering the flower. This lower lobe is sensitive to a touch, not springing up rapidly however, but taking from five to fifteen seconds to close against the upper plate. In the course of half an hour or less, if no pollen is placed on it, it opens again. If, however, pollen from another flower be placed on it, it closes firmly against the upper plate, with which it remains in contact for many hours. On opening again it is no longer sensitive, and the corolla soon after withers. It is quite evident that if a bee or other large insect enter the flower without pollen on its head, it is almost certain to come into contact with the lower stigmatic lobe, which will then close up, but only to open again in a short time. In order to get at the honey in the bottom of the flower however, the insect pushes past the anthers, which would probably dust its head with pollen. On visiting a second flower, it again comes in contact with the stigma, but this time leaves some pollen on it, and thus secures fertilization.

M. moschatus, the common musk plant, shows the same irritable stigma.

Veronica. The species of this genus, though hermaphrodite, and not nearly so irregular as other flowers of the order, are probably all unfitted for self-fertilization. From this statement I must except some of the small herbaceous European species. In our species the anthers are more or less proterandrous, and their filaments diverge widely as they dehisce, while the style projects forward quite out of the flower.

V. traversii—which I have only seen in cultivation—produces immense numbers of white, very conspicuous flowers, which have a little honey but no scent. On bright days they are visited by great numbers of insects, chiefly Hymenoptera and Diptera.

V. buxifolia is similarly very white, melliferous and scentless. It is an extremely common plant at elevations of 2,000 feet and upwards. *V. lyalli* and *V. cataractæ* (an abundant West Coast plant) are similarly characterized.

V. salicifolia produces conspicuous racemes of white, lilac, or purple flowers which are very fragrant and produce a little honey. They attract great numbers of insects, chiefly species of Diptera and moths, besides one or two butterflies.

V. elliptica, which is especially a sea-side plant, has large and conspicuous flowers, which are very fragrant, and secrete a very considerable amount of honey.

Nat. Ord. Lentibularieæ.

This order contains only two genera, *Utricularia* and *Pinguicula*, of which the former is represented by four species in New Zealand. These are rather rare, or what is more probable are very readily overlooked, except, however, at flowering time, when they are conspicuous enough, though small.

Utricularia monanthos occurs abundantly in the bogs at the head of Paterson's Inlet, Stewart Island. The plant is very minute, bearing one or two bright purple flowers at the summit of a slender scape, a half to four inches high. (Pl. X. fig. 4*a*). The few leaves are very small and narrow, and almost always submerged, while the creeping rhizome or root bears two or more of the small compressed bladders from which the genus takes its name. The flowers are evidently adapted for cross-fertilization. The corolla is bilabiate, the lower lip being flattened and expanded at its distal end into a broad landing stage. This is purple in colour, and furnished with a bright yellow glandular line—the honey guide—down the centre. The upper lip (fig. 4b) stands nearly erect, while the base of the corolla is produced downwards into a spur or nectary (though I found no honey in it). The two stamens lie under the upper lip; the filaments diverge somewhat widely below, but are curved inwards in their upper part, bringing the anthers close together under the stigma. This latter is a flap or plate opening downwards, so as to project somewhat over the entrance to the nectary, and partly covering the anthers. If an insect alighted on the lower lip of the flower, and advanced to suck honey from out the nectary (for, though I did not find any, there can be little doubt that at suitable times the spur does contain honey), its head would probably come first into contact with this flap. This would bend down, exposing the middle or stigmatic portion, to which any pollen on the insect's head would adhere. The lower side of the flap, which is not stigmatic, would meanwhile completely cover the anthers. On withdrawing its head the insect would rub it against the anthers first, and then push up the lower side of the flap, which would not, however, receive any pollen during the withdrawal. I think it quite impossible that this species can be self-fertilized. From its habitat, standing, as the flowers do, right out of the water, it is probably visited by small species of Diptera.

As already mentioned, the name of this genus is derived from the bladders (Lat. *utriculus)* attached to the leaves or rhizomes. The primary function of these bladders would appear to be that of floating the plant during the flowering season to the top of the water in which it grows. The following quotation from De Candolle's "Vegetable Physiology" is extracted from Le Maout and Decaisne's "System of Botany," p. 591 :—"These bladders are rounded and furnished with a kind of moveable operculum. In the young plant they are filled with a mucus heavier than water, and the plant, submerged by this ballast, remains at the bottom. Towards the flowering season the leaves secrete a gas which enters the utricles, raises the operculum, and drives out the mucus, when the plant, now furnished with aerial bladders, rises slowly and floats on the surface, and there flowers. This accomplished, the leaves again secrete mucus, which replaces the air in the utricles, and the plant re-descends to the bottom, and ripens its seeds in the place where they are to be sown."

This view of the function of the bladders may apply in the case of such species as *U. neglecta* (of Europe), which bears them on the leaves, and is quite destitute of roots ; but in the case of the species under consideration, and all others which bear them on the subterranean rhizomes or creeping stems, some other explanation must be sought. It is probable that the view advanced by Darwin in his "Insectivorous Plants," p. 395, is the correct one—that the bladders have now become adapted (whatever may have been their original function) for the capture of small aquatic animals, and their subsequent absorption. In the work named Darwin details very minutely the structure of the bladders of *U. neglecta.* These are remarkably well adapted for the capture of prey, their aperture being furnished with bristles directed into the interior of the cavity, like a rat-trap. Entrance into the bladder is easily accomplished, but, once in, escape is almost impossible. The interior of the bladder is lined with what are termed "quadrifid processes," which are four elongated cells borne almost crosswise from the summit of a minute projection or foot-stalk. Besides these there are "bifid processes," similarly placed on stalks, and various forms of glands. All these bodies are found to have the power of absorbing decaying animal matter, as well as weak solutions of salts of ammonia and urea. As the older bladders are found to contain animal remains always more or less disintegrated, there seems little doubt that their presence must be beneficial to the plant. As to what entices the animals entrapped to enter the bladders no satisfactory explanation has been given as yet. The transparency of the bladder membrane, and the presence of long bristles or antennæ, may induce small aquatic animals to attempt the passage. Darwin suggests that "perhaps small aquatic animals habitually try to enter every small crevice, like that between the valve and collar, in search of food or protection.* I can myself vouch for the inquisitiveness of many of the small Entomostraca, those species particularly which, like *Cypris*, are secure in a two-valved shell, being the boldest in this respect. The bladders do not seem to digest their prey, there being no glands for secretion; and fragments of meat, etc., placed in bladders, were found unacted on at the end of three days. It is probable that the animals which force an entrance into the bladders become asphyxiated, owing to the contained oxygen being all used up, and that, as their bodies decay, the products thus resulting are absorbed by the various processes on the walls.

The bladders on our Stewart Island species—*Utricularia monanthos*—are somewhat different from any of the species described in Darwin's book. They are almost circular in outline, and laterally compressed, and vary in diameter from $\frac{1}{20}$ to $\frac{1}{8}$ of an inch. Running almost completely round them is a well-defined vascular bundle (fig. 5*a* & *b*) the inner end of which forms the thickened collar or neck, against which the valve closes, while the outer and upper end is sometimes continued into a horn-like antenna, or is abruptly truncated. On each side of the entrance are the so-called "antennæ," which in this species are narrow at the base, and expand outwards in a palmate manner, ending in numerous unicellular hair-like processes. That portion of the bladder between the entrance and stalk by which it is attached, is bordered by a flange or expansion of the cellular tissue of the walls on each side. This, together with the overlapping antennæ, forms a sort of covered way to the entrance. There are no spines directed into the interior of the cavity, as in *U. neglecta*, nor could I detect any glands, other than the numerous quadrifid processes (fig. 6) with which the whole inner surface is lined. The arms of these processes are nearly equal in length. The outside of the bladders is covered with rounded pit-like cells, at the junctions of many of the hexagonal cells of the parenchyma.

The smaller bladders were usually semi-transparent and empty, but the larger ones were mostly filled with dark brown or blackish material. This seemed to consist of disintegrated animal and vegetable remains, most of it destitute of recognizable structure, but containing Diatoms, Algæ, etc., and in many cases Entomostraca. All the larger bladders had from one to as many as ten specimens of the common Entomostracan, *Cyclops novæ-zealandiæ*, sometimes quite entire, and at other times in fragments. A good-

* *Loc. cit.*, p. 409.

sized *Daphnia* was also obtained in one; the body was reduced to a brownish mass, but the bivalve shell and portions of the limbs were intact. The Diatoms and other minute organisms are probably present not as prey, but as commensalists or messmates, taking advantage of the rich food obtainable in the bladders to take up their residence in them.

Of the four species of *Utricularia* described in the Handbook Fl. N. Z., three have their bladders borne on the rhizome, while *U. protrusa* has floating stems and capillary leaves like the English species. A fifth species has been mentioned by Mr. Kirk,* but apparently not described, as occurring in Rotomahana, and having the same arrangement of the bladders on the leaves.

Nat. Ord. Verbenaceæ.

Teucridium parvifolium occurs plentifully enough near Dunedin, but I have not examined its flowers.

Myoporum lætum, the only other representative of the order in this part of the island, is also extremely common. This plant produces its flowers chiefly from November to January, but it continues to put out blossoms sparingly for a considerable part of the year. These unseasonable flowers are commonly defective, their anther-cells being destitute of pollen and their pistil also being more or less aborted. I cannot conceive of what use they are to the plant. The ordinary flowers are white and conspicuous, and produce a little honey. They have little or no scent, and I cannot say whether they are self-fertile or not. The lining of hairs on the lobes of the corolla probably serves to impede small and unsuitable insects from obtaining the honey.

Nat. Ord. Labiatæ.

This large order—the flowers of which present such a variety of contrivance to ensure cross-fertilization—is represented by two very small plants in New Zealand, belonging to the genera *Mentha* and *Scutellaria*. The latter I have not seen.

Mentha cunninghamii belongs to a genus in which the corolla does not show the extreme irregularity of typical Labiates. There is a tendency also to dimorphism, which this species among others exhibits, one of the characters given in the "Handbook of the N.Z. Flora," p. 226, being "Stamens included in the corolla-tube of some flowers, exserted in others." I have not, however, noticed this difference. Nor have I noticed any tendency towards production of female as well as hermaphrodite flowers, which prevails in some species. The flowers of our species are only slightly irregular; they are, however, proterandrous, strongly sweet-scented, and produce a great amount of honey, and are consequently much visited by insects.

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* "Trans. N. Z. Inst." Vol. V., p. 343.

Nat. Ord. Plantagineæ.

Plantago raoulii is the only common plant of this order. Though its flowers are hermaphrodite, they seem to be exclusively cross-fertilized, and to depend on the wind for the performance of this necessary occurrence. They are very inconspicuous, scentless and destitute of honey. As soon as the flowers open, the long papillose stigmas protrude, while the stamens remain undeveloped. The flowers lowest down the spike open first and those at the top last, and the withering of the stigmas takes place in the same order. As the stigmas wither, the filaments commence to lengthen, bearing at their extremity the versatile anthers full of light friable pollen. Even then of course some of the upper flowers are only in the pistillate stage, and may get pollen from flowers lower down the same spike, but in most cases it must be blown from flowers either on different plants or different spikes.

Nat. Ord. Chenopodiaceæ.

The plants of this order bear very inconspicuous flowers, which are sometimes hermaphrodite, but more commonly polygamous. *Chenopodium triandrum* is the only one I have examined with care. When hermaphrodite, its flowers are very distinctly proterogynous, the stigmas withering completely before the anthers dehisce, so that in this, as in diœcious forms, self-fertilization is impossible. It is an anemophilous plant, and this will probably be found to be a character of all the New Zealand species of the order.

Nat. Ord. Polygoneæ.

Polygonum aviculare is apparently self-fertilized, the flowers being small and destitute of honey or scent.

The species of the genus *Muhlenbeckia* are anemophilous. They are almost always diœcious, though sometimes imperfectly hermaphrodite. They are very inconspicuous in colour, destitute of scent and honey, and furnished with large plumose or papillose stigmas. I have not noticed any insects visiting them.

Rumex flexuosus and *R. neglectus* are hermaphrodite. The flowers are distinctly proterandrous however, and dependent for fertilization on the wind.

Nat. Ord. Thymeleæ.

The only plant of the genus *Pimelea* which I have looked into is the common but very variable *P. prostrata*. Though hermaphrodite in structure, this species is diœcious in function, and will probably tend rapidly to become so in structure as well. In those forms of it which are truly hermaphrodite there is a simple contrivance to prevent self-fertilization. Just before the flowers expand, the style (which is placed to one side of the perianth) is shorter than the stamens, but, as they open, it lengthens rapidly, and carries the stigma up one side and past the expanding anther-cells.

Of those which are diœcious in function there are two forms, which, though growing usually side-by-side, are distinct enough to be taken for two varieties. The male or staminate form is considerably larger and more conspicuous than the other. When fully open the two stamens are quite exserted from the perianth-tube. At this stage the slender style, with its minute, *almost glabrous*, stigma, is only about half the length of the perianth-tube, but, after the anthers have dihisced, it lengthens very much and protrudes between the lobes of the perianth, as if to ensure fertilization. Having reached this stage further development ceases, the small ovary with its contained ovules, which never become fertilized, commences to shrivel, and ultimately the whole flower withers and falls off.

The smaller pistillate flowers have a long style, bearing at its summit a capitate stigma, which is so crowded with glandular or papillose hairs as to be almost globose, and which projects at the mouth of the perianth. Nearly half way down the tube are the two minute stamens, with shrivelled anthers containing no pollen. Probably between these two forms, and truly hermaphrodite ones which are proterandrous, there are intermediates. I have not yet found any forms absolutely diœcious in structure, though the species seems tending towards this. I think that in the gradation from the proterandrous hermaphrodite form to the staminate form, in which the first part of the proterandry is carried out but the second fails to be carried out, we see the step by which the diœcism (to coin a word) of this plant is attained.

In all its forms the flowers of this plant are small, but conspicuous by their association into terminal corymbs; they are sweet-scented and their tubes invariably contain honey, so that they must be very attractive to insects.

Drapetes dieffenbachii has extremely small and rather inconspicuous flowers, which are not crowded into masses as in the preceding species. I could not detect any smell or honey, yet I am inclined to think that this plant is tending in the same direction as *Pimelea prostrata.* There seem to be two forms, in one of which the pistil is very much smaller than the other. I did not make out, however, whether there was a difference of function in the two kinds. They are probably visited by minute Lepidoptera, which swarm in immense numbers among low-growing plants during the summer months.

In the lower orders of Dicotyledonous plants wind-fertilization is the rule, and, as if effectually to prevent self-fertilization, most of the plants belonging to them have the sexes separate. Thus *Fagus menziesii* (Nat. Ord. Cupuliferæ) has inconspicuous monœcious flowers; *Epicarpurus microphyllus*, *Urtica incisa*, and *U. ferox* have diœcious flowers; while *Australina pusilla* and *Parietaria debilis* are monœcious or polygamous. All these five belong to Nat. Ord. Urticeæ. The only exception to this general rule is in *Euphorbia glauca*, which appears occasionally to be visited by insects, and the involucres of which, though not very conspicuous, are yet of a bright purple colour, and enclose more or less honey. The introduced *E. peplus*, which is a common weed in this part of New Zealand, though producing very small flowers, is evidently dependent on insect-aid for fertilization. The anthers ripen after the pistil, and the four horned glands glisten with a plentiful secretion of honey. The stamens are not visible within the involucral bracts until the female flower is hanging quite out of reach.

All the Coniferæ, I believe, are anemophilous, our New Zealand species being no exception to the rule. Their flowers are either monœcious or diœcious, and the male flowers are produced in such mass as to scatter their pollen in clouds.

Monocotyledons.

In this class, as has been pointed out by Sir J. Lubbock in his work already quoted, the contrivances and means of adaptation to secure the visits of insects are not so numerous nor so complicated as in Dicotyledons, if we except the remarkable order of Orchideæ. Still we have some interesting modes of fertilization, even outside of this order, as perfect as any yet detailed.

Nat. Ord. Orchideæ.

The modes of fertilization of many of the species of this order have been described already by Mr. T. F. Cheeseman and myself.*

Earina mucronata, though differing considerably in appearance from *E. autumnalis*, is similar in structure, and only fitted for cross-fertilization. The flowers are very fragrant and produce a large amount of honey.

Dendrobium cunninghamii. The mode of fertilization I have already described.† This last summer, 1879–80, I found it in great quantity and flowering in magnificent profusion in Stewart Island. In nearly every plant examined the flowers contained a large amount of honey. In one lot of eighty examined ten had their pollinia removed.

Sarcochilus adversus. I obtained a few flowers of this rare little species from dry rocks close to the edge of the harbour near Port Chalmers. Though one of the smallest and most inconspicuous Orchids in New Zealand it is absolutely incapable of self-fertilization, but is dependent on insects,

* "Trans. N.Z. Inst.," Vol. V., p. 352; Vol. VII., p. 349; and Vol. XI., p. 418.

† "Trans. N. Z. Inst.," Vol. XI., p. 419.

and the mechanism by which cross-fertilization is effected is the most perfect of its kind. The flowers are produced in few-flowered racemes seldom exceeding an inch in length, and more or less hidden by the leaves. They are much more regular than the majority of Orchid flowers, are greenish in colour, with a few purple lines on the labellum, and do not exceed one-tenth of an inch in diameter.

At first sight I thought that owing to their inconspicuous appearance they must certainly be self-fertilized, but besides being slightly fragrant, I noticed that they secreted a considerable amount of honey between the base of the column and the fleshy, ridged labellum, and this caused me to look more narrowly into their structure. The four pollinia are united into two almost globular masses, which are attached by a caudicle to a broad flat disc fixed to the rostellum. If this be removed from the anther, which is at the top of the column, it at once commences to contract, and thus causes the pollinia to be depressed to a nearly horizontal position. This depression is almost identical with that which occurs in the British *Orchis mascula*, as described by Darwin,* but there is a somewhat different action in our species, in that the two masses of pollinia separate slightly at the same time. The time taken by this contraction and depression of the caudicles, was about ten seconds. If these were attached to the proboscis of a small insect, they would on their first withdrawal from the anther be in such a position as to strike the rostellum of the next flower they visited, but this is obviated by the depression of the caudicle, so that, in the short interval of time mentioned, they are so placed as to project into the deep and somewhat two-lobed stigmatic cavity under the rostellum.

In my former paper† I stated that *Chiloglottis cornuta* seemed exclusively adapted for self-fertilization. This I am now enabled to verify, for a number cultivated indoors, and covered by a hand-glass during the flowering season, produced a fine full capsule from each flower.

Of the *Thelymitras*, *T. longifolia* is very frequently self-fertile, but prominent forms are no doubt crossed by insects. *T. uniflora*, on the contrary, which produces very brilliant blue flowers, is chiefly dependent on insect aid, and is a great honey-producing species.

Nat. Ord. Irideæ.

This order is only represented in New Zealand by the genus *Libertia*, two species of which are found in Otago.

L. ixioides is an extremely common plant, particularly in dry, sandy situations. The white, hermaphrodite flowers have no scent, but in bright sunny weather secrete a considerable amount of honey, and are very conspicuous. I have not detected any difference in the time of ripening of the

* "Fertilization of Orchids," p. 6. † "Trans. N.Z. Inst.," Vol. XI., p. 424.

anthers and stigma, but the styles diverge in a different direction from the stamens, and only their tip is stigmatic.

L. micrantha, which is a very abundant plant in the dense bush bordering the West Coast sounds, is also furnished with pure white, delicate, hermaphrodite flowers. These have no scent, nor have I been able to detect any honey, and they are probably self-fertile, though occasionally visited by insects.

Nat. Ord. Naiadeæ.

The only species of the order which I have looked into is the ubiquitous *Potamogeton natans*. According to Delpino, quoted by Sir J. Lubbock,* this plant is proterogynous. I could not distinguish this peculiarity as being very well marked. The flowers are hermaphrodite, and probably can fertilize themselves; but they are also anemophilous, and produce a quantity of light powdery pollen, which is easily shaken out of the anthers.

Triglochin, which also has one species in New Zealand, *T. triandrum*, is stated by Axell† to be proterogynous. I have not observed this plant carefully.

Nat. Ord. Liliaceæ.

Callixene parviflora, a beautiful little snowdrop-like plant, is common in the woods of the West Coast, the Bluff, and Stewart Island. I have not been able to notice any contrivance to secure cross-fertilization, and, with the exception of the prominent colour, the flowers have no great attractiveness to insects, being destitute of scent and honey.

Cordyline australis—the common cabbage-tree—produces great massive panicles containing thousands of whitish flowers. These are hermaphrodite, but are evidently greatly dependent on insects. They are powerfully fragrant, and secrete a good deal of honey. I have seen them surrounded by great numbers of insects, chiefly Diptera, which, on bright sunny days, swarmed on them in hundreds.

Astelia—which is usually separated into a distinct order, *Asteliæ*—is characterized among other things by its polygamo-diœcious flowers.

A. nervosa is the only common species in this part of Otago, and is unique in its fertilization, for its flowers are very inconspicuous owing to their colour and are produced quite among the large foliage leaves, while lastly the plants themselves grow in the bush. Its habitat debars it from being wind-fertilized, the plants usually occurring in sheltered parts of the bush, where even a strong wind is little felt. The flowers are completely diœcious in function, but hermaphrodite in structure, though always more or less imperfect. The panicles of male flowers are much more lax and prominent than those of the female flowers, and are lighter and more con-

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* "British Wild Flowers," p. 159. † Loc. cit., p. 161.

spicuous in colour. The perianth-lobes are somewhat chaffy and completely re-curved, so as to expose the wide disc, covered with its secretion of honey. The centre of this disc, within the stamens, has a conical stylopodium destitute however of a stigma. The ovary is fairly well-developed and contains numerous ovules, but these never seem to be fertilized, and always become aborted.

The female flowers are in a stout, rigid, and short panicle; which is very glossy and dark green in colour. The flowers have short, erect, perianth-lobes and no trace of stamens. The ovary is well-developed, and bears on its summit three clearly defined sessile stigmas.

Both kinds of flower are extremely fragrant, and attract considerable numbers of Diptera to them.

Anthericum hookeri is always hermaphrodite, while the much handsomer *A. rossii* found in the Auckland and Campbell Islands is always diœcious. Our species has bright yellow flowers, and is probably visited and greatly aided in its fertilization by insects, but it has neither honey nor scent. The stamens are somewhat proterandrous, the three opposite the outer perianth lobes always so.

On Frazer Peaks, Stewart Island, I found a very stunted form of this species, tending strongly towards cleistogamy. The flowers were crowded on short rigid scapes, and had their perianth-lobes so greatly reduced in size as to give the racemes a pale yellowish-green hue. The stamens also were greatly reduced, but the ovaries were well developed.

Phormium tenax is another of those large open-flowered species which are chiefly fertilized by birds. I have little doubt that large insects occasionally visit the flowers, but they depend chiefly on the tuis and honey-birds which visit them. Kakas and parakeets also aid sometimes, but the former are too heavy to be welcome visitants, and most probably do more damage than good.

The flowers secrete a large amount of honey, and are distinctly proterandrous. As only the extreme tip of the style is stigmatiferous, and does not become so until most of the pollen has been scattered, it is probable that the flowers are not capable of self-fertilization.

Into the modes of fertilization of the more inconspicuously-flowered orders of plants I have not gone, but there is little doubt that many interesting adaptations will be found to exist among them, and that their close examination will yield valuable results. It is a somewhat common remark that little remains to be done by an original worker among our flowering plants. Nothing could be more incorrect, however, than such a statement, for our knowledge is extremely limited and fragmentary. It is manifestly so in those respects which I have already pointed out in the earlier part of this paper, but it is also the case in nearly every other department of the subject. Botanists may rest contented when they can answer satisfactorily why there are so many diversities of form and structure among plants, and can give a conclusive reason for the occurrence of each peculiarity. Meanwhile, we require patient and continuous observation for many years, even to open up the main subject touched upon in this paper.

One question I would commend for enquiry among others is this:—How can we account for so many coriaceous and woolly-leaved plants in these islands, belonging, too, either to endemic genera, or to genera which are not so specially characterized in other parts of the world? Seeing that there are no herbivorous Mammalia to be defended against, the only solution I can offer as probable lies in the abundance and size of our Orthoptera (grasshoppers, etc.), which are particularly abundant on the mountains, where these coriaceous and woolly-leaved plants are also chiefly found.

The following are the only works or papers I am acquainted with, which refer to the subjects mainly alluded to in this communication, as far as New Zealand plants are concerned.

(1873). T. F. Cheeseman: "On the Fertilization of New Zealand Species of *Pterostylis*." "Trans. N. Z. Inst." Vol. V., p. 352.

(1875). ,, "On the Fertilization of *Acianthus* and *Cyrtostylis*." "Trans. N. Z. Inst." Vol., VII., p. 349.

(1877.) C. Darwin: "Fertilization of Orchids" (2nd Edit.), pp. 88-90, 127, etc.
,, "Different Forms of Flowers," pp. 181, 285, 332, etc.

T. F. Cheeseman: "On the Fertilization of *Selliera*." "Trans. N.Z. Inst.," Vol. IX., p. 542.

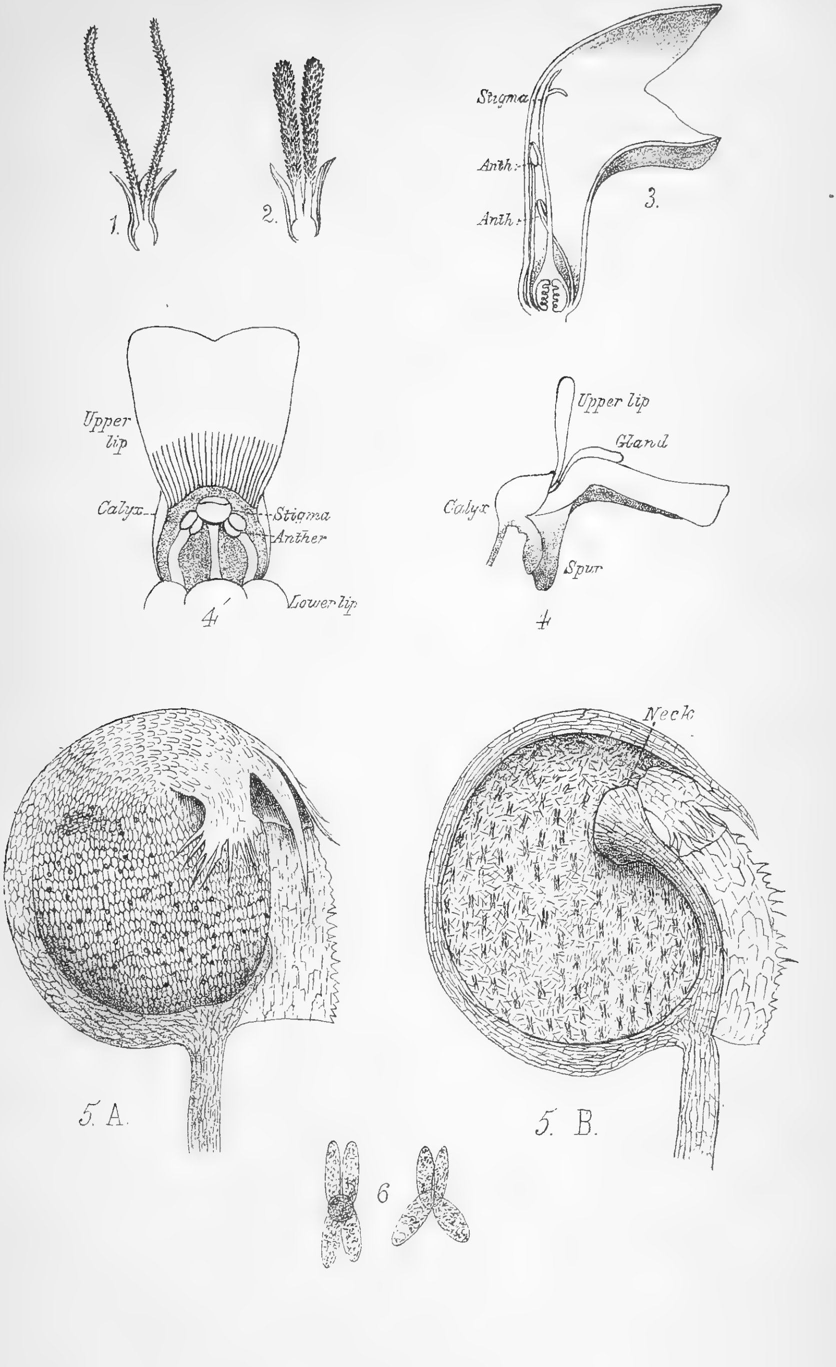
(1878.) ,, "On the Fertilization of *Glossostigma*." "Trans. N.Z. Inst.," Vol. X., p. 353.

(1879.) Geo. M. Thomson: "On Cleistogamic Flowers of the Genus *Viola*." "Trans. N.Z. Inst.," Vol. XI., p. 415.

,, "On Means of Fertilization among some New Zealand Orchids." "Trans. N.Z. Inst.," Vol. XI., p. 418.

DESCRIPTION OF PLATE X.

Fig. 1. *Coprosma propinqua*—female flower—magnified.
2. ,, *rotundifolia* ,, ,,
3. *Mimulus luteus*.
4. *Utricularia monanthos*—*a.* flower—side view.
,, ,, *b.* ,, front view of upper lip.
5. ,, ,, bladders magnified 26 diameters. *a.* external appearance. *b.* same cut through the middle, showing the neck of the collar forming the neck of the cavity.
6. ,, ,, quadrifid processes magnified 115 diameters.



G.M.T. del.

To illustrate Paper by G.M.Thomson.

Art. XXXIV.—*Note on* Donatia novæ-zealandiæ, *Hook, f.*

By George M. Thomson, F.L.S.

[*Read before the Otago Institute, 29th June,* 1880.]

This interesting little plant, in the absence of the fruit, was placed originally by Sir J. D. Hooker in the order Saxifrageæ, and in his Handbook he speaks of it* as the only representative in New Zealand of the herbaceous tribe of Saxifrages proper. Up to within a very recent period, however, its exact systematic position was matter of considerable uncertainty. A few years ago, Baron Ferd. von Mueller expressed his decided opinion† that its resemblances were so near those of *Phyllachne*, that it should be placed along with that genus among the Stylidieæ, and this opinion he again published in Trimen's "Journal of Botany" for 1878, p. 174. In the absence of fruit, however, this affinity could not be considered as finally established. Mr. Petrie, Inspector of Schools for Otago, having recently obtained, at considerable trouble, numerous specimens of *Donatia* in fruit, forwarded them to Baron von Mueller, who has thus been enabled to prove his former assertions. It is to be regretted that Baron von Mueller in publishing the results of his last examination of the plant in question, should have elected to do so in an Italian journal, instead of in one accessible to the majority of those interested in the subject. The following description of the fruit and seed, together with the other information I record on the subject, is translated from "*Dal Nuovo Giornale Botanico Italiano*," Vol. XI., N. 3, (July, 1879):

"Fruit indehiscent, turbinate, completely bilocular, rarely trilocular, flat on the top and almost tumid on its margin, about 2 lines long. Placentæ short, situated almost at the apex or above the middle of the dissepiment. Seeds few in each loculus, rarely many ripening, pendulous or patent, attached without a funiculus, obliquely ovate or ellipsoid, $\frac{1}{3}$–$\frac{1}{2}$ line long; testa membraneous, dark, shining, reticularly striated; hilum basal with the chalaza at the extremity more strongly coloured, almost brown; raphe not prominent; albumen amygdaline; embryo very small, remote or quite free from the hilum, often shorter than the albumen; cotyledons ovate-rotundate, almost equalling in length the central thin radicle, or the radicle united with the cotyledons into an almost ovate body."

Baron von Mueller regards the corolla of *Donatia* as gamopetalous, but having its tube shortened or suppressed, as occurs in the Rubiaceous genus *Galium*. The other points adduced are (1) the union of the stamens with

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* "Handbook of the N.Z. Flora," p. 58.

† "Fragmenta," VIII., 39-41.

the style (as in the Stylidieæ), which, though not complete in *Donatia*, nevertheless places the filaments really in the centre of the flower, and entirely away from the calyx; (2) the minute embryo similar to that of *Stylidium* though its position may not be near the hilum; (3) the placentation, which is that of *Stylidium*, and not that of the normal Saxifrages; (4) the internal structure of the seeds, which agrees better with that of Stylidieæ than of Saxifrageæ; and (5) the normal number of two stamens in *Donatia*, which is not represented in any other Saxifrage. From these various considerations he places the genus among the Stylidieæ, of which the following enumeration of the known genera is given, which will prove useful to New Zealand botanists.

Candollea, Labill. in Ann. du Mus. Paris, VI., 453, t. 63–64.
Stylidium, Sw. in Willd. Spec. Plant. II. 146, an. 1805.
Leeuwenhockia, R. Brown, Pr. 572.
Phyllachne, R. and G. Forst. Char. Gen. 115, t. 58.
Fostera, L. fil., in Nov. Act. Soc. Reg. Upsal, III., 184, t. 9.
Donatia, R. and G. Forst. Char. Gen. 9, t. 5.

Art. XXXV.—*New New-Zealand Plants.* By Dr. S. Berggren. Hon. Mem. N.Z. Inst. Communicated by G. M. Thomson, F.L.S.*

[*Read before the Otago Institute, 29th June,* 1880.]

Phyllachne haastii, Berggr.

Leaves imbricating at the oblong plano-convex base, semi-terete, scarcely thickened at the apex, with a simple nerve, upper half of the column exserted, stigmatic lobes oblong, recurved, capsule turbinate, seeds 6-12 on the central undivided placenta.

Kelly's Hill, Canterbury Alps.

This is the plant which I referred to *P. colensoi*, Hook f., in Lund's "Physiograph. Sältskaps Minnesskrift," 1878, tab. III., figures 1-27. From that plant this is distinguished by the dull olive-green leaves, the upper half of which is terete, and not swollen at the tips. The single nerve is unbranched, whereas in *P. colensoi* there is a lateral branch on each side. The seeds are few in number, and the upper part of the placenta is not divided into two branches as in that species.

* From the Journ. of Botany, Vol. IX., p. 104, April, 1880.

Dracophyllum kirkii, Berggr.

Shrubby; leaves patent, fascicled, with a sheathing base, dilated from above, not auricled, narrowed, broadly concave, truncate or mucronate at the apex, glaucous above, striate below; flowers solitary, shortly pedicelled, 2–3-bracteate, bracts and sepals ovate, acuminate, ciliated on the margins, filaments longer than the anthers, fastened all the way below the middle.

I wrongly referred (*l.c.* tab. IV., fig. 1–11) this plant to *D. uniflorum*, Hook f. It is distinguished from all the other species of this genus with solitary flowers by the shape of the leaves, which are almost canaliculate, and like the leaves of those species which have compound inflorescence, especially *D. strictum.* The relative length of the anthers and filaments, as well as the point of insertion of the stamens, presents some difference in this species from both divisions of the genus.

Mount Torlesse, in Canterbury Alps.

Carex buchanani, Berggr.

Reddish-brown; culms cæspitose, graceful, strong, leaves subequal to the culm or longer, tenacious, semiterete, scabrid on the margin; bracts exceeding the culm, the lower sheathing, the upper not sheathing; spikes 5–6, oblong, the lowest distant from the others which are approximate, the terminal one cylindrical male, the rest female or male at the very base, scales obovate, at length hispido-cuspidate, pale, membraneous, torn at the margin, perigynia elliptical, plano-convex, beaked, beak bifid, and with its upper margin ciliated, serrate, purple-spotted, nerveless, glabrous, covered by the scale, stigmas 2. (*C. tenax*, Berggr., *l.c.* tab. VII., fig. 1–7—a name already used for another species).

Distinguished from *C. raoulii*, Boott, by the very tenacious semiterete leaves, the terminal spikelet without female flowers, and the nerveless glabrous utricle.

Art. XXXVI.—*On the Fertilization of* Thelymitra.

By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 21st June*, 1880.]

That cross-fertilization is the almost universal rule in the great family of Orchids is a generalization first propounded and sustained by reliable evidence by Mr. Darwin, in his "Fertilization of Orchids." Many memoirs and short papers on the subject have appeared since the publication of the first edition of this work in 1862, but, taking them collectively, they only give additional confirmation to Mr. Darwin's views. It is true that, to the two or three cases of self-fertilization given by Mr. Darwin himself, several other instances have since been added, but even then the total number is small, and bears no sensible proportion to the overwhelming majority depending on cross-fertilization for the production of seed.

Some of the most interesting exceptions to the rule yet recorded occur in the Australian and New Zealand genus *Thelymitra*. The Australian species have been ably investigated by Mr. Fitzgerald, who finds in the genus almost all the links between forms that are utterly sterile and barren without insect aid, and others that are regularly self-fertilized from one generation to another, and in which the flowers have almost become cleistogene. As nothing has been published about the New Zealand species, I propose to give a sketch of the fertilization of one of them—*T. longifolia*, pointing out some apparent differences between the method employed here and that which according to Mr. Fitzgerald is in use in Australia.

Thelymitra longifolia is probably the most abundant Orchid in the North Island. Its favourite station is on clay hills, but it can also be found in dry rocky places, on sand-hills, and even in wet swamps; in short, in all soils and situations, with the exception that it is rarely (if ever) seen in the *dense* forest, although often luxuriating in the shade of the "tea-tree scrub." As might be predicted of a plant having such a wide range of habitats, it is extremely variable. Small specimens are often seen barely two inches in height, with a narrow leaf and single small flower. Every intermediate can be traced between this and the large stout form eighteen inches, or even two feet, high, with a broad leaf, and a spike of from ten to twenty large flowers. The colour of the flowers is usually white, but pink and blue flowered varieties are common.

The perianth differs from that of most Orchids in being composed of six *nearly equal* leaflets, which spread on all sides when expanded; so that the flower has little of the irregular and often fantastic appearance of many of its allies, but rather resembles an *Ixia* or *Sisyrinchium*.

The column may be roughly described as hood-shaped, the upper part being produced over and above the anther into a broad three-lobed projection, the middle lobe (which is much the largest) being blunt and smooth, but the lateral ones densely fringed with cilia at their extremities. The anther is placed about half way up the face of the column. It is two-celled, each cell containing two granular plate-like pollen-masses. From each side of the base of the column a low wing-like expansion curves round towards the front of the flower, meeting opposite to the labellum. A small recess is thus enclosed, within which the stigma and rostellum are placed; both organs being detached from the column proper. The stigma is a broad shield-like body situated in front of and slightly below the anther.

At its base it is thick and fleshy, but it becomes thin and membranous towards the sides and two-lobed summit. The rostellum is lodged between the terminal forks of the stigma, in front of which it projects as a rounded boss. When mature, it consists entirely of viscid matter, covered with an extremely delicate membrane. At this stage its connection with the stigma is easily ruptured, so that it can be readily removed by a slight touch.

The anther attains its full size and development while the flower is yet in the bud, and long before expansion each cell splits down its outer face, exposing the pollinia. As these rest immediately behind the rostellum, and in contact, or nearly so, with its viscid posterior surface, they invariably become firmly attached to it. After this takes place, the column lengthens considerably, thus causing the anther to occupy a higher position relatively to the stigma and rostellum than before. As the pollinia have become affixed to the rostellum, they cannot accompany the anther in this movement, and the anther-case being dragged from them they remain hanging to the back of the rostellum in the narrow passage existing between the stigma and column; the upper part of the pollinia slightly overtopping the stigma. This is the state of things just before the expansion of the flower.

In fine sunshiny weather the flowers usually open about nine o'clock in the morning, neatly reclosing about four or five in the afternoon. There is, however, considerable irregularity as to this, some varieties only opening for a short time in the middle of the day, others remaining expanded for a much longer period. In cloudy or showery weather the flowers never expand so fully as on a clear day. In stormy or very wet weather they generally do not open at all. I have observed that when rain has obtained access into the flower the pollinia are frequently washed into a pulpy mass at the bottom of the recess behind the stigma; so that there can be no doubt that the closing of the flower acts primarily as a protection for the pollen against rain or dew; although in some of the varieties it certainly seems to be carried further than is required for this purpose. The flowers are quite scentless, and I have never observed that any nectar is secreted.

If a newly-expanded flower is taken and a blunt needle inserted in such a manner that the front of the rostellum is touched, the viscid matter composing this organ at once adheres to the needle, and if it is withdrawn, taking care to move the point in an upward and forward direction, the rostellum, with its attached pollinia, cannot fail to be brought away with it. This experiment should only be tried with flowers that have recently expanded, for, from reasons that will become apparent further on, the pollinia can only be removed with certainty immediately after the flower first opens.

So far, the whole structure of the flower seems designed to favour cross-fertilization through the agency of insects; and there can be no doubt that if the flowers were regularly visited by suitable species this would inevitably take place. But, from some reason—probably from the want of sufficient attraction—insects seldom visit the flowers. For the last seven years, I have made it a practice to watch beds of this Orchid, and save on two occasions I have never seen winged insects enter the flowers; and in both these cases the pollinia were not removed. It should, however, be mentioned that a minute thrip-like insect is sometimes abundant on the pollen, on which it probably feeds; but it is much too small to be of any service in removing the pollen from flower to flower, although it may be useful in another way. But although insects have not been actually observed in the act of removing the pollen, I have yet been able to collect evidence proving that they occasionally, though very rarely, do this. Thus, in November, 1876, seventy-five flowers were examined, and two had lost their pollinia—evidently removed by some insect. In November, 1878, 103 flowers were examined, and two of these had their pollinia removed. Lastly, in November, 1879, out of forty flowers three had the pollen-masses missing. In three instances I have also found pollen scattered over the stigma, the pollinia being still intact in their places at the back of the rostellum. These facts are quite sufficient to show that cross-fertilization does occasionally, though very rarely, take place.

Few of our indigenous species mature seed so abundantly as *Thelymitra longifolia*, almost every flower producing a ripe capsule. Taking this in connection with the facts mentioned above, it is obvious that we have to do with a case of self-fertilization. The mode in which this is effected appears to be as follows:—The upper part of the stigma is thin and membranous, and has its margin slightly revolute, even when in the bud. After expansion this rolling back is carried to a greater extent, so that the edge of the stigma, and even a small portion of its anterior surface, comes into contact with the pollen-masses hanging directly behind it. Pollen-tubes are at once emitted into the substance of the stigma, usually so rapidly that before a flower has been expanded more than a single day the pollinia are glued so firmly to the margin of the stigma that they could not be removed by insects, even if they visited the flowers. Pollen-tubes are also frequently emitted into the upper part of the posterior surface of the stigma. Besides this, it often happens that the tops of the pollen-masses (which, as we have seen, slightly overtop the stigma) are broken down by some means, either by the shaking of the flowers by wind or by the minute thrip-like insect already mentioned, and the pollen scattered over the front of the stigma. By one of these methods, or by both combined, I believe that the flowers are regularly self-fertilized, and the perpetuation of the species secured.

Mr. Fitzgerald, in the introduction to his magnificent work on Australian Orchids, states that *T. longifolia* is fertilized in the bud in Australia. This, however, is certainly not the case in New Zealand, save when a long succession of wet weather has prevented the flowers from opening at their proper time. In ordinarily fine seasons I always find that the pollinia are intact and free from the stigma on the expansion of the flower, and come away with the rostellum on its removal. He also states that the flowers open for one hour only in the middle of the day. In New Zealand nearly all the varieties open for a much longer period than this, the chief exception being a blue-flowered form with very long and slender staminodia, apparently an intermediate between *T. longifolia* and *T. pulchella.* I cannot agree with Mr. Fitzgerald in considering the opening of the flowers "useless," for even admitting that the stigma had been penetrated by pollen-tubes prior to the expansion of the flower, yet if pollen should be brought from a different plant and placed on the stigma, it would probably have a prepotent influence, and destroy any effect produced by the plant's own pollen. To me it appears that the opening of the flowers is highly important, even if it takes place for only an hour, for it gives a chance of cross-fertilization being effected, and the great value of this is now well established. It is curious that Mr. Fitzgerald's researches should appear to go towards proving that *T. longifolia* is more exclusively self-fertilized, and the flowers more nearly cleistogene, in Australia than in New Zealand; for, considering the admitted paucity of insects in New Zealand, and the much damper and cooler climate, the exact converse of this might have been anticipated.

The whole case of *Thelymitra* is most interesting, and at the same time perplexing in the highest degree. On the one hand we find the flowers possessing a viscid rostellum, to which the pollen-masses become spontaneously attached, and with which they can be removed,—clearly an adaptation for cross-fertilization through insect agency. On the other hand we see that the form and position of the stigma is such that it early comes into contact with the pollen-masses, an end which is also encouraged by the margins of the stigma slightly bending back towards the pollinia; we also find that in some of the varieties the flowers remain closed for a large part of the day, thus absolutely preventing the access of insects. It is impossible to doubt that these circumstances favour self-fertilization. We are thus driven to the same conclusion that Mr. Darwin has arrived at in the case of the Bee Orchis:—that in the same flower there exist elaborate contrivances for directly opposed objects. To believers in the theory of evolution, the case is not without an explanation. If we could trace back the modifications through which the plant has passed, we should probably arrive at a remote ancestor bearing flowers regularly cross-fertilized by insects, as is the case with most Orchids at the present day. We should probably find that from some reason—it might be from the flowers becoming less attractive, or from the proper insects becoming less plentiful—the flowers were not so regularly visited as before. It would then be an advantage to the plant to be occasionally self-fertilized, in order that a sufficiency of seed should be obtained to perpetuate the species. Varieties having a tendency to self-fertilization would then be rigorously selected. The process of modification having once commenced, I see no difficulty in its being carried on to any extent, provided that the visits of insects continued to decrease, and that consequently the necessity for self-fertilization became more pressing. In this way the species would become more and more self-dependent, until we find it, as it is at present, almost uniformly self-fertilized. At the same time, any structures existing in the flower for purposes of cross-fertilization would hardly be modified if they did not prevent self-fertilization from taking place, but would be retained in their original shape, although perhaps but seldom, or even never, performing their proper functions.

Most writers on the subject maintain that it is a positive disadvantage to a species to be self-fertilized for a long length of time. But here we have the case of a plant which is probably self-fertilized for many generations in succession, but which is yet a vigorous and predominant species, accommodating itself to a wide range of habitats, protecting itself against encroachment by other species, and highly successful in the battle of life.

Art. XXXVII.—*Description of a New Species of* Loranthus.

By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 25th October,* 1880.]

Some time ago my friend, Mr. James Adams, the head master of the Thames High School, kindly forwarded to me specimens of a handsome new *Loranthus* discovered by him in the Thames district, and which differs widely from any of the known species inhabiting New Zealand. During a recent visit to the Thames I was able to examine the plant in a living state, and to obtain a good series of specimens, from which the following description has been drawn up. I have much pleasure in associating the name of the discoverer with the species.

Loranthus adamsii, n.sp.

A small perfectly glabrous bush, two to three feet in height. Branches terete. Leaves opposite, one and a half to two and a half inches long, broadly oblong, obovate or oblong-obovate, narrowed into a short stout petiole or almost sessile, very thick and coriaceous, veins hardly conspicuous, margins recurved. Inflorescence axillary ; peduncles very short, each bearing two to four sessile flowers at the top. Bracts—three at the base of each flower (one bract and two bracteoles), small, concave. Flowers rather large, one and a half to two inches long, reddish, more or less tinged with yellowish-green. Calyx with four minute triangular teeth. Corolla narrow at the base, swollen in the middle, and then contracted just below the limb ; lobes four, separating about a quarter of the way down, but the corolla often splits nearly to the base on one side, the four petals then pointing all in one direction. Stamens four ; anthers narrow-linear, basifixed. Stigma capitate. Fruit not seen.

Habitat: Thames goldfields, parasitic on *Coprosma*, *Myrsine* and *Melicope*. Flowers in September and October.

According to the elaborate sketch of the genus given by the author of the "Genera Plantarum," our plant must be placed with a group of Indian and Malayan species possessing a corolla with the petals united nearly to the top, and with three bracts at the base of each flower, and which forms the sub-genera *Macrosolen* and *Elytranthe*. *Loranthus flavidus*, so common in the *Fagus* forests of Nelson and Canterbury, is referred to the same group, but is a somewhat anomalous member of it.

Loranthus colensoi has much of the habit and foliage of *L. adamsii*, but is much larger, and can be at once distinguished by the free petals and the absence of bracts.

Search should be made in hilly and wooded districts for *Loranthus tenuiflorus*, of which only a single specimen, preserved in the Kew Herbarium, is known, and the exact locality of which has been lost. It can be distinguished from the other species by the oblong versatile anthers, which place it in a division of the genus almost wholly composed of South American species.

ART. XXXVIII.—*Contributions towards a List of the New Zealand* Desmidieæ.

By W. M. MASKELL, F. Roy. Micros. Soc.

[*Read before the Philosophical Institute of Canterbury, 7th October*, 1880.]

Plates XI. and XII.

THE following catalogue by no means pretends to contain a *complete* list of the Desmidieæ in this country ; but it has been compiled because, as I believe, no attempts have yet been made to record the existence here of

European species or the discovery of new ones. And yet, were it not for the extreme minuteness of the plants composing this family (the largest of which is only visible to the naked eye under certain lights), I venture to think that the elegance of form and varied grace which distinguish them would have drawn universal consideration to them. Unfortunately, they cannot be cultivated, and occurring as they do in wayside ponds and amongst masses of water-weeds their very existence is generally despised and probably almost unknown.

I have had occasion already, when treating of the New Zealand Coccidæ,* to remark upon the difficulty experienced here in studying the different classes of animals or plants, a difficulty arising chiefly from the want of books of reference. Geographical obstacles to communication between various parts of the colony stand much in our way, but these might be got over. But in examining any species it is imperative to know, as far as possible, whether it has ever been referred to elsewhere or by anyone else, and to be able, at least approximately, to determine its affinities. For this purpose easy access to works of reference is indispensable if satisfactory knowledge is aimed at; and this is just what is wanting here. The difficulty is still more enhanced in the case of such objects as the Desmidieæ, because it is quite impossible to keep them for any length of time in their original state: so that often, before comparison could be made with species described as existing elsewhere, the specimens would be ruined and lost. And drawings, let them be ever so apparently accurate, cannot, until all specific characters are thoroughly made out, supply the place of the object itself, at least for purposes of study.

The Desmidieæ are, to students in Christchurch, particularly subject to this difficulty. The standard work on them, Ralfs' "British Desmidieæ," is more than thirty years old, and microscopic investigation has made immense strides since its publication. Descriptions, references, and sometimes figures, are scattered in papers by different authors in such periodicals as the "Journal of Microscopical Science," the "Annals and Magazine of Natural History," the "Zoolog-Botanische Gesellschaft" of Vienna, etc. And, independently of the difficulty of searching for and collating these *disjecta membra*, it is the case, unfortunately, that in Christchurch the series of such periodicals is much broken, confused, and difficult of access. Ehrenberg's great work on the Infusoria (a copy of which is, I believe, shortly to be added to our library) is still older than that of Ralfs. It follows from what I have said that, in investigating and describing any such family as that of the Desmidieæ, the student, even after all his pains, has to

* "Trans. N. Z. Inst.," Vol. XII., p. 291.

rely greatly upon his own judgment and observation, and if these should not unfrequently lead him into error he may at least feel relieved from responsibility.

As this paper purports to be only a catalogue, and the Desmidieæ have already received much attention elsewhere, I need not stop to characterize the family here, beyond simply quoting the description given by the "Micrographical Dictionary:"—"A family of Confervoid Algæ, consisting entirely of microscopic flexible organisms inhabiting fresh water." In this general description they differ from the Diatomaceæ in the character of "flexibility," as opposed to "brittleness." Long considered to be animals, (by Ehrenberg and others), they are now universally recognized as plants.

It will be seen by the following list that I believe I have observed at Christchurch sixteen genera of Desmidieæ proper, containing sixty species. I say "proper," because there is also the genus *Pediastrum*, of which three species are common here; but as I think this is not really one of the family, I have paid less attention to it. I have added the three species of *Pediastrum* to the list, as the genus is usually referred to in works on the Desmidieæ, but probably several more species may occur here.

Of the sixty species of true Desmidieæ in the list, six are as I think new or undescribed, and there are also two species of the genus *Ankistrodesmus*, which I could not identify. The lower forms of life, particularly pond-life, seem to be pretty much the same all over the world, and I ought to give here some explanation of my reasons for venturing to add some six new species to those already known. If I am rightly informed, in the kindred family of the Diatomaceæ only one new species has for several years been described in New Zealand, (of the genus *Nitzschia*, by Mr. J. Inglis, lately), and it may be thought unlikely that in the Desmidieæ there should be greater variety. For this reason I think it well to explain why the six plants just referred to seem to me not referable to any known species (always remembering what I said just now as to the dearth of works of reference here.)

The Desmidieæ have two modes of propagation:—1. By conjugation, or the union of two separate plants producing between them what is called a "zygospore." 2. By division, where each frond separates into two parts, and in the process of separation two new parts grow between the old ones, until, as the new segments attain the size and form of the old ones, complete separation takes place, and each old segment floats away accompanied by its new "half." Now, undoubedly, as Mr. Archer remarks,* in order to be absolutely certain as to a species, it ought to be followed throughout all its stages, that is, from the production of a "zygospore," through full

* "Quart. Jour. Micr. Science," Vol. II., New Series, 1862, p. 236.

growth to the production again of another "zygospore." But, as he also very truly observes, this would be practically impossible with the Desmidieæ, for the "zygospores" in very many instances are quite unknown, and in all are difficult of detection. I may observe here that in the course of three years study of these plants I have never met with a single instance of a Desmid with attached zygospore. Scattered bodies, which appeared to be zygospores, I have seen, but, as Ralfs remarks, unless they are actually attached to segments of a frond it cannot be well known to what plant they belong. Moreover, although zygospores have, by other observers, been frequently seen, their ultimate history is in all cases at present obscure; and as the "Micrographic Dictionary" says, "the reproduction of the Desmidiaceæ still offers a wide field for investigation." Conjugation, in its earlier stages, I have seen on a few occasions.

On the other hand, the process of division seems to be much more frequent, and I have myself observed it several times in the genera *Closterium*, *Micrasterias*, *Docidium*, and others. In the filamentous genera, such as *Hyalotheca*, division is less common.

Now, although the actual following-out of the process of *conjugation* may be difficult, or perhaps impossible, I take it that when on several occasions the process of *division* is to be observed; when, in such cases, the resulting frond is identically similar to other and frequently seen fronds; when there is also at different times of the year, and perhaps in different years, complete similarity in the specimens examined; and when no trace can be found, in descriptions of species by authors, of fronds having the same characters—there is at least very strong evidence that the plants under review form a definite species different from the known species. To use Mr. Archer's words, "Constantly recurring identical forms must be assumed to be the descendants of similar progenitors."* Moreover, division, as I imagine, can only take place in *mature* fronds; immature plants could scarcely propagate; consequently any plant seen in process of division must, if no previous record of its characters can be found, be taken as new.

For these reasons I have ventured to set down a few plants as new species, and not merely as varieties. Referring again to the Diatomaceæ, I believe that it has been ascertained that about ninety per cent. of those plants in New Zealand belong to European species. In the Desmidieæ, out of sixty plants I consider six new, and two doubtful; not a larger proportion.

As I have used the word "varieties," it may be well to remark that in many of the species which I have set down here as European, more especially perhaps in the genus *Cosmarium*, I have noticed peculiarities which do

* *Loc. cit.*, p. 238.

not seem to have been mentioned by authors. The discussion of these would lead me beyond the scope of this paper, and perhaps the characters to which I refer would not even suffice to raise the plants even to "varieties."

It will be seen from my list that the following genera are not, as far as I know, represented here (I speak of the neighbourhood of Christchurch) :—*Didymoprium*, *Desmidium*, *Xanthidium*, *Arthrodesmus*, *Tetmemorus*. Also, that *Euastrum* and *Cosmarium* appear to furnish comparatively few species, and *Staurastrum*, out of fifty-six species described, has furnished only seven.

I have not mentioned, as a rule, the locality of each species observed, desiring rather to avoid iteration. In two or three cases where I have obtained specimens from other places, the fact is stated ; but, where no mention is made, the plant was gathered in the neighbourhood of Christchurch, and chiefly in the fish-ponds of acclimatization societies.

I may remark, in conclusion, that I have preserved in slides almost all the plants named in the following catalogue. In the process of preservation the question of the best fluid for the purpose naturally engaged much attention, and I have tried several. No fluid, as my experience goes, is entirely satisfactory. Camphor-water and Thwaites' fluid appear at first to preserve the plants in all their natural beauty and colour, but after a time they fail. Ralfs' fluid has the same objection, and is, moreover, not very clean. Glycerine, to which I have had final recourse, is the best of all. When the plants are first immersed in it they usually, indeed, shrivel into shapeless masses, but after a few minutes they swell out again and regain their proper form. In glycerine, as in all the other fluids, the endochrome is much affected, but I think that the beauty of the cell-walls themselves is brought out better in this than anything else. *Spirotænia* will not stand anything, even distilled water spoils it. As a matter of fact, no Desmid can really be preserved unhurt, and no preserved specimen can equal the natural plant. In the Diatomaceæ the case is quite different. But, taking them all round, I believe that of all preservative fluids glycerine is the best.

CATALOGUE OF DESMIDIEÆ.

1. **Hyalotheca,** Ehrenberg.

H. dissiliens, Smith. (R. I.)*

Common, especially in spring.

This plant seems particularly liable to a disease (?) produced apparently by a species of *Pythium*.

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* The letter R with a figure after the name of a species denotes the plate in Ralfs' work where the plant is figured. Thus (R. XVI.) means, "Ralfs' 'British Desmidieæ,' Plate XVI."

2. **Aptogonum**, Ehrenberg.

A. undulatum, sp. nov.

Figures 1–4.

The frond is filamentous, somewhat fragile, and without gelatinous sheath. It is plane, or only very slightly twisted, and, as a rule, not long, but with sometimes as many as fifty joints.

Joints bi-crenate at the margins, and on the sides excavated so as to leave between them an oval foramen. Viewed from below the length of each joint is equal to the breadth. In the side view the height is rather more than the breadth. Under-view quadrangular, the angles rounded, and the foramen easily distinguishable. Upper view also quadrangular, but across the foramen two projections are seen, one from each joint, meeting at the centre. Side view quadrangular below, but curvate above, giving a wavy appearance to the margin of the frond. The projecting processes are seen in this view springing from the curve. The lower edge is bi-crenate. End view quadrate below, with a projection at each of the lower angles, convexo-triangular above, with a projection at the apex. In an empty joint the median projecting process is visible. When slightly tilted, the end view shows the quadrangular under-side with bi-crenate edge. Endochrome bright green. Rays in end view inconspicuous.

Not common.

This plant seems to be intermediate between *A. desmidium*, Ehr., the European species, and *A. baileyi*, the American species. In the former the edges of the joints are bi-crenate, but there are no projecting processes between them, and the end view is concavo- instead of convexo-triangular. In the latter there are the projecting processes, but the edges are not crenate but straight, and the end view (as given by Ralfs, Plate XXXV) shows a rectilinear triangle. I find no mention also, in the descriptions of either of these species, of the curvate appearance shown in the side view of my *A. undulatum*, which gives the peculiar wavy edge to the filament. In Dr. Wallich's paper* on Desmidieæ from Bengal, he figures *A. baileyi* clearly without any undulating margin, though he shows the end view more convexo-triangular than in Ralfs' figure.

Length of joint (outside measurement), under or upper view, $\frac{1}{1330}$ inch. Height of joint in side view, $\frac{1}{1140}$ inch.

3. **Sphærozosma**, Corda.

S. vertebratum, Brébisson. (R. VI.)

Not common.

S. excavatum, Ralfs. (R. VI.)

* "Annals of Nat. Hist.," 1860.

Very rare, I think. At least I have only seen two specimens in as many years. It is excessively fragile.

S. filiforme, Ehrenberg. (R. p. 209.)

Fig. 25.

Distinguished from the other species of the genus by having the joints united by *double* processes inclosing a quadrate foramen, instead of only a single process.

Rare, but perhaps more frequent than either of the two last.

This plant appears not to exist in England, being referred by Ralfs only to Germany. In specimens which I have preserved in fluid, the joints sometimes seem to diminish and increase in size owing to the twisting of the filament. The same appearance is seen in the American species, *S. pulchrum*, Bailey, (Ralfs, p. 209).

4. **Micrasterias** Agardh.

M. rotata, Greville. (R. VIII.)

Fig. 5.

Common, especially in spring.

M. denticulata, Brébisson. (R. VII.)

Doubtful.

There is great difficulty in satisfactorily distinguishing these two species, and authorities are by no means clear. Ralfs doubts whether the two plants are not really the same; as also does Dr. Wallich in his description of Desmidieæ from Bengal; and Mr. Archer* shows, that often in papers *M. denticulata* has been referred to while *M. rotata* is meant. Mr. Archer, indeed, strongly supports the distinction between the two. I would by no means venture to intrude here in the discussion, beyond observing that almost every specimen which I have seen has the eight subdivisions and the sharp ultimate teeth of *M. rotata;* secondly, that on a few occasions I have found some which could *doubtfully* be referred to *M. denticulata;* thirdly, that I was able once to observe the actual process of division described and figured by Mr. Lobb,† and certainly the old segments of the frond were *M. rotata*, though Mr. Lobb throughout refers to *M. denticulata*. The process is shown in fig. 5; this, taken from a specimen actually observed dividing, shows clearly the teeth of *M. rotata;* but the new segments forming agree exactly with Mr. Lobb's figure. There could be no doubt about it, the whole appearance of the plant was that of *M. rotata;* was there a confusion in Mr. Lobb's mind between the two? On the whole, I believe that *M. rotata* occurs here in profusion; *M. denticulata* perhaps also, but sparingly.

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* "Quart. Journ. of Micros. Science," n. series, vol. II., 1862, p. 244.

† "Trans. Micr. Soc. London," n. ser., vol. I., 1861, p. 1, and pl. I.

M. thomasiana, Archer ("Qu. Journ.," 1862).

Doubtful.

This plant I only mention because I have found one specimen, clearly a *Micrasterias*, showing distinctly apiculate elevations on the surface of the frond, disposed circularly about half-way between the centre and the edge, and also some appearance of the median projections of Mr. Archer's species. The plant, from these peculiarities, was certainly not *M. rotata;* but I had not then seen Mr. Archer's paper, and unfortunately also lost the specimen before I could fully examine and figure it, and have never seen one since. The mention of it here may induce search for it. Close investigation will be necessary to distinguish it when the frond is full of endochrome, the peculiar markings can only be well seen in an empty frond. But the plant when found will repay examination, being one of the most beautiful of all this extremely beautiful genus.

M. thomasiana is described and figured in the "Quart. Journ. of Micros. Science," Vol. II., new series, 1862, p. 236, and plate XII.

M. ampullacea,* sp. nov.

Figs. 6–8.

Frond angular-elliptic; segments three-lobed; the end lobe with bipartite angles; lateral lobes bi- or trifid, distinct, deeply divided, sinuous, with apices ending in three minute spines; edges serrated.

The end lobe is exserted, sub-cylindrical for most of its length, then suddenly broadening to the angles which are bifid with long divisions. The cylindrical portion is slightly wider towards the centre of the frond. Of the two divisions at each ultimate angle the outer is the longest, and the inner one is not in the same plane.

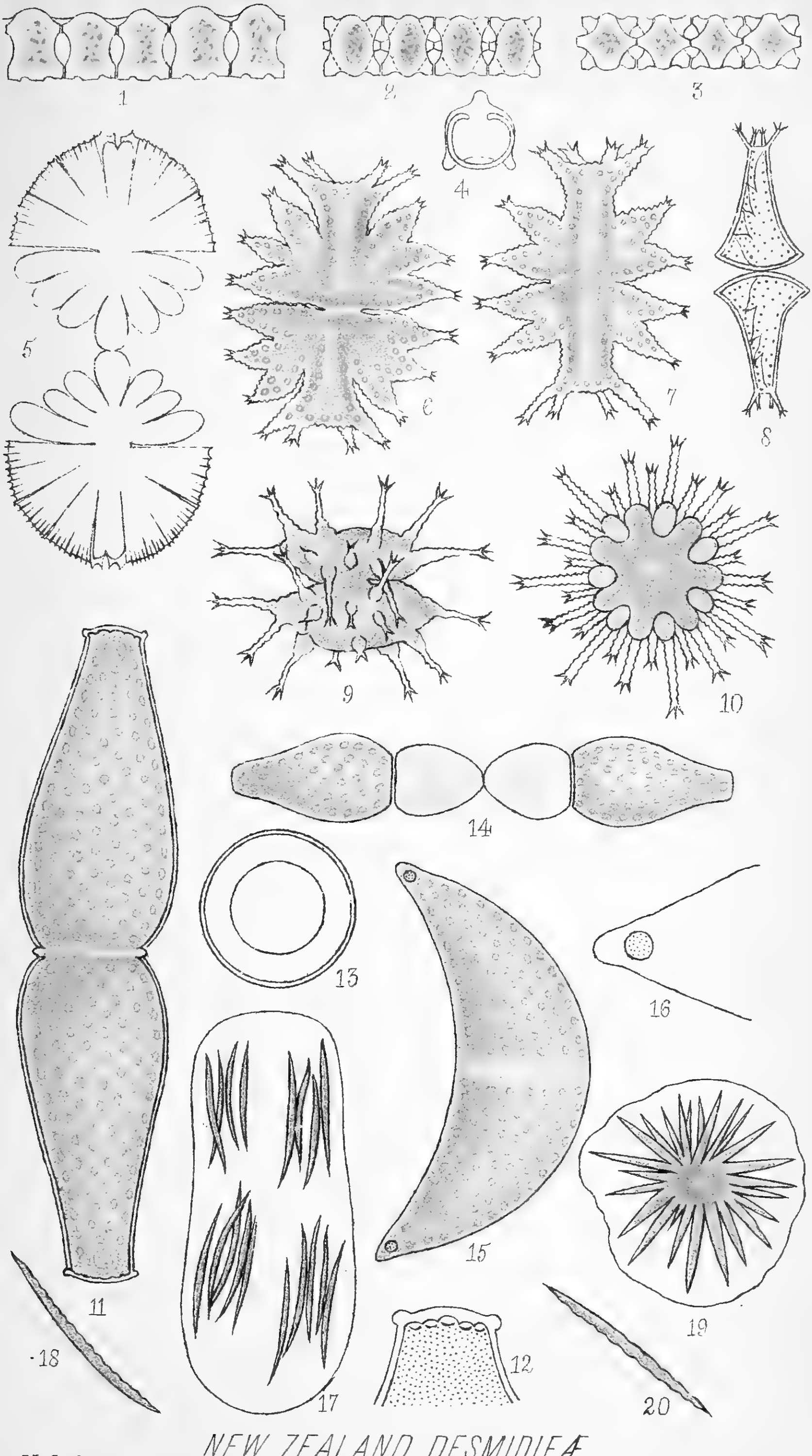
The lateral lobes are deeply divided into two or three (but more commonly two) subdivisions; and when there are three the extra subdivision is caused by the forking of that portion of the original two which is nearest the end of the terminal lobe. Each subdivision is sinuous-edged; narrow at the base, then slightly widening, then suddenly contracting to a long narrow shaft; in fact somewhat after the shape of a flask.

The edges are serrated, and the empty frond punctate. A row of puncta usually follows the edge of each lobe. The apices of the lobes, and of the divisions at the terminal angles, are crowned with three minute spines.

The endochrome is bright green, extending almost to the edges. Vesicles inconspicuous.

In side view, the frond shows like two flasks set with their broad ends together; these are the median or terminal lobes, and the lateral lobes show their edges in perspective. The dilation at the base of the sub-

* This must not be confounded with *Euastrum ampullaceum*, Ralfs.



Maskell, del.

NEW ZEALAND DESMIDIEÆ.

cylindrical median lobes is here well seen, and the divergence of the planes of the processes at the ultimate angles is also clear. The edges, in this view, are smooth.

Zygospore unknown, but I have seen specimens in early stages of conjugation (?).

Length of frond (exclusive of terminal processes), $\frac{1}{150}$ inch; breadth, over all, $\frac{1}{180}$ inch; breadth in side view, $\frac{1}{450}$ inch; breadth at constriction, $\frac{1}{880}$ inch.

Common.

This pretty little plant belongs to that section of *Micrasterias* of which *M. crux-melitensis* may be taken as the type, a section in which the orbicular or sub-elliptical frond is cut into separate lobes by much wider sinuses than in, for example, *M. rotata*. *M. ampullacea*, by its three lobes and the bifid projections at the angles of the terminal lobes, approaches the following described species:—*M. americana*, Ralfs; *M. baileyi*, Ralfs; *M. morsa* variety δ, Wallich (this ought to be *M. americana* var.); and *M. mahabuleshwarensis*, Hobson. But none of these show the peculiar flask-like shape of the lobes in my species. In *M. americana* the lateral lobes widen considerably outwards, whereas in *M. ampullacea* they narrow rapidly outwards. In all the others, unless the figures given are inaccurate, the lateral lobes taper *at once* from their bases, whereas those of *M. ampullacea*, with their sinuous edges, seem to have their widest part a little distant from the base. *M. baileyi* has quite smooth edges, without serrations. Dr. Wallich's variety δ has angular, tapering, strongly spined lobes; and Mr. Hobson's plant (with its fearful and wonderful name) is altogether different in the shape of the lobes; and moreover has, according to the description, serrations *only* in the sinuses of the lateral lobes. None of the authors named have given a side view of his plant.

M. ampullacea, when the lateral lobes are *trifid*, as in figure 6, tends somewhat towards *M. foliacea*, Bailey, but that plant is distinctly quadrangular and otherwise different.

Dr. Wallich, in describing his species from Bengal, proposes to amalgamate almost all the species of *Micrasterias*, and would probably consider the differences between his variety δ and my *M. ampullacea* as only climatic or accidental. But I would venture to observe that, as remarked above, constantly recurring identity of form in large numbers of specimens, obtained under various conditions, must point to something rather more important than mere accidental variety. I would look upon such a difference as bifid or trifid lateral lobes as constituting only a variety (if even it amounted to that); but if, in New Zealand, a plant has *always* sinuous flask-like lobes, and, in Bengal, *always* angular tapering lobes, there is at least great evidence in favour of distinctness of species. And, in fact, taking a gradation from *M. ampullacea*, through *M. foliacea*, *M. americana*, and the rest, to *M. rotata*, why should they not all be simply varieties ? When, indeed, it has come to be thoroughly understood what a "variety" is, and what a "species" is, all doubts can be cleared up. Meanwhile, I offer my *M. ampullacea* as a distinct, and, I venture to think, an elegant species of the genus.

5. **Holocystis,** Hassall.

Micrasterias, Ralfs.

This genus is separated from *Micrasterias* by having the lateral lobes almost or quite parallel, not radiant. But the distinction seems scarcely sufficient. Ralfs, who wrote after Hassall, refuses to accept his nomenclature, pointing out that the dentation at the extremity of the lobes is scarcely consistent with the proposed name. However, as Mr. Hassall's name has been accepted by later writers, I leave it here.

H. incisa.

Micrasterias incisa, Kützing.

Figure 24.

I believe this plant to be identical with one from Bengal, described and figured by Dr. Wallich.* It is there called a "variety" of Kützing's species, but I have not seen the original plant. Dr. Wallich makes *two* varieties, in one of which the edge of the terminal lobe is emarginate; in the other it is not so. The plant here, as shown in my figure, exhibits both characters; this is due to the immaturity of the non-emarginate segment. When fully grown, both segments are emarginate.

6. **Euastrum,** Ehrenberg.

E. elegans, Brébisson ; or, *E. binale*, Turpin. (R. XIV.)

Rare.

Figure 26.

I have seen two specimens (one of which I have preserved). The plant may be of either of these species, though it may be probably *E. binale*, as the sides of the terminal notch do not extend beyond the lateral spines. Both species are extremely minute, from $\frac{1}{900}$ to $\frac{1}{1400}$ of an inch long, and somewhat variable.

7. **Cosmarium,** Corda.

C. ralfsii, Brébisson. (R. XV.)

Common.

C. meneghinii, Brébisson. (R. XV.)

Not uncommon.

C. crenatum, Ralfs. (R. XV.)

Rare.

* "Ann. and Mag. of Nat. Hist.," Vol. V., third series, 1860.

C. undulatum, Corda. (R. XV.)

Not uncommon.

The difference between these two species is, generally, that the segments of *C. crenatum* are longer than broad, those of *C. undulatum* broader than long; but, in order to thoroughly distinguish them, the sporangia should be observed. Those of *C. undulatum* have long spines divided at the apex; those of *C. crenatum* short spines.

C. botrytis, Bory. (R. XVI.)

Not uncommon.

But I cannot make sure of this plant. My specimens may really belong to the next species, from which *C. botrytis* differs only in the slightly truncate ends, a scarcely satisfactory character.

C. margaritiferum, Turpin. (R. XVI.)

Common.

A very handsome plant, somewhat variable in size. The "swarming" motion of the granules is often very conspicuous in this and the last species.

C. broomeii, Thwaites. (R. XVI.)

Not uncommon.

Chiefly distinguishable from the last by the compressed or straight ends. The slight inflation at the middle, in the end view, is often difficult to make out in the live plant.

C. phaseolus, Brébisson. (R. XXXII.)

Rare.

The characteristic feature is the very small circular inflation at the centre of the segments seen only in the end view. The frond is extremely minute, length $\frac{1}{787}$ inch, breadth $\frac{1}{833}$, according to Ralfs.

C. moniliforme, Turpin. (R. XVII.)

Very rare.

C. granatum, Brébisson. (R. XXXII.)

Very rare.

C. pyramidatum, Brébisson. (R. XV.)

Rare.

C. ornatum, Ralfs. (R. XVI.)

Doubtful. Not uncommon in spring.

I have not been able to satisfy myself as to this species. Some specimens have undoubtedly the truncate projection beyond the margin, but I have not made out the linear arrangement of the puncta on the empty frond.

8. **Staurastrum**, Meyen.

S. dejectum, Brébisson. (R. XX.)

Common.

S. orbiculare, Ehrenberg. (R. XXI.)

Common.

S. muticum, Brébisson. (R. XXI.)

Not uncommon.

Differs from *S. orbiculare* in having a narrower isthmus between the elliptic segments.

S. polymorphum, Brébisson. (R. XXII.)

Common.

S. gracile, Ralfs. (R. XXII.)

Common.

S. tetracerum, Kützing. (R. XXIII.)

Rare.

S. avicula, Brébisson. (R. XXIII.)

Doubtful. Rare.

Figures 31, 32.

I have a specimen which seems to me to agree in all points with this species, with the exception that the edges of the segments are slightly crenated instead of smooth. The angles end in a forked spine or awn, agreeing thus with *S. avicula*.

9. **Didymocladon**, Ralfs.

D. stella, sp. nov.

Figures 9, 10.

The frond is small; the segments in front view roughly fusiform, with many long projecting processes; two of these processes spring from each of the opposite angles of each segment. Segments united by a rather wide isthmus, so that the terminal separation is somewhat wide and gaping. Of the two angular processes one in each segment is nearly parallel to the corresponding one of the other segment; the other is somewhat widely divergent. Below these, at each end of the isthmus, spring two more projections on each segment, pointing towards the other segment and slightly outwards. Other processes spring from the outer portion of each segment. All the processes have crenate edges, and each terminates in three spines. The appearance of the frond in this view is like two roughly fusiform bodies joined at the sides, and further clasped together by long spiny branches projecting in all directions.

The front view shows a star of many points. Focussed for the extreme end, nearest the eye, it shows seven rays, behind which a number of others are seen a little out of focus. As many of these rays are almost, if not quite, in the same line as some in front or behind them, it is not easy to count the exact number; but I have made out as many as twenty-eight, and probably that is the normal number. The rays (which are the processes seen in the front view) vary in length. Those at the ends of the segments are shortest, or at least appear so from perspective effect; so that a view of the longest and most numerous rays is obtained by focussing to the middle of the frond.

The processes, or rays, are cylindrical, slightly tapering, being somewhat dilated at the base.

Endochrome bright green; vesicles scattered.

Extreme length in front view, including processes, $\frac{1}{270}$ inch, without processes, $\frac{1}{570}$ inch; length of processes in end view, from centre of the star to tip, $\frac{1}{520}$ inch.

Rare.

This is an extremely beautiful little plant, especially when seen in its star shape from the end view.

I have placed it under *Didymocladon*, although it differs in several particulars from the English species. Ralfs gives the generic characters as follows:—"Frond simple, constricted in the middle, angular, each angle having two processes, one lateral, and in front view nearly parallel to the adjacent one of the other segment, the other superior and divergent." All these characters are found in my species, and I have no doubt that it belongs to *Didymocladon*. But, in the English plant, the end view is either triangular or quadrangular, never more; and in neither case can it present anything like the star form of *D. stella*; moreover, the processes terminate only in *two* spines, whereas *D. stella* has three. Ralfs says that the English species, *D. furcigerus*, is "rough with pearly granules which, being arranged on the processes in transverse lines, produce a crenate appearance on their margins." In *D. stella* the edges, as far as I can make out, are distinctly crenate.

At first sight, in end view, *D. stella* might be mistaken for a zygospore of some other species, from its stellate form. But the front view at once shows this to be incorrect, and an empty frond clearly shows that it is a distinct and full-grown plant.

10. **Penium**, Brébisson.

P. digitus, Ehrenberg. (R. XXV.)

Common in spring.

P. closterioides. (R. XXXIV.)

Rare.

11. **Docidium**, Brébisson.

D. clavatum, Kützing. (R. XXVI.)

Not uncommon.

D. ehrenbergii, Ralfs. (R. XXVI.)

Common.

Distinguished from the last by having three to five small tubercles at the extremities of the segments.

D. baculum, Brébisson. (R. XXXIII.)

Doubtful.

I am by no means sure that I have really seen this plant here.

D. truncatum, Brébisson. (R. XXVI.)

Not common.

A fine large species, not unlike *D. clavatum*, but broader and more tapering towards the ends ; indeed, generally a larger plant.

D. dilatatum, sp. nov.

Figs. 11–14.

The frond is large, stout, cylindrical, distinctly constricted at the middle, and the suture forms a thickened ring projecting at each side. The segments are not very broad at the base, but widen considerably immediately after, and at about half their length begin to taper to within a short distance from the end, when they again slightly dilate. At the extreme end there is a minute globular tubercle at each side, and along the edge three to five others, giving it a crenate appearance.

End view circular.

The empty frond is distinctly punctate, and I have seen specimens almost granulate.

In the process of division, the new segments commence as minute orbicular hyaline globules between the original segments ; the globules gradually enlarge, becoming after a while elliptical, then slightly tapering ; the terminal dilation, visible in the old segment, is not seen until the separation takes place (and, indeed, for a short time after) ; the terminal edge is rounded, and the coronet of tubercles is absent. It is not uncommon to find fronds apparently almost symmetrical, except that one segment is rounder or more ovate than the other. This is the new segment formed in division.

The endochrome is bright green, the vesicles numerous, scattered, and conspicuous, and at the extremities are seen the moving granules in a circular globule characteristic of the genera *Docidium* and *Closterium*, but this globule is not always clearly visible. I have seen once or twice also a kind of circulation in the endochrome similar to that observed in *Closterium lunula*. In these cases the particles travelled from the middle towards the end along the edge, and a return current (as it might be called) from the end towards the middle was visible nearer the axis of the frond.

Length of frond, $\frac{1}{33}$ inch ; greatest breadth, $\frac{1}{250}$ inch.

Rather common in spring.

This fine plant appears to be most nearly allied to *D. truncatum*, Brébisson, but it differs from that (and, indeed, I think all the other species of *Docidium*) in the total absence of all inflations at the base of the segments. The edge of *D. dilatatum* is continuously smooth from the median suture to the terminal angles, whereas even in *D. truncatum* (where the inflations seem to be smallest) there is apparent a slight undulation of outline. It differs also from *D. truncatum* in the presence of the terminal tubercles, absent in that species. Moreover, the bold dilation of the segments near the base, the subsequent tapering, and again subsequent dilation to the end, seem to distinguish the plant from all others of the genus. *D. coronatum*, Brébisson, has similar terminal tubercles, but otherwise is quite different.

12. **Triploceras**, Bailey.

A genus separated from *Docidium* on account of the projecting processes at the ends of the segments. In the American, Indian, and Chinese species these seem to be indifferently set down as being two or three. The generic name implies *three*; my species has two.

T. tridentatum, sp. nov.

Figs. 21–23.

Frond small, slender, depressed, very slightly constricted at the middle. Total length, about twelve times the breadth in front view.

Segments furnished with a number (fifteen to eighteen) of whorls of denticulate projections pointing generally towards the extremity, but those near the middle of the frond project more perpendicularly. Edges between the teeth linear, not curved. Between the last whorl and the terminal projections is a short space without whorls, and at the base of the terminal processes are (at each side) three angular tri-cuspidate smaller processes (fig. 23).

Terminal processes two, sub-rectangular, divergent, ending each in three sharp teeth. Edge of frond between the processes curved.

Lateral denticulations not conical, but somewhat quadrate, like the teeth of a circular saw, pointing forwards.

Endochrome dark green, darkest at the axis. At the middle is a small lighter green space, in which often granules may be seen "circulating," that is, travelling in distinct currents—those near the axis from the extremity of the frond to the middle, those near the edge from the middle towards the extremity of the frond.

The section is rectangular, and in side view the frond is much narrower than in front view.

I think the empty frond is punctate, but the puncta are extremely minute and require a high power to distinguish them.

Length of frond, $\frac{1}{45}$ inch; breadth, front view, $\frac{1}{550}$ inch; side view, $\frac{1}{3000}$ inch.

Rare: from an almost dry ditch near the Fendalton road.

This pretty little plant is evidently closely allied to forms described from America, Bengal, and Hong Kong. From the first-named country, Prof. Bailey describes *T. verticillatum* and *T. gracile*; from Bengal we have *Docidium (Triploceras) pristidæ*, Hobson, and also *T. gracile*, Archer, from Hong Kong. But in none of these can I find the *two tridentate* terminal processes, and the *three* tri-cuspidate processes at their base, of my *T. tridentatum*. The American species, as shown in Ralfs' tab. XXXV., end in simple uni-dentate or bi-dentate processes; so does the Chinese plant figured by Mr. Archer (Quart. Micros. Journal, 1865, Pl. VII.); and Mr. Hobson's figure and description (Quart. Journal, 1863, p. 169) leave very much to be desired. Also the number of teeth in each whorl described in all these plants seems to be less than in *T. tridentatum*, but I lay no stress on this point.

I can scarcely set down as a mere "variety" a plant showing such considerable differences as these. Unless all previous figures are greatly inaccurate, the terminal and sub-terminal processes of *T. tridentatum* are sufficiently distinct to render it, I should say, a new species.

13. **Closterium**, Nitzch.

C. lunula, Müller. (R. XXVII.)

Common.

C. acerosum, Schrank. (R. XXVII.)

Figure 33.

Common; also, from Leithfield, plentifully.

This species seems to vary a good deal in length: some specimens from Leithfield are $\frac{1}{220}$ inch long: some from Christchurch $\frac{1}{24}$ inch. It is distinguished from *C. lunula* by greater slenderness and curvature, and by having its vesicles in a single row. Ralfs states that the empty frond is colourless; many of the species here have a distinct brown tinge. I observed also a tendency in several plants to assume a somewhat sigmoidal shape, the two ends turning opposite ways.

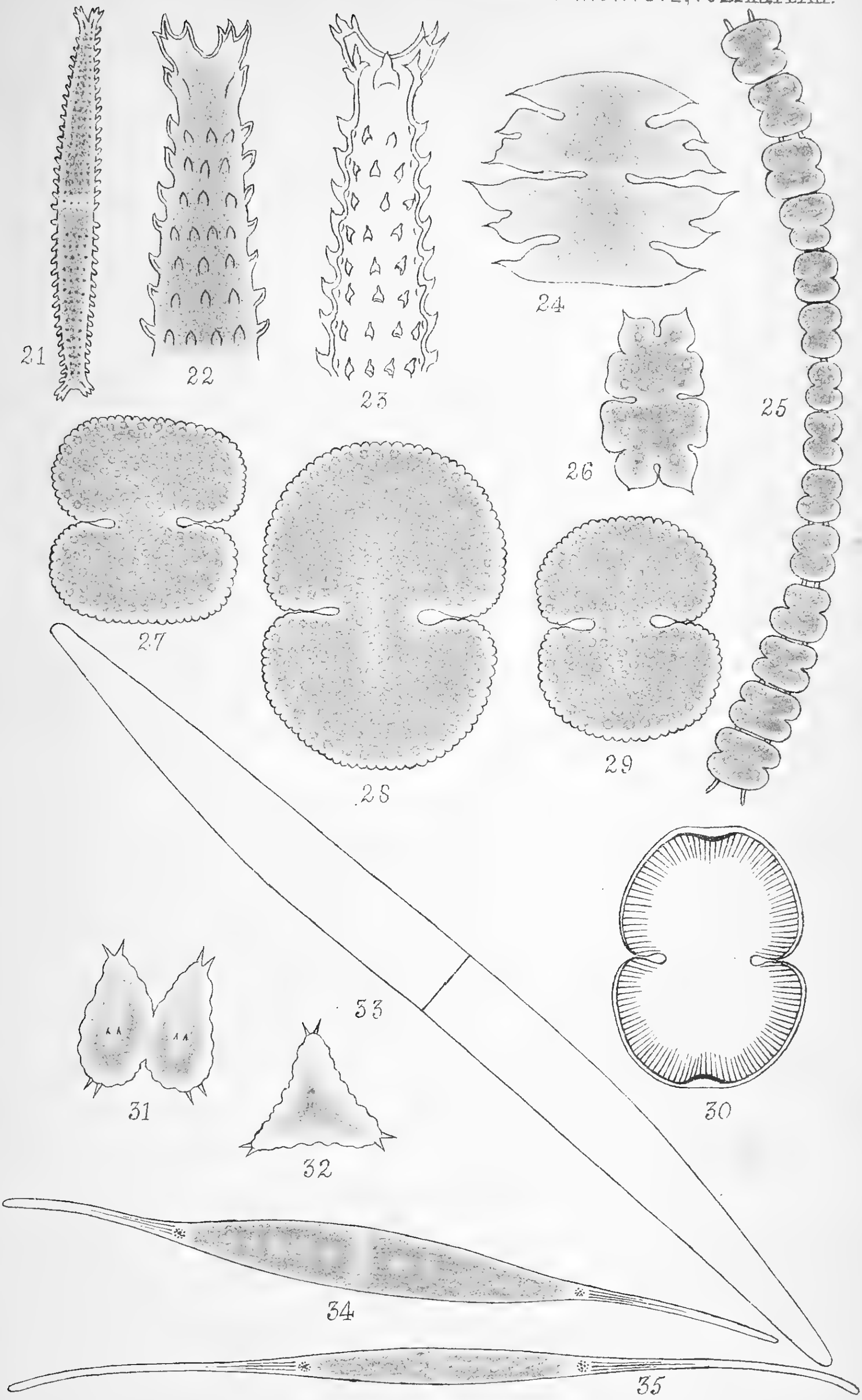
C. lineatum, Ehrenberg. (R. XXX.)

Not common.

C. selenæum, sp. nov.

Figures 15–16.

Frond bright green, large, stout, visible to the naked eye, distinctly lunate, the outer margin forming a bold circular curve, the inner margin also curved but more slightly; no inflation at the middle; ends rapidly tapering, sub-acute, a little rounded, and at the extreme tip turned very



NEW ZEALAND DESMIDEÆ.

Maskell, del.

slightly outwards; no median suture; fillets several, but obscure, sometimes not visible; vesicles numerous, scattered. The empty frond is colourless, with no striæ. The globule of moving granules is very small, and situate quite close to the tip.

Common in spring.

This is a fine handsome plant, and I think not agreeing with the European species. Those which in form approach nearest to it are *C. ehrenbergii*, Meneghini, *C. leibleinii*, Kützing, and *C. moniliferum*, Bory; but it differs from all in the absence of median inflation of the inner margin, which is conspicuous in all three, especially the first. *C. ehrenbergii* also has conspicuous longitudinal fillets, and the ends are thick and round. *C. moniliferum* is too small, and its vesicles are in a single row; and the same may be said of *C. leibleinii*, otherwise this species might agree almost wholly with my *C. selenæum*. However, the outward bending of the extreme tip of *C. selenæum*, mentioned above, would seem to separate it from all other species with acute ends. This bending is very slight, and best distinguishable in the empty frond, but I find no mention of any such character in the European species, with the exception of *C. turgidium*, Ehrenberg; but in that plant the bending is very conspicuous, the ends are thick and round, and the whole plant different. *C. decussatum*, Kützing, is striated.

Length of chord of arc, $\frac{1}{55}$ inch; breadth at the middle, $\frac{1}{300}$ to $\frac{1}{160}$ inch; from tip to middle along the frond, $\frac{1}{80}$ inch.

C. leibleinii, Kützing. (R. XXVIII.)

Fairly common.

C. dianæ, Ehrenberg. (R. XXVIII.)

Common.

These two species may be easily mistaken. Ralfs considers them probably identical. I have judged by the absence or presence of a median inflation.

C. didymotocum, Corda. (R. XXVIII.)

Rare; from Fernside.

C. striolatum, Ehrenberg. (R. XXIX.)

Not common.

C. didymotocum has no striæ; *C. striolatum* has numerous and close but distinct striæ. Both species have a varying number of median sutures. Both are somewhat dark-coloured; indeed *C. didymotocum* is at times almost black.

C. juncidum, Ralfs. (R. XXIX.)

Common.

C. setaceum, Ehrenberg. (R. XXX.)

Fairly common.

C. rostratum, Ehrenberg. (R. XXX.)

Not common.

Differs from *C. setaceum* in its greater size and in having the slender beaks shorter than the body of the frond. I show the two plants in figs. 34 and 35; is the distinction between them sufficient?

C. acutum, Lyngbye. (R. XXX.)

Rare.

14. **Spirotænia**, Brébisson.

S. condensata, Brébisson. (R. XXXIV.)

Not uncommon in spring.

This plant is more affected than any other which I have seen by the fluids used for mounting or preserving. I have tried glycerine, camphor water, Ralfs' fluid, etc.; but they all shrivel up the endochrome considerably, and as the beauty and characters of *Spirotænia* are quite lost unless the endochrome be uninjured, preserved specimens are useless. Distilled water even seems to have a bad effect. Almost all other Desmids stand mounting in glycerine well, but this is quite spoilt by it.

15. **Ankistrodesmus**, Corda.

A. falcatus, Corda. (R. XXXIV.)

Very common.

A. acutissimus, Archer, (Qu. Journ., 1862).

Rare.

I had sometimes observed this plant and was struck by its peculiarities before meeting with Mr. Archer's description,* and had considered it a *Closterium*, but it evidently shows the oblique transverse band, and mediolateral (to coin a word) pale space referred to by Mr. Archer. The plant is very rare, and from its minute size ($\frac{1}{500}$ inch long, $\frac{1}{10000}$ inch broad) requires a high power to examine it.

Ankistrodesmus sp. indet.

Figs. 17, 18.

Common.

I have frequently found specimens clearly belonging to this genus, but am doubtful as to its specific affinities. The cells are aggregated in bundles, but instead of crossing each other as in *A. falcatus*, they are arranged in parallel lines, and they are also only very slightly lunate, often quite straight. In some specimens I observed a definite mucous envelope enclosing four such parallel bundles as in fig. 17.

Length of the cells, $\frac{1}{660}$ inch; breadth, $\frac{1}{7000}$ inch.

Ankistrodesmus sp. indet.

Figs. 19, 20.

* "Quart. Journ. of Micr. Science," Vol. II., New Ser., 1862.

The cells are quite straight, aggregated in a single bundle, and radiating from the centre. A mucous envelope may be made out.

Length of cells, $\frac{1}{880}$ inch.

16. **Scenedesmus**, Meyen.

S. quadricauda, Turpin. (R. XXXI.)

Common.

S. acutus, Meyen. (R. XXXI.)

Rare.

S. obliquus, Turpin. (R. XXXI.)

Rare.

17. **Pediastrum**, Meyen.

This is not, I believe, really a genus of Desmidieæ, but as it is referred to in most works on the family I insert it here.

P. tetras, Ehrenberg. (R. XXXI.)

Common.

P. boryanum, Turpin. (R. XXXI.)

Common.

Pediastrum sp. indet.

Common.

Resembling generally *P. boryanum*, but wanting the long points on the marginal cells.

I have added a few figures showing species about which I am doubtful, or in which, as remarked in my introductory sentences, there seem to be peculiarities worthy of observation.

At some future time, if possible, I should wish to enter more fully into the details of these peculiarities, which may have been observed elsewhere but have not been recorded.

Sphærozosma filiforme, Ehrenberg.

Fig. 25.

Ralfs (Tab. XXXV.) gives a figure of *S. pulchrum*, Bailey, an American species. The figure is rough and without much detail, bat shows alternate decrease and increase, " an appearance probably caused by the twisting of the plant." But the English species are not, says Ralfs, twisted. The New Zealand species certainly is, as I have several times observed, and as my figure shows.

Euastrum elegans or *binale*, Brébisson.

Fig. 26.

I give a figure of my plant which, as remarked in the catalogue, may be either of the two European species.

Cosmarium margaritiferum, Turpin.

Figs. 27–29.

I give here three different forms which I believe to be the same plant, on account chiefly of their similar side view, which is *elliptic* in all three.

The first (fig 27) is very much like *Cosmarium broomeii*, Thwaites, (R. XVI.), and for a long time I believed it to be that plant. But *C. broomeii* has, in side view, a very distinct inflation at the middle, which my plant has not.

The second (fig. 28) resembles in outline *C. pyramidatum*, Brébisson, but that species has a smooth instead of a pearly edge. Also, in its slightly truncate ends, it approaches somewhat *C. botrytis*, Bory, (R. XVI.), but I think it is much too large, and the pearly granules are rounder. Besides, the truncation is often almost inconspicuous.

The third (fig. 29) is the normal form of *C. margaritiferum*, occurring here commonly.

On the whole, I would set all three down as the same plant, though fig. 28 *may* be *C. botrytis.*

Cosmarium ralfsii, Brébisson.

Fig. 30.

The figure shows the slight compression of the ends and thickening of the inner surface of the cell-wall, neither of which has been noticed, I think, elsewhere, but which I have observed here somewhat frequently. When first seen I took them to be accidental, but have since seen many examples.

Staurastrum (avicula?).

Figs. 31, 32.

Had I obtained several specimens of this plant I should probably have considered it as new from its crenate edges and double terminal spines; but having only seen one I do not like to make sure of it. Ralfs (tab. XXIII.) figures *S. avicula* with smooth edges and a single mucro. The numerous species of *Staurastrum* are mostly very minute, and I think not very clearly differentiated.

Closterium acerosum, Schrank.

Fig 33.

The figure shows the sigmoid form sometimes assumed here by this plant, and alluded to above in the catalogue.

Closterium rostratum, Ehrenberg.

Fig. 34.

Closterium setaceum, Ehrenberg.

Fig. 35.

The figures are given to show the resemblance between the two plants.

The difference in length of the beaks seems scarcely enough to distinguish them. Ralfs says that the vesicles of *C. setaceum* are " none or indistinct." I have certainly observed them here.

DESCRIPTION OF PLATES XI. AND XII.

Figure 1.	*Aptogonum undulatum*, side view	× 400
2.	,, under view	× 400
3.	,, upper view	× 400
4.	,, end view	× 400
5.	*Micrasterias rotata*, dividing	× 90
6.	*Micrasterias ampullacea*, trifid	× 200
7.	,, bifid	× 200
8.	,, side view	× 200
9.	*Didymocladon stella*, front view	× 400
10.	,, end view	× 400
11.	*Docidium dilatatum*	× 200
12.	,, end of frond	× 400
13.	,, section	× 200
14.	,, dividing	× 100
15.	*Closterium selenæum*	× 100
16.	,, end of frond	× 350
17.	*Ankistrodesmus*, sp.	× 400
18.	,, single cell	× 800
19.	,, sp.	× 400
20.	,, single cell	× 800
21.	*Triploceras tridentatum*	× 90
22.	,, end of frond	× 350
23.	,, ,, empty	× 350
24.	*Holocystis incisa*, var.	× 350
25.	*Sphærozosma filiforme*	× 700
26.	*Euastrum binale* (?)	× 700
27.	*Cosmarium margaritiferum*	× 350
28.	,, ...	× 350
29.	,, ...	× 350
30.	*Cosmarium ralfsii*, empty	× 200
31.	*Staurastrum (avicula ?)*	× 700
32.	,, ...	× 700
33.	*Closterium acerosum*, sigmoid	× 200
34.	*Closterium rostratum*	× 200
35.	*Closterium setaceum*	× 200

Art. XXXIX.—*On the Structure of* Hormosira billardieri.

By T. A. Mollet.

[*Read before the Philosophical Institute of Canterbury, 4th November*, 1880.]

Plates XIII. and XIV.

The genus *Hormosira*, which belongs to one of the three sub-orders of the Algæ, the Fucaceæ, is described by Hooker in his "Handbook of the N.Z. Flora" as follows:—"Root discoid. Frond olive-brown, without distinct organs, dichotomously branched, moniliform, internodes inflated, fertile. Fruit diœcious. Conceptacles sunk in the periphery of the internodes, containing subsessile narrow-pyriform spores and unbranched paranemata."

This genus, confined to Australian and New Zealand seas, has as its sole representative the species *billardieri*:—"Frond 6–18 inches long, very variable in size and robustness; internodes obconical, wingless." After thus describing it, Hooker mentions three varieties—*banksii*, *labillardieri*, and *sieberi*; but many of the features of these occur in the seaweed forming the subject of this paper. In fact, the shape of the internodes is far from being constant, and it must be admitted, as has been done by Harvey,* that the various forms described are most probably one and the same.

In "Phycologica Australica"† the different forms will be found figured, and, after describing them, the author concludes by supposing them all to be one species, varying slightly, due to the different conditions of growth, such as exposure, depth of water, etc.

The branching of this seaweed is generally dichotomous (commonly so-called), but is very often trichotomous, either irregular on the summit of the internode, or the three branches placed at equal intervals along the upper edge (Pl. XIV., fig. 1). It is not unusual to see as many as four branches springing from one internode (Pl. XIV., fig. 2), and in two or three cases I have noted six.

At times lateral branches are found (Pl. XIV., figs. 2 and 3). Internodes are also occasionally found united towards their base (Pl. XIV., figs. 4 and 5). This junction might at first sight appear to be a node, with two internodes springing from it; but the fact of its being hollow and in communication with their two cavities precludes the possibility of such an idea.

A most important point not mentioned in any of the works I have had access to (including the Australasian Floras in the Christchurch Public Library), is that the branching does not always take place from the inter-

* In the section Algæ, Hooker's "Flora of Tasmania," Vol. II., p. 285.

† "Phycologica Australica," Harvey, Vol. , pl. 135.

nodes, but frequently from the nodes themselves. It may be dichotomous (Pl. XIV., figs. 6 and 7), polychotomous (Pl. XIV., fig. 8), or take the form of a lateral shoot (Pl. XIV., fig. 9), in the same manner as the internode mentioned above.

The plants used in this investigation received no chemical preparation whatever; they were gathered in the living state, and left to dry for some days, after which time they were in a firmer and better condition for making thin sections than when freshly gathered. If kept, however, too long in a very dry atmosphere they showed a great tendency to brittleness, in which state they were very difficult to cut.

Before proceeding to the detailed structure of the plant, I would also mention that I have adhered to Hooker's nomenclature in regard to the terms node and internode. A node is generally looked upon as that part of the plant from which branches or leaves arise; but, in this case, the secondary stems generally branch out from the inflated internodes (see previous remarks on branching), which are therefore incorrectly named.

Nodes.—The nodes, which are solid throughout, consist externally of a single layer of thin polygonal cells (Pl. XIII., fig. 1), somewhat resembling the epidermis of the Phanerogamia, but unlike the latter are in a living state, many being found in the process of division. These cells, though very irregular in outline, are mostly hexagonal, and are so easily separated from the limiting tissue beneath, that in most of the sections made fragments of the tissue which they go to form were continually seen. This layer appears to be absent in the species of Fuci examined by Mr. F. O. Bower,* as he in no place mentions its existence.

The layer of tissue next beneath is composed of minute oblong cells, gradually increasing in size as they recede from the external tissue. Towards the surface these cells are oblong, but they become more oval-shaped towards the inner tissues. (Pl. XIII., figs. 2 and 3.) It is only in very thin sections that the shape of these cells—the granular contents of which are deeply coloured with chlorophyll—can be satisfactorily determined; in thicker ones they appear to be of much greater length than is really the case. This layer corresponds with the "limiting tissue" of F. O. Bower.

The tissue adjoining on the inner side, his cortical tissue, is an aggregation of irregularly-shaped cells, containing small quantities of chlorophyll, and having no clearly-defined division between the cell-walls (Pl. XIII., figs. 2 and 3). This layer graduates from the limiting tissue on the outside into a mass of parallel cells, forming the central part of the node (Pl. XIII., figs. 2 and 3).

* On the Development of the Conceptacle of the Fucaceæ. ("Quart. Journ. Micro. Science," January, 1880.)

These parallel cells contain a minute amount of chlorophyll, and are in shape cylindrical, their average length being about five times the diameter; but the boundary of the cell-wall, which could not be traced in the cortical tissue, is here occasionally clearly distinguishable in transverse section.

Internodes.—The internodes, which are in the early state semi-transparent, become olive-brown when mature; and the cavity which is invariably found in them contains a saline solution. This central cavity is to be detected in even the very young stages of their growth, when they are no more than ·03 inch in diameter. The only exception to the above is the basal internode, which is solid throughout, but the one next above has a small hollow centre, and the third, and sometimes fourth, is furnished with a nearly full-sized cavity (Pl. XIV., fig. 6).

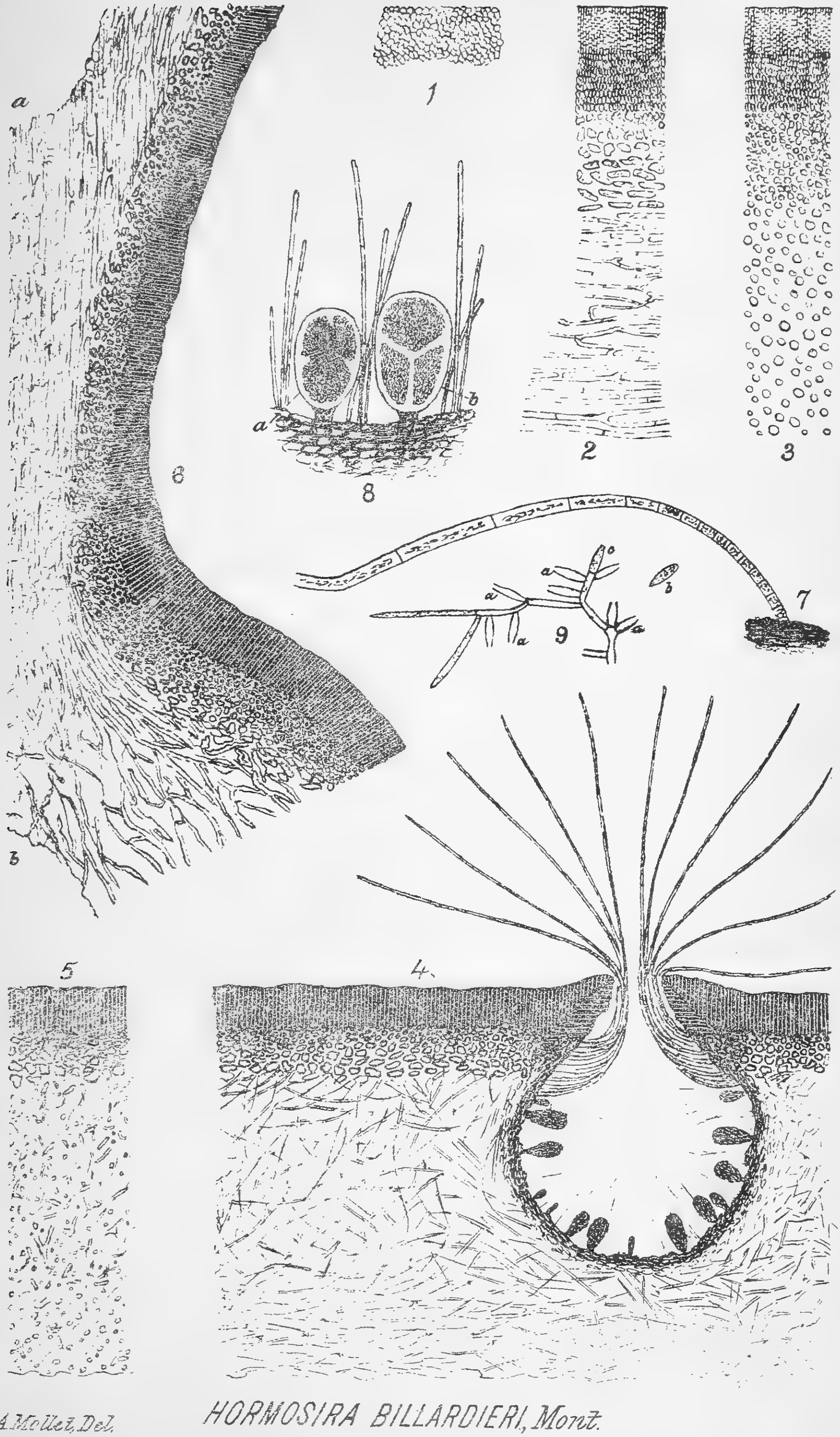
A few central threads, extending from the base to the top, may be seen by splitting open a fresh internode. Their structure somewhat resembles that of the nodes, the same thin layer of outer tissue being present, and within this also the minute oblong cells of the limiting tissue (Pl. XIII., figs. 4 and 5). The cortical tissue, however, differs slightly from that in the node, the cells being if anything more compact, though more irregular in outline.

Between the cortical and innermost tissue lies a mass of cells joined together endwise, and forming long strings branching frequently, and without any apparent uniformity (Pl. XIII., figs. 4 and 5). These cells are tubular and mostly straight, but at times curved and bent at various angles. In some cases two adjacent rows of cells will be connected by a short tube, with a septum midway, reminding one most forcibly of the conjugation of *Spirogyra*.

The innermost tissue of the internode is a collection of parallel rows of cylindrical cells (Pl. XIII., figs. 4 and 5), somewhat akin to the previous layer, which in structure resembles this innermost tissue.

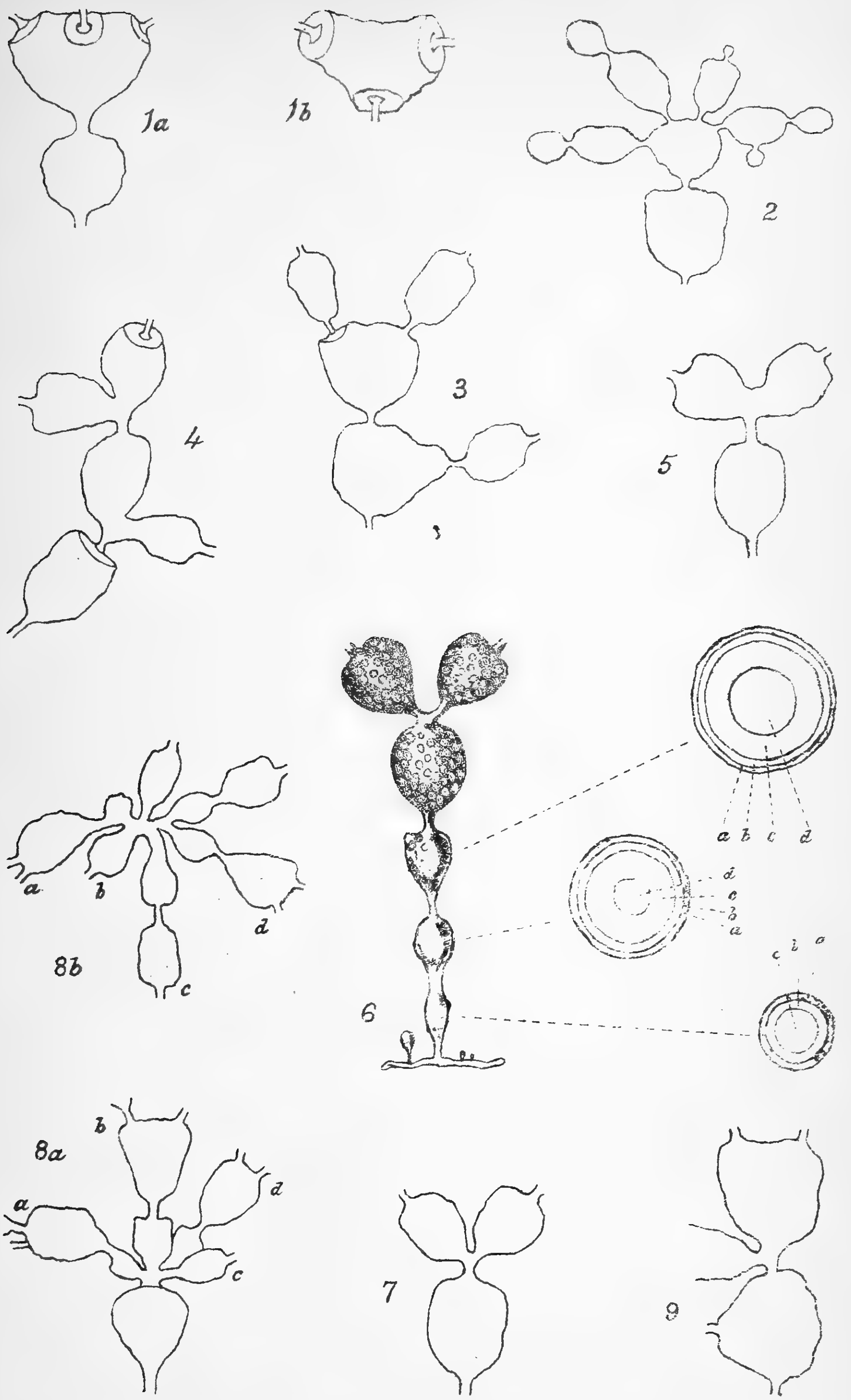
All these tissues, though described as different layers, must not be supposed to have a strong line of demarcation between them. On the contrary, they blend almost imperceptibly into each other, with the exception of the limiting tissue, which is moderately well-defined, and the outer single layer of polygonal cells. Owing to the thickness and gelatinous nature of the cell-walls in the cortical and inner tissues, the cells unite to form a transparent medium, the cavities in which are the only guide as to the size and shape of the original components of the structure.

As regards the connection between the different tissues in the node and internode, it may be remarked that the outer single layer is continuous, also the limiting and cortical tissues (Pl. XIII., fig. 6); but the layer of parallel cells divides into two equal parts (as seen in longitudinal section) on leaving



T. A. Mollet, Del.

HORMOSIRA BILLARDIERI, Mont.



T. A. Mollet, Del. HORMOSIRA BILLARDIERI, Mont.

the proximal end of the node. At the distal end the central part of the tissue comes to an abrupt termination, leaving the surrounding mass only to pass on into the internode, where the parallel cells are comparatively few, being replaced by those of irregular shape.

Conceptacles.—The conceptacles, containing the sexual organs, are scattered over the surface of the internode, or, rather, in its outer tissues. The conceptacles are flask-shaped, and about ·03 inch in diameter. The tissue lining them is of two distinct kinds; that of the mouth and about one-sixth of the depth of the cavity resembles, and is apparently a continuation of, the limiting tissue (Pl. XIII., fig. 4), but the remainder consists of cortical tissue. These facts would lead to the supposition that the origin of these conceptacles is the same as that of those in *Fucus serratus*;* but on this point I am not prepared to give a definite opinion.

At some little distance within the mouth of the conceptacle (male and female), viz., from the termination of the limiting tissue, and extending to about an equal depth within the cavity, is to be found a collection of multicellular hairs, which protrude for some distance out of the mouth of the conceptacle. (Pl. XIII., fig. 4.) These hairs are quite distinct from, and have no resemblance to, the slender filaments hereafter mentioned. At the base the length of the cells, of which these hairs are composed, is equal to the diameter; but as we trace the cells on towards the free end, we find them gradually elongating till, at the extremity, their length is many times that of their diameter. (Pl. XIII., fig. 7.)

In the female conceptacle (Pl. XIII., fig. 4) the remaining surface is densely covered with slender filaments, most of them extending nearly to the centre of the cavity. The oogonia, irregularly scattered among these paranemata, contain in the primitive stage yellow granular matter, which slowly changes, as they increase in size, to a dark brown colour, and finally divides to form four oospheres. (Pl. XIII., figs. 4 and 8.)

In the conceptacle containing the male organs of reproduction, the slender filaments are wanting; but their place is occupied by thick clusters of branched hairs (Pl. XIII., fig. 9), upon which are formed the antheridia. The cell-walls of the latter are divided into two layers—an inner and an outer; the outer forming part of the branching hair. When the antheridium is mature it escapes slowly from this outer cell-wall, and is then seen to consist of the previously inner cell-wall filled with antherozoids. (Pl. XIII., fig. 9.)

Referring again to the oogonia, which I have not seen in a mature condition, it may be well to state that they appear, when young, cylindrical; at

* See F. O. Bower, *loc. cit.*

a later stage, pyriform; and when nearly ripe, obovoid. (Pl. XIII., figs. 4 and 8.)

I have had no opportunity of studying the fertilization of this seaweed, but am assured by Prof. Hutton that April is the best time of the year to witness it, and that it is over by June, being evidently confined to the autumn months. I have only to add that my thanks are due to the above-named gentleman, for the kind interest he has manifested in the subject throughout.

DESCRIPTION OF PLATES XIII. and XIV.

(All the figures natural size unless otherwise specified.)

Hormosira billardieri.

Plate XIII.

1. Epidermal tissue of polygonal cells (× about 180 diam.).
2. Longitudinal half-section of node, showing limiting, cortical, and parallel tissues (× about 120).
3. Transverse ditto (× about 120).
4. Longitudinal section of tissues of internode, showing limiting, cortical, irregular, and parallel tissues; also female conceptacle with multicellular hairs, paranemata, and oogonia (× about 60).
5. Transverse section of tissues of internode (× about 60).
6. Longitudinal half-section of node and ends of two internodes, showing stoppage of most of parallel cells at distal end *a*, and their division into two parts at proximal end *b* (× about 40).
7. Multicellular hairs of conceptacle, $\frac{1}{3}$ length, showing division into cells (× about 180).
8. Paranemata and oogonia, latter nearly mature (× about 180).
    - *a.* oogonium with contents divided into four parts, one of these partly hidden by remaining three.
    - *b.* oogonium with contents differently divided.
9. Branch bearing antheridia (× about 180).
    - *a.* Empty antheridial cells (outer cell-wall of antheridium).
    - *b.* Escaped antheridium (inner cell-wall enclosing antherozoids).
    - *c.* antheridium, not fully mature.

Plate XIV.

1*a*. Portion of frond, showing trichotomous branching from upper internode. Side view.

1*b*. The same branching internode. Top view.

2. End of branch showing quadrichotomous branching, and young internode springing from side of an older one.
3. Lateral branching from internode.
4. Union of two internodes near their base.
5. Ditto.

6. Dichotomous branching from node. Sections of basal internode and the next two above, as seen by the naked eye. (Three times nat. size.)
   a. Limiting tissue.
   b. Cortical tissue.
   c. Inner tissues.
   d. Cavity containing saline solution.
7. Dichotomous branching from node.
8*a*. Polychotomous branching from node. Front view.
   a, *b*, etc., mark the same branches as in fig. 8*b*.
8*b*. Ditto. View from above.
   a, *b*, etc., mark the same branches as in fig. 8*a*.
9. Lateral branching from node and internode.

Art. XL.—*A Visit to Stewart Island, with Notes on its Flora.*

By D. Petrie, M.A.

[*Read before the Otago Institute, 29th June*, 1880.]

In the month of January of this year Mr. G. M. Thomson and I made a short excursion to Stewart Island for the purpose of dredging in the inlets, and examining, as far as we could, the flora of that little-known part of New Zealand. Our examination of the flora was confined to the country around Paterson's Inlet, and that in the neighbourhood of Port Pegasus.

Paterson's Inlet is for the most part comparatively shallow, and extends more than half-way across the greatest breadth of the island. It is surrounded on nearly all sides by hills of moderate elevation, with rather steep slopes that are clothed with "bush" to the water's edge. At the head or north-western extremity of the inlet however, it is bordered by a low tract some three miles in width, which is difficult of access except near high water, in consequence of extensive shoals. From this part of the inlet there extends for a good many miles to the westward a flat swampy area, some three miles or less in average width, and raised but little above sea-level. It is drained by a forked creek, which is tidal in its northern branch for at least six miles. About six miles from the inlet this flat area is connected by a rather narrow, low, boggy valley bending to the south, with a similar area of low swampy land abutting on Mason Bay and the west coast of the island. The distance from sea to sea is probably about thirteen miles. Sand-hills occur at intervals throughout the flat areas at the head of the inlet and Mason Bay respectively, but they do not extend into the connecting valley. It is evident that at no remote date a strait here ran across Stewart Island, separating the high land in the north, of which Mount Anglem is the culminating point, from the southern portion. I believe that a depression of fifty or sixty feet would suffice to restore this strait, and part Stewart Island once more into two. At the head of the inlet the sand-hills present a very remarkable appearance, forming parallel chains that run for two or three miles in straight or nearly straight lines at considerable distances from one another. Their singular arrangement is not easy to explain, but it may be due to the fact that the direction of the prevailing winds, and of the tidal flow through the former strait, would be east and west. Though the sand-hills are evidently of recent origin, they are everywhere covered by about six inches of sandy mould, and overgrown by fern, heath, gravels, rushes, and manuka.

With the exception of the already-mentioned flat areas, there is no grass-covered land in the neighbourhood of Paterson's Inlet. Even in these the grass is very sparse, except in a few patches of no great extent, and it is mixed with a very copious growth of manuka, ferns, (*Pteris*, *Gleichenia*, *Lindsæa*, and *Schizea*), *Carpha*, *Calorophus*, *Cladium*, and *Lepidosperma*. In the boggy parts, which occupy by far the largest portion of the low land, a curious assemblage of alpine plants is found, comprising *Alepyrum*, *Oreobolus*, *Donatia*, *Helophyllum*, *Liparophyllum*, and *Actinotus (Hemiphues)*.

The *Liparophyllum*, probably *L. gunnii* (hitherto known only from Tasmania), is extremely abundant in the wettest parts, and forms a strong turf, held together by its matted and branched root-stocks. It bore abundant fruit, though the latter was scarcely ripe at the time of our visit.

The plant which I have named *Actinotus (Hemiphues) novæ-zealandiæ* belongs to a genus hitherto found only in the alpine parts of Tasmania and Australia. It grows abundantly side by side with *Liparophyllum*, but affects somewhat drier situations. The genus *Actinotus (Hemiphues)*, which includes this new addition to the flora of New Zealand, belongs to a section of the great natural order of the Umbelliferæ. It differs very widely from every other genus of that order, and occupies a singularly isolated position. Instead of having two similar mericarps, like the rest of the Umbelliferæ, Dr. Hooker tells us that one of the mericarps appears as if wholly suppressed, but his dissections have satisfied him that it is not really suppressed, but "is entirely incorporated with the others, and its cavity obliterated."

I had the good fortune some three years ago to discover on Stewart Island both *Liparophyllum* and *Actinotus (Hemiphues)*, but I was not at the time able to identify them. Some months before this excursion was undertaken, Mr. Kirk, F.L.S., of Wellington, pointed out to me the close resemblance *the one* bore to the *Liparophyllum* of Tasmania. The *Actinotus (Hemiphues)* we are able to identify from the structure of the fruit, and of a withered flower found at Port Pegasus. It seems to me probable that another species of *Actinotus (Hemiphues)* occurs in the same localities, but by no means in such abundance as *A. (H.) novæ-zealandiæ.* The plant in question was found only in fruit, the structure of which presented all the characteristics of the genus, and it will, I have little doubt, prove to be another species of this anomalous genus, probably new to science, and certainly new to the flora of New Zealand. It is worthy of remark that in Tasmania both *Liparophyllum* and *Actinotus (Hemiphues)* grow in alpine bogs and moist places, while in Stewart Island they flourish almost at sea level.

The occurrence of *Donatia novæ-zealandiæ* at the same low elevation is certainly surprising. It has not been found either in the bogs of Southland or on the Bluff Hill, which offers many situations favourable for its growth. The lowest elevation at which I have elsewhere met with it is 3000 feet, on the summit of Maungatua, near the Taieri Plain. Lyall found it on mountains near Preservation Inlet, but the height is not stated. It is extremely remarkable that a plant which does not descend below 3000 feet in the latitude of Dunedin should flourish at sea-level in that of Paterson's Inlet, and the fact bears emphatic testimony to the severity of the climate of Stewart Island.

Of the interesting plants found in this locality, I may next mention *Utricularia monanthos*, and *Eleocharis sphacelata.* The latter grew in two or three deep pools in peaty soil, and specimens were procured with considerable difficulty. It is singular that this species, which ranges from the extreme north of New Zealand to Stewart Island, should have been found in the South Island only in one or two spots in Westland and at Bluff Island, a locality at one time held to be very doubtful. *Utricularia monanthos* grows almost exclusively in pools, at the time of our visit for the most part dried to the consistency of sticky mud. Its rhizomes are abundantly provided with bladders similar to those of the European species, whose structure and functions have been investigated with great care and skill by Darwin. (See his "Insectivorous Plants.") This eminent naturalist was led to the conclusion that the bladders serve as traps for minute aquatic animals such as the Entomostraca, whose protoplasm is in some obscure manner made available for the nourishment of the plant. Mr. Thomson has examined roughly the structure and contents of the bladders attached to specimens gathered by us, and he informs me that remains of Entomostracans and other minute aquatic animals were present in all, sometimes in considerable quantity. Two other insectivorous plants were common here, viz., *Drosera binata* and *D. rotundifolia.* Insects are so frequently caught in the glandular hairs of their leaves that these herbs are known among the observant Southland settlers as "fly-catchers."

Some years ago an attempt was made to utilize the flat tracts between Mason Bay and Paterson's Inlet as a sheep run, and portions of the lower slopes of the hills were cleared, by burning, to extend the area of grass-bearing land. About six hundred sheep were placed on the ground, but they did not thrive, and few now survive the hardships of a life in this inhospitable locality. The country appears to be wholly unsuitable for depasturing sheep, unless considerable portions of the higher ground were cleared and sown with grass, an improvement that would involve a heavy outlay. A few spots of the low land grow grass luxuriantly, but much of it must be under water a great part of the year, and a very large proportion of the remainder is always inaccessible bog. Drifted grass and twigs caught in the branches of the manuka bushes indicated that floods, sufficient to inundate the greater part of the low country, are not unknown.

The grasses found here are of little value for pasturage. *Danthonia raoulii* (brown snow-grass) and *D. semi-annularis* were the most abundant, and the latter was by far the most widely spread. *Poa australis* (silver or white tussock) is by no means plentiful, and is dwarfed in size, and inclined to form a loose sward. The only other fodder grass of any consequence was *Danthonia quadriseta*. In general, the grass is extremely sparse, and is almost choked by the abundant growth of rush-like and Cyperaceous plants. There can, I think, be no doubt that this, the only open part of Stewart Island, is in its present condition wholly unsuitable for either agricultural or pastoral occupation. No doubt draining would make some improvement, but the fall is so slight, and the soil so saturated with frequent heavy rains, that general drainage would probably do but little good. However this may be, it will be a very long time before this part of Stewart Island will have any other resources than timber and the produce of its fisheries.

At the mouth of the inlet lies an island of considerable size called the Neck. It is connected by a sand-bank with the southern mainland, has a very fertile soil, and is occupied by a number of Maori and half-caste families. The sand-bank joining this island to the southern mainland has evidently filled up a former eastern outlet of Paterson's Inlet, and has encroached on it from the south. We may account for the change by the gradual drifting of the sand before the southerly winds, which are the prevailing ones here, and the transportation of material in the same direction by the tides flowing from the southward. The condition and situation of the Neck are strikingly analogous to those of Otago Peninsula. Both have been islands at a recent date; both are now connected with the southern mainland by a narrow sandy isthmus; both are fertile and largely composed of volcanic rocks; and both have been recently converted from islands into peninsulas by the gradual encroachment of sand blown from the south. I think I am justified in saying so much about the direction from which the sand-hills at the Ocean Beach, Dunedin, encroached on the former channel connecting Otago Harbour and the ocean, from the well-known accumulation of sand from the south-east between Black Head and Green Island, and on Sawyer's Head between Tomahawk and the Ocean Beach, while there are no corresponding accumulations at the eastern or south-eastern end of these beaches.

On the Neck we found a very handsome species of *Olearia (angustifolia)* growing abundantly near the beach. It is a species so far as is at present known peculiar to Stewart Island, and was met with also at Port Pegasus. Side-by-side with it grew *Olearia colensoi*, which attains to the dimensions of a tree, and has a stem often as much as a foot in diameter. It is a species that has a very wide range, and in Stewart Island ascends from sea-level, where it attains its maximum size, to 1,500 feet at Port Pegasus. Elsewhere in New Zealand it is an alpine plant.

From Paterson's Inlet we made our way to Port Pegasus. The country here has every appearance of recent glaciation, and the rounded outlines of the hills recall vividly the roches moutonnées so well marked to the south andwest of Lake Wanaka. The district around this harbour is composed entirely of a granite-like rock composed of large crystalline masses of albite, felspar, quartz, and mica.

The harbour is very picturesque, and breaks up into several branches, one of which penetrates to within a few miles of the west coast. To the west are two very striking conical hills, known as the Frazer Peaks, the larger of which has a very elegant and regular outline. Both are composed of the granite so plentiful in the district, and they glitter in the sunshine as if covered with a thin coating of snow. We were not favoured with good weather during this part of our cruise, and were consequently prevented from examining the district so fully as we had hoped to do. For two days the weather was so stormy that we could dredge only in the most sheltered parts of the anchorage, and for the most part with very meagre results. In the bush, which surrounds the port on all sides, we found a species of *Coprosma*, apparently new but allied to *C. colensoi*, and also in great abundance *Gahnia procera*. The tidal flats at the head of the various branches of the harbour are covered with *Zostera nana*. At the lower levels *Actinotus (Hemiphues) novæ-zealandiæ* was abundant, and also *Astelia linearis*, elsewhere in New Zealand an alpine plant. At the intermediate levels *Drosera stenopetala* and *Senecio lyalli* were met with. The latter is very common in this part of the island, but we did not see it anywhere around Paterson's Inlet. The specimens were, however, small and poorly grown as compared with those to be met with on the mountains of the interior of Otago. The flowers on Stewart Island were all yellow, while in the Otago alpine localities they are often white. The occurrence of this alpine plant at so low a level in Stewart Island, as well as its dwarfed proportions, give additional proof of the severity of the climate in this part of the colony. Near the summit of the more northerly of the Frazer Peaks, we gathered a robust form of *Forstera sedifolia*, which constitutes a very distinct, large-flowered variety, and may prove a distinct species. We also found here a robust form of what may prove to be *Celmisia hectori*, though I am inclined to rank this also as a distinct species. At all levels we found a new species of *Ehrharta*, which I have described under the name of *E. thomsoni*, in honour of my fellow-worker on the expedition. The description and drawings appear in the Transactions of the Institute for the past year. *Ligusticum intermedium*, which occurs along the south coast of Otago from Nugget Point to the western sounds, grew plentifully along the shore of the upper reaches of the port. In one or two sheltered spots in deep shade, we found excellent specimens of what appears to be *Stilbocarpa polaris*. The specimens were a little past flowering, but had not the fruit mature, so that we could not determine with accuracy whether it is identical with the plant found on Campbell Island and the Lord Auckland group. I may add here that on a former excursion Mr. G. M. Thomson collected *Myrsine chathamica* a little to the south of Port Pegasus.

For the purposes of settlement the country around Port Pegasus is of no value whatever. The lower hills are clad with manuka, which has been partly burned off; but there is no grass land, and very few grasses of any kind are to be met with. *Ehrharta thomsoni*, though widely spread, is very small and of no economic value. A time may come when the granitic rock, so abundant here, may prove valuable; but its distance from any market, and the great facilities for working the inexhaustible stores of excellent building-stone found at Port Chalmers, will render the time at which it may be utilized very remote.

On returning from Port Pegasus we proceeded to the Bluff. We had intended to visit Mount Anglem and explore the alpine flora likely to be found on it, but unfavourable weather prevented us from carrying out this part of our programme.

Appended is a list of the flowering plants gathered by us. For the identification of the Coniferæ Mr. Thomson is responsible; the others have been examined by myself as well as by him. The list, which cannot be considered as by any means exhaustive, especially as regards the alpine plants, will be of considerable interest to botanists as extending the limits of distribution of some well-known forms.

LIST OF PLANTS GATHERED ON STEWART ISLAND.

RANUNCULACEÆ.

Ranunculus plebeius, *Br.*
Ranunculus lappaceus, *Sm.*, *var.* multiscapus
Ranunculus acaulis, *Banks and Sol.*

MAGNOLIACEÆ.

Drimys colorata, *Raoul.*

CRUCIFERÆ.

Cardamine hirsuta, *L.*

VIOLARIEÆ.

Viola filicaulis, *Hook. f.*
cunninghamii, *Hook. f.*
Melicytus ramiflorus, *Forst.*
lanceolatus, *Hook. f.*

PITTOSPOREÆ.

Pittosporum tenuifolium, *Banks and Sol.*

CARYOPHYLLEÆ.

Stellaria parviflora, *Banks and Sol.*

TILIACEÆ.

Aristotelia racemosa, *Hook. f.*

LINEÆ.

Linum monogynum, *Forst.*

GERANIACEÆ.

Geranium microphyllum, *Hook. f.*
Geranium molle, *Cav.*

CORIARIEÆ.

Coriaria ruscifolia, *L.*

ROSACEÆ.

Rubus australis, *Forst.*
Geum parviflorum, *Commerson* (a very small var.)
Acæna sanguisorbæ, *Vahl.*

SAXIFRAGEÆ.

Donatia novæ-zealandiæ, *Hook. f.*
Carpodetus serratus, *Forst.*
Weinmannia racemosa, *Forst.*

CRASSULACEÆ.

Tillæa moschata, *DC.*

DROSERACEÆ.

Drosera stenopetala, *Hook. f.*
Drosera spathulata, *Labill.*
Drosera binata, *Labill.*

HALORAGEÆ.

Haloragis uniflora, *Kirk.*
Haloragis micrantha, *Br.*
Callitriche verna, *L.*

MYRTACEÆ.

Leptospermum scoparium, *Forst.*
Metrosideros lucida, *Menzies.*
Metrosideros hypericifolia, *A. Cunn.*
Myrtus pedunculata, *Hook. f.*

ONAGRARIEÆ.

Fuchsia excorticata, *Linn. f.*
Epilobium nummularifolium, *A. Cunn.*
linnæoides, *Hook. f.*
Epilobium alsinoides, *A. Cunn.*
rotundifolium, *Forst.*
tetragonum, *L.*
Epilobium pubens, *A. Rich.*

FICOIDEÆ.

Mesembryanthemum australe, *Soland.*
Tetragonia expansa, *Murray.*

Umbelliferæ.

- Hydrocotyle americana, *Linn.*
- asiatica, *Linn.*
- muscosa, *Br.*
- Hydrocotyle novæ-zealandiæ, *Kirk.*
- Apium australe, *Thouars.*
- filiforme, *Hook.*
- Ligusticum intermedium, *Hook. f.*

Araliaceæ.

- Stilbocarpa polaris, *Dcne. and Planch.*
- Panax simplex, *Forst.*
- edgerleyi, *Hook. f.*
- anomalum, *Hook.*
- Panax crassifolium, *Dcne. and Planch.*
- longissimum, *Hook. f.*
- colensoi, *Hook. f.*
- Schefflera digitata, *Forst.*

Corneæ.

- Griselinia littoralis, *Raoul.*

Rubiaceæ.

- Coprosma lucida, *Forst.*
- tenuicaulis, *Hook. f.*
- rhamnoides, *A. Cunn.*
- parviflora, *Hook. f.*
- propinqua, *A. Cunn.*
- Coprosma fetidissima, *Forst.*
- species (undetermined)
- acerosa, *A. Cunn.*
- Nertera depressa, *Banks and Sol.*
- dichondræfolia, *Hook. f.*

Compositæ.

- Olearia angustifolia, *Hook f.*
- colensoi, *Hook. f.*
- nitida, *Hook. f.*, forming large bushes
- ilicifolia, *Hook. f.*
- avicenniæfolia, *Hook. f.*
- Celmisia longifolia, *Cass.*
- Lagenophora forsteri, *DC.*
- Brachycome odorata, *Hook f.*
- Cotula perpusilla, *Hook. f.*
- squalida, *Hook. f.*
- Cassinia fulvida, *Hook. f.*
- Gnaphalium bellidioides, *Hook. f.*
- trinerve, *Forst.*
- Gnaphalium filicaule, *Hook. f.*
- luteo-album, *Linn.*
- involucratum, *Forst.*
- collinum, *Labill.*
- Erechtites prenanthoides, DC.
- arguta, DC.
- glabrescens, *Kirk.*
- Senecio bellidioides, *Hook. f., var. B.*
- lautus, *Forst.*
- lyallii, *Hook. f.*
- rotundifolius, *Hook. f.*
- elæagnifolius, *Hook. f.*
- Taraxacum dens-leonis, *Desf.*
- Sonchus oleraceus, *Linn.*

Stylidieæ.

- Forstera sedifolia, *Linn. f., var.*
- Phyllachne subulata, *Müller.*

Campanulaceæ.

- Wahlenbergia saxicola, *A.DC.*
- Pratia angulata, *Hook. f.*
- Selliera radicans, *Cav.*

Ericeæ.

- Gaultheria antipoda, *Forst.*
- Cyathodes acerosa, *Br.*
- empetrifolia, *Hook. f.*
- Leucopogon frazeri, *A. Rich.*
- Pentachondra pumila, *Br.*
- Dracophyllum longifolium, *Br.*
- rosmarinifolum, *Forst*
- muscoides, *Hook. f.*

Myrsineæ.

- Myrsine urvillei, *A.DC.*
- Myrsine chathamica, *Müller.*

Primulaceæ.

- Samolus littoralis, *Br.*

Gentianeæ.

- Gentiana montana, *Forst.* Sub-erect var.
- Gentiana saxosa, *Forst.*

Boragineæ.

- Myosotis capitata, *Hook. f.*

Convolvulaceæ.

- Convolvulus soldanella, *Linn.*

Scrophularineæ.

Veronica salicifolia, *Forst.*
elliptica, *Forst.*
buxifolia, *Benth.*
Ourisia macrophylla, *Hook.*
colensoi, *Hook. f.*
Euphrasia, species undetermined.

Lentibularieæ.

Utricularia monanthos, *Hook. f.*

Plantagineæ.

Plantago raoulii, *Decaisne.*
Plantago brownii, *Rapin.* Form with sepals subacute.

Chenopodiaceæ.

Chenopodium glaucum, *Linn.*, *var.* ambiguum.
Atriplex billardieri, *Hook. f.*

Polygoneæ.

Muhlenbeckia adpressa, *Lab.*
Rumex neglectus, *Kirk.*

Thymeleæ.

Drapetes dieffenbachii, *Hook.*

Coniferæ.

Podocarpus ferruginea, *Don.*
totara, *A. Cunn.*
Podocarpus dacrydioides, *A. Rich.*
Dacrydium cupressinum, *Soland.*

Orchideæ.

Earina mucronata, *Lindl.*
autumnalis, *Hook. f.*
Dendrobium cunninghamii, *Lindl.*
Gastrodia cunninghamii, *Hook. f.*
Corysanthes triloba, *Hook. f.*
rivularis, *Hook. f.*
Microtis porrifolia, *Sprengel.*
Caladenia lyalli, *Hook. f.*
Pterostylis graminea, *Hook. f.*
Chiloglottis cornuta, *Hook. f.*
bifolia, *Hook. f.*
Thelymitra longifolia, *Forst.*
uniflora, *Hook. f.*
Prasophyllum colensoi, *Hook. f.*

Irideæ.

Libertia ixioides, *Sprengel.*

Naiadeæ.

Zostera nana.
Triglochin triandrum, *Michaux.*
Potamogeton natans, *Linn.*

Liliaceæ.

Rhipogonum scandens, *Forst.*
Callixene parviflora, *Hook. f.*
Astelia nervosa, *Banks and Sol.*
Astelia linearis, *Hook. f.*
Anthericum hookeri, *Hook. f.*, *var.*
Phormium tenax, *Forst.*
Herpolirion novæ-zealandiæ, *Hook. f.*

Junceæ.

Juncus communis, *E. Meyer.*
planifolius, *Br.*
Juncus bufonius, *Linn.*
Luzula campestris, *De Cand.*
Luzula oldfieldii, *Hook. f.*

Restiaceæ.

Leptocarpus simplex, *A. Rich.*
Calorophus elongata, *Lab.*
Alepyrum pallidum, *Hook. f.*

Cyperaceæ.

Schœnus brownii, *Hook. f.*
Carpha alpina, *Br.*
Eleocharis sphacelata, *Br.*
Isolepis riparia, *Br.*
cartilaginea, *Br.*
nodosa, *Br.*
Cladium glomeratum, *Br.*
gunnii, *Hook. f.*
Gahnia procera, *Forst.*
Lepidosperma tetragona, *Labill.*
Oreobolus pumilio, *Br.*
Uncinia ferruginea, *Boott.*
filiformis, *Boott.*
rupestris, *Raoul.*
Carex lambertiana, *Boott.*
neesiana, *Endl.*
trifida, *Cavanilles.*
stellulata, *Goodenough.*
Carex testacea, *Solander.*

GRAMINEÆ.

Ehrharta thomsoni, *Petrie*.
Microlæna stipoides, *Br.*
avenacea, *Hook. f.*
Hierochloe redolens, *Br.*
alpina, *Rœm. & Schulles.*
Agrostis æmula, *Br.*
billardieri.
avenoides, *Hook. f.*
quadriseta, *Br.*
Arundo conspicua, *Forst.*
Danthonia cunninghamii, *Hook. f.*
raoulii, *Steud.*
semiannularis, *Br.*
Trisetum antarcticum, *Trinius.*
Poa imbecilla, *Forst.*
australis, *Br.*, *var.* lævis.
colensoi, *Hook. f.*
Gymnostichum gracile, *Hook. f.*

ART. XLI.—*Description of new Species of* Carex.

By D. PETRIE, M.A.

[*Read before the Otago Institute, 1st February*, 1881.]

Carex parkeri, n.s.

A SMALL slender species; culms 3–5 inches; leafy at and above the base, smooth, grooved; leaves flat, smooth, striate, shorter than the culm, sheathing at the base; sheaths more membranous and strongly striate; spikelets two or three, forming a compact head; bract glume-like, with a short awn; male flowers below, female above; glumes ovate, obtuse or subacute, one-nerved, dark-purplish, paler at and near the nerve; utricle subequal with or longer than the glume, ovate oblong, rather compressed, with entire beak and numerous faint nerves; stigmas two.

This species stands near *C. colensoi.*

Hab. A hill near Mount Aspiring, 5,000 feet.

Carex kaloides, n.s.

A tall, slender, cæspitose species; culms drooping, two feet or more, sparingly leafy at the base, rounded, smooth; leaves shorter than culm, narrow, flat or involute, deeply grooved, slightly scabrid at the edges, most tenacious; spikelets 9–12, lower compound distant, upper approximate, arranged on alternate sides of the long (3–5 inches) scabrid rachis; lowest bract setaceous, very long; male flowers at the top few, sometimes wanting, female flowers below; glumes linear-lanceolate, scarious, 1–3-nerved, the nerves produced into a slender awn; utricle linear-lanceolate, plano-convex, ending in a tapering two-winged bifid beak, the wings finely serrate; stigmas two, short.

A very distinct species. The leaves have an exceedingly strong fibre.

Hab. Carrick range, Otago, 4,000 feet; Deep Stream, Otago, 1,000 feet.

Carex viridis, n.s.

A slender tufted species; culms erect, 6–12 inches, grooved, smooth; leaves sheathing at the base, narrow, concave, smooth, shorter than the culm; spikelets 6–9, few-flowered, crowded into a compound spike about one inch long, and arranged alternately on the flattened rachis; bracts glume-like, scarious, linear-lanceolate, 1–3-nerved, the nerves produced into a slender awn; male flowers above few and wanting in many spikelets, female below; glumes linear-lanceolate, pale, membranous, acuminate, one-nerved; utricle linear-lanceolate, nerved, plano-convex; beak long, very narrow, tapering, 2-dentate, with two finely serrated wings; stigmas two.

This species is close to *C. kaloides*, described above. Its stouter leaves, small habit, and short compact head of spikelets, at once distinguish it.

Hab. Rough Ridge, 3,000 feet; Nevis Stream, Otago, 2,000 feet.

Art. XLII.—*On the Genus* Corallospartium.

By J. B. Armstrong.

[*Read before the Philosophical Institute of Canterbury, 5th August,* 1880.]

The singular Papilionaceous plant known to the settlers of Canterbury as the coral broom, was included by Sir Joseph Hooker in Brown's genus *Carmichælia*, and described as *Carmichælia crassicaulis* in his "Handbook of the New Zealand Flora." Even prior to the publication of the handbook however, I had always doubted whether the plant was really referable to that genus, and often since that time the doubt has recurred to me. I have therefore been induced to go fully into the matter whilst arranging the species of *Carmichælia* for my work on the New Zealand flora, and having examined an extensive series of specimens in the hope of being able to come to some definite conclusion, I have now decided to separate the plant from that genus, and to adopt for it the name *Corallospartium*, as the pods and flowers seem to me to present as good distinctive characters as many other accepted genera. Our new genus comes nearest *Carmichælia*, from which it is readily distinguished by the compressed one-seeded pod, splitting into two valves, and the fascicled woolly flowers. As far as I have been able to ascertain, the genus is in no way related to any non-New Zealand genus; it may be described as follows:—

Corallospartium crassicaule, Armstrong.

Carmichælia crassicaulis, Hk. f.

A straggling, erect, or sub-erect or decumbent shrub 18 inches to 3 feet high, rarely more. The branches and branchlets are dark green, and densely pubescent when young, glabrous and straw-coloured when old, obtuse, very stout, $\frac{1}{3}$–1 inch broad, terete below, much compressed above, deeply channelled in parallel lines. The leaves are trifoliate or quinquifoliate ; the leaflets linear, oblong, or oblong-obtuse, shortly stalked, pubescent, $\frac{1}{4}$–$\frac{1}{2}$ inch long, very often altogether absent. The flowers are $\frac{1}{4}$–$\frac{1}{3}$ inch long, arranged in dense, globose, axillary fascicles which contain 10–20 flowers. The pedicels are about $\frac{1}{8}$ inch long, slender, densely-clothed with soft grey hairs. The calyx is campanulate or cylindrical, $\frac{1}{6}$ inch long, densely woolly, obscurely two-lipped, with two short subacute teeth in the upper lip, and three similar teeth in the lower lip. The standard is broadly orbicular or oblong, $\frac{1}{3}$ inch diameter, much reflexed. The wings are narrow and much shorter than the keel, oblong, auricled at the base and turned upwards.

The keel is nearly $\frac{1}{2}$ an inch long, oblong, obtuse, and turned upwards at the point. The stamens are 8–10 in number, the filaments extremely slender, the upper stamen free, the others united into a tube from above the middle and sheathing the ovary. The style 1, much stouter than the stamens, woolly at the base with the point turned upwards. Both the style and the stamens are enclosed in the folds of the keel. The bracteoles are minute, woolly. The pod is about $\frac{1}{4}$–$\frac{1}{3}$ inch long, deltoid or triangular in outline, splitting into two valves, much compressed, one-seeded, coriaceous, with the surface distinctly reticulated, prolonged above into a broad rounded wing, below into a short, sharp, straight beak. The seed is oblong-reniform, dark brown, $\frac{1}{8}$ inch long, with a slightly thickened funicle, and double flexured radicle. Ovary villous with white hairs.

Hab.—The *Corallospartium* is found in numerous localities in the alps of Nelson, Canterbury, and Otago, at altitudes varying from 2,000 to 5,000 feet, but is most common in the Canterbury Provincial District at about 3,000 feet. It is nowhere very abundant, and is rarely found in fruit. I think it is very probable that other species of this genus will be discovered, as there are doubtless very many new plants yet to be found in the South Island.

None of the numerous specimens examined show any important variations, and it appears that the New Zealand species of Papilionaceæ are generally much less variable than any other order of the same extent. The difficulties experienced by students of the genus *Carmichælia* arise more from the sameness of the species when dried than from any great tendency to vary. I have carefully examined large numbers of Australian Papilionaceous plants, but have found none of them in any way resembling this either in flowers or pods, and indeed it seems very certain that there is but a very slight relationship between the Australian and New Zealand Leguminous plants. Indeed the connections between the floras of New Zealand and Australia have been very much exaggerated by all the writers who have yet paid attention to the subject.

Art. XLIII.—*Descriptions of new and rare New Zealand Plants.*
By J. B. Armstrong.

[*Read before the Philosophical Institute of Canterbury, 1st July,* 1880.]

Clematis marata, J.B.A.

A climbing shrub, evergreen, rarely deciduous. *Branches* extremely slender, forming dense interlaced masses among scrub or grass, hairy or pubescent. *Branchlets* extremely slender, dark brownish-green, channelled, clothed with appressed, rather scattered, white hairs. *Leaves* dark brown in colour, opposite, trifoliate, 1 inch long, on long pubescent or hairy channelled petioles 2–4 inches long; *leaflets* ½–1 inch long, ⅛–¼ inch wide, narrow-linear, obtuse, pubescent or pilose, simple or three-lobed, or obscurely crenate; *veins* very obscure. *Flowers* sweet-scented, very numerous, greenish-yellow, ½–1 inch diameter. *Peduncles* very silky, one-flowered, 1–3 inches long, arranged in axillary fascicles, each with four small, hairy, lobulate or entire, sessile, foliaceous bracts, ½–1 inch long, ⅛–¼ wide. *Sepals* four, linear-oblong, obtuse; *outside* covered with dense silky hairs, and ciliated; *inside* puberulous, distinctly veined, revolute at the tips. *Petals* 0. *Stamens* 12–20, in several series, the two inner series shorter and less perfect than the others. *Anthers* short narrow, oblong, not tailed. *Carpels* 10–20. *Achenes* silky, the styles elongated into feathery white awns.

Hab.—Canterbury and Nelson; common.—*J.B.A.* A very distinct little species, readily recognized by its small size and narrow leaflets.

Ranunculus subscaposus, Hk.f., var. *canterburiensis.*

A small alpine one-flowered herb a few inches high. *Roots* fibrous. *Stem* very short, erect. *Leaves* all radical, united by the sheathing bases of their petioles. *Petioles* very slender, 2–4 inches long, with remarkably broad sheaths, glabrous except a few scattered white hairs. *Blade* about ½ an inch long, broadly cuneate, 2–5-lobed, glabrous, coriaceous, lobes not incised. *Scape* one-flowered, sunk among the bases of the leaves, less than 1 inch high, erect, clothed with long, shaggy, white hairs. *Flower* ½–1 inch diameter, bright yellow. *Sepals* 5, oblong, obtuse, membranous, spreading, as long as the petals. *Petals* 5, oblong, obtuse, with 1–2 much-depressed glands near the base. *Stamens* very short. *Achenes* not seen.

Hab.—Upper Rangitata.—*Mr. J. F. Armstrong.* A curious little plant, differing from *R. subscaposus* in the erect habit, almost glabrous, less deeply-divided leaves, and the lobes not incised, also in the much larger leaf sheaths and slender petioles. The leaves are much smaller and more coriaceous, much less hispid and different in form. I have very little doubt but this will turn out to be a distinct species when more specimens are obtainable.

Carmichælia gracilis, n.sp.

A climbing or twining shrub with very slender twiggy branches 5–6 feet long, climbing among bushes. *Branches* glabrous or very minutely pubescent, striated, terete, naked and simple below, much branched above and leafy; *branchlets* extremely slender. *Leaves* numerous for the genus, trifoliate, shortly stalked. *Leaflets* broadly obcordate, $\frac{1}{4}$–$\frac{1}{2}$ inch long; the terminal one always the largest, undulated on the margins, sometimes obscurely serrate or crenate, bright green above, whitish below. *Veins* very finely reticulated. *Flowers* $\frac{1}{4}$–$\frac{1}{2}$ inch long in 2–8-flowered, loose, lateral, erect racemes. *Pedicels* extremely slender, straight, $\frac{1}{3}$ inch long, covered with minute glandular pubescence, each with a very short, narrow-linear ciliated bract at its base. *Calyx* densely minutely pubescent. *Teeth* acuminate, ciliated, the two lower the smallest. *Corolla* white and purple. *Standard* broadly orbicular, longer than the wings. *Keel* deeply incurved. *Stamens* and *style* as in the genus. *Ovary* slightly silky. *Pod* very coriaceous, nearly half an inch long with a broad replum, wrinkled valves, and a curved awl-shaped beak $\frac{1}{5}$ inch long. *Seeds* dark brown, mottled with white.

Hab.—Site of the city of Christchurch, formerly common but now extinct. My specimens were collected sixteen years ago. It is a very pretty plant when fresh, easily distinguished from the other species of the genus by its slender twining habit, trifoliate leaves, pubescent calyx and small bracts.

Aciphylla crenulata, J.B.A.

A glabrous herb 2 feet or so high. *Radical leaves* few, 4–10 inches long, pinnate, with broad sheathing petioles. *Leaflets* in 2–3 pairs, 3–4 in. long, $\frac{1}{4}$ wide, linear, pungent at the tips, perfectly glabrous, very finely crenulate. *Midrib* strong, bright red when fresh, other veins obsolete. *Panicle* 18 inches long, oblong, loose-flowered. *Floral leaves* very numerous, flaccid, sheaths broad and membranous. *Leaflets* three, the two lower very small, narrow-linear, the upper one 3–6 inches long, linear, pungent. *Umbels* rising from the leaf-sheaths, simple or compound, on extremely slender stalks 1–3 inches long. *Involucral leaves* numerous, $\frac{1}{8}$–$\frac{1}{4}$ inch long, very narrow-linear and membranous. Flowers and fruit imperfect in my specimens.—"New Zealand Country Journal."

Hab.—Sources of Rakaia and Waimakariri.—*J.B.A.* This is a beautiful plant when fresh, with red midribs which give it a somewhat striking appearance. It is more flaccid than any other species, and seems sufficiently distinct from any previously described, being however somewhat intermediate in character between *A. lyallii* and *A. monroi.*

Stilbocarpa lyallii, Armstrong.

A number of living plants of the Stewart Island form of *Stilbocarpa* were presented to the Christchurch Botanic Gardens by the Rev. Mr. Stack, who collected them. Having cultivated them for two or three years, I now feel satisfied that they are specifically distinct from the Auckland Island *S. polaris*, Planch., which has been cultivated in the garden for many years, and which flowered freely three years ago. I therefore propose to distinguish the Stewart Island plant as *S. lyallii*, in honour of Dr. Lyall, who first collected it. Unfortunately I have not been able to obtain flowers or fruit, but there is no doubt as to the genus. The leaves of *S. lyallii* are reniform, 4–8 inches across or more, with a closed—not open—sinus, rather bluntly bi-serrate, not coarsely lobed, perfectly glabrous, polished and shining above, wanting the stout bristles of *S. polaris*, below dull, with a few scattered white hairs. The petiole is truly terete, striated and clothed with soft white hairs, not flattened and deeply channelled as in *S. polaris*. In *S. polaris* the upper surface of the leaves is ribbed, or much wrinkled, but quite smooth in my plant, which is also by far the handsomer of the two, although the black shiny fruit of *S. polaris* is very ornamental.

Olearia angustata, Armstrong.

I find that this plant has been described by Mr. Kirk as *O. oleifolia*.* My name however, has several years priority, having been used in gardens for the past ten years. The plant was first collected by Messrs. J. F. Armstrong and W. Gray in their exploring tour in the upper Rangitata valley in the year 1869.

I have another new species of *Olearia* from Stewart Island, collected by the Rev. Mr. Stack. It bears considerable resemblance to *O. nitida* in the foliage, but the leaves are cordate, entire, and larger than in that species. It has not yet flowered. Another species of the same genus, brought from the Tararua mountains by Mr. H. Budding, may also be new. It was sent as *O. lacunosa*, but differs from that plant in the leaves being much narrower, longer, less distinctly lacunose, more deeply revolute, nearly glabrous above, and in the strong white midribs. It has not flowered with us. The true *O. lacunosa* was first collected by Mr. J. F. Armstrong, in 1865, in Canterbury.

Celmisia linearis, n.sp.

A small, perennial, tufted, aggregated herb. *Stem* erect, simple or branched, covered with the sheathing bases of old leaves, very stout for the size of the plant. *Leaves* densely imbricated, 2–3 inches long, $\frac{1}{5}$ to $\frac{1}{4}$ broad, linear, sub-acute, coriaceous, not rigid, covered above with persistent pellicles of appressed silvery hairs; below with silvery white glistening tomentum, which becomes brown with age. Convex by the recurvature of the margins. *Midrib* sunken above, keeled below; *sheaths* often 1 inch long, broad and

* "Trans. N. Z. Inst.," Vol. XI., p. 463.

membranous; *scapes* one-flowered, 6–8 inches high, clothed with loose white tomentum, rather stout. *Bracts* 4–6, very narrow-linear, 1 inch long, acute, convex, with a long sheath covered with matted cottony hairs. *Heads* 1–1½ inch diameter. *Involucral scales* numerous, in 2–3 rows, ½–¾ inch long, very narrow-linear, densely woolly, with glabrous subulate tips. *Ray-florets* numerous, 1 inch long, narrow, white. *Disc* yellow, glabrous. *Pappus* ¼ inch long. *Achenes* hispidulous.

Hab.—Canterbury Provincial District, 2,500–4,000 feet, forming broad patches among grass.—*J.B.A.*, first collected in 1866. In most colonial herbariums two plants are confounded under Hooker's name of *C. monroi*, the above and the true *C. monroi*, which has much larger leaves deeply furrowed in parallel lines, and larger flowers with glabrous achenes, and fewer stouter bracts.

Brachycome simplicifolia, n.sp.

A small, tufted, branching, perennial herb, 3–4 inches high, stout and leafy. *Radical leaves* 2–3 inches long, linear-spathulate or linear, obscurely three-nerved, obtuse, with broad membranous sheathing petioles and revolute margins; quite entire, except the sheaths which are somewhat shaggy, glandular-pubescent, or glabrous. *Scapes* 1–3 inches high, pubescent, 1–2-flowered, striated or channelled. *Cauline leaves* or *bracts* few, 1 inch long, linear-spathulate, obtuse, sub-amplexicaul, glandular-pubescent, more distinctly nerved than the leaves. *Heads* ½ an inch in diameter. *Involucral scales* 12–16, in one series, or with a second outer series of 2–3 scales only, linear-lanceolate, or oblong, acute, distinctly three-nerved, coriaceous, appressed, with purplish membranous margins. *Ray-florets* short, oblong, obtuse, few or absent, white. *Disc-florets* tubular, 3–5 toothed. *Pappus* entirely absent. *Achene* compressed, $\frac{1}{10}$ inch long, glandular-pubescent, thickened at the tip. *Receptacle* very narrow, convex, papillose.

Hab.—Nelson Provincial District, *Mr. C. W. Jennings.* Marlborough Provincial District (1869).—*J.B.A.*

Erechtites pumila, J.B.A.

A small slender herb 2–4 inches high, simple or sparingly branched, annual. *Radical leaves* few, ⅙–⅓ inch long, petiolate, ciliate, puberulous or glabrous, spathulate or oblong, obtuse, coarsely toothed or lobulate or entire. *Veins* obsolete. *Scape* extremely slender, hairy or scabrid, with a single terminal head. *Bracts* 4–6, linear, sessile, sub-amplexicaul, hairy, obtuse or acute, lobulate or entire, the upper two with dark brown dilated tips. *Heads* ⅓ inch long, ¼ inch wide. *Involucral scales* 8–10, linear, delicately membranous, green with white margins, nearly glabrous; some with acute, crimson points, others with blackish dilated tips, in one series, with a few pubescent brown-tipped bracteoles at the base, representing a second series. *Pappus hairs* numerous, slender, very soft. *Achenes* few, $\frac{1}{12}$ inch long, linear, hispid, slender, indistinctly grooved, not angled, with a short discoid top.

Hab.—McKenzie Country.—*Mr. J. F. Armstrong*, December, 1877.

A singular little plant, differing from all other New Zealand species of the genus in its diminutive size and annual character, also in the solitary heads.

Senecio buchanani, J.B.A.

A small dense-growing shrub about 3 feet high; the branches, petioles and leaves below, entirely covered with closely-appressed light brown tomentum. *Petioles* about 1 inch long, tomentose. *Leaves* ovate or obovate or oblong, obtuse or sub-acute, entire, thickly coriaceous, 1–2 inches long; when young covered on both surfaces with brown tomentum; when old glabrous above. *Veins* distinctly reticulated, often of a silvery white colour. *Heads* oblong or obconic, yellow, $\frac{1}{4}$–$\frac{1}{2}$ inch diameter, situated on the branches of a terminal or lateral, tomentose, leafy panicle, which is about 4 inches long and contains 6–10 heads. *Peduncles* leafy, simple or forked, bracteate, tomentose. *Involucral* scales, in one row, very thick, and purple at the tips, covered on the outside with white cottony hairs. *Ray* absent. *Anthers* thickened at the tips. *Pappus hairs* white, thickened upwards, slender, scabrid. *Achene* grooved, glabrous. *Receptacle* pitted.—"New Zealand Country Journal," Vol. III., p. 56.

Hab.—Mount Egmont, Arthur's Pass, Kaikoura, and in Otago. I have no hesitation in pronouncing this plant to be quite distinct from any other *Senecio*, although it appears to have been confounded with *S. elæagnifolius* by Sir J. D. Hooker and other New Zealand authors.

Senecio stewartiæ, n.sp.

Among a number of living plants brought from Stewart Island by the Rev. Mr. Stack, and kindly presented by him to the Christchurch Botanic Garden, I find a fine new *Senecio* which has not yet flowered, but will probably prove quite distinct. I propose to attach the above name to it provisionally, until I am able to furnish a better description. It has the habit of *S. huntii*, F. Müeller, but is a much smaller plant. The leaves are about three inches long, linear-lanceolate, narrower than in *S. huntii*, more sharply acute, very obscurely serrated, without the obscure ribs of that species, more finely reticulated above, and below wholly covered with loose white tomentum, quite different from the grey, closely appressed tomentum of *S. huntii*. The leaves above are densely glandular dotted, in the young state pubescent and viscid, glabrous and shining when old. The leaf scars are larger and darker coloured than in *S. huntii*. If this should prove to be a mere variety of the Chatham Island plant, it will add another to the already numerous links connecting the flora of those islands with the southern islets.

Myosotis capitata, Hk.f., var. *albiflora.*

Stouter than in the type. *Leaves* linear-spathulate, thick and somewhat fleshy, hispid with white hairs 4–6 inches long. *Flowers* in dense scorpioid racemes, several of which are united into a many-flowered head, flowers pure white, shortly pedicelled. *Calyx* five-lobed below the middle. Other characters as in the type.

Hab.—Stewart Island.—*Rev. Mr. Stack.* This is a very beautiful variety, with the flowers of a different colour from the mainland plant, and the foliage larger and more fleshy. Unfortunately it is very difficult to cultivate, showing a remarkable impatience of confinement.

Gentiana hookeri, J.B.A.

A dark green perennial herb, sending up numerous sub-decumbent branches. *Roots* fibrous. *Stem* very short. *Radical leaves* numerous, crowded, petiolate, spathulate or linear-spathulate in outline. *Petiole* 2–3 inches long, pubescent, slender, channelled with a broad clasping base. *Blade* 1–2 inches long, flaccid, membranous, obtuse, entire or rarely obscurely crenate, minutely pubescent on both surfaces, gradually narrowed into the petiole. *Midrib* evident, remaining veins obsolete or nearly so, when present parallel to the midrib. *Cauline leaves* numerous, opposite, of two kinds, the lower as in the radical leaves but smaller, the upper sessile, linear, acute, 1 inch long. *Flowers* numerous, white and yellow, $\frac{1}{2}$ to 1 inch diameter. *Peduncles* 2–4 inches long, slender, striated or slightly winged, one-flowered. *Calyx* cleft almost to the base into five narrow, acuminate teeth. *Corolla* five-cleft to below the middle, white or yellow, with faint blue veins; lobes sub-acute. *Fruit* not seen.

Hab.—Canterbury and Otago Provincial Districts, common at considerable elevations.—*J.B.A.*; Stewart Island.—*Rev. Mr. Stack.*

Gentiana saxosa var. γ, Hk.f. ?

A beautiful plant, at once distinguished from the other New Zealand species by its flaccid habit and deeply cut calyx. Its nearest relative is *G. novæ-zealandiæ*, Armstrong.

Nat. Order Scrophularineæ.

Siphonidium, nov. gen.

Leaves opposite. *Flowers* hermaphrodite. *Calyx* campanulate, deeply four-toothed, much wrinkled when dry; *teeth* with narrow acuminate points. *Corolla* funnel-shaped with an extremely slender curved tube 3 inches long, dilated upwards, swollen or slightly spurred about three-fourths of the way up at the commencement of the broadest part; *throat* campanulate; *limb* two-lipped; *upper lip* of one narrow, erect or sub-erect, concave lobe; *lower lip* of three nearly equal, spreading, rounded lobes, throat not tumid, but having a few scattered hairs. *Stamens* four, didynamous, inserted on the throat, included, the two lower the longest. *Anthers* two-celled, introrse. *Style* extremely slender, a little longer than the stamens, with a two-lobed stigma. *Ovary* superior. *Capsule* two-celled, loculicidal? included within the calyx. *Seeds* minute. (Capsule immature.)

This genus is allied to *Euphrasia*, from which it differs in the long curved gibbous tube and bi-lobed stigma. It also approaches the South American genus *Gerardia*, and in some characters the South African *Lyperia*.

Siphonidium longiflorum, n.sp.

A small creeping or trailing herb. *Branches* clothed with scattered spreading hairs. *Leaves* opposite, $\frac{1}{4}$ inch long, entire, linear-lanceolate, rarely ovate, acuminate, obscurely three-nerved, pubescent or glabrous, shortly petiolate. *Flowers* solitary, axillary, very shortly peduncled, not bracteate. *Corolla* pubescent, pale blue (?) with darker veins.

Hab.—Karamea, west coast of Nelson.—*Mr. Spencer.*

Some allowance must be made for the above description, as many more specimens are wanted to furnish a good diagnosis. I have seen only one perfect flower.

Grammitis pumila, n.sp.

A very small species, less than 1 inch high. *Rhizome* seldom more than 1 inch long, creeping, epigeous, comparatively very stout, covered with membranous imbricating scales, and sending down slender hair-like fibres.

Fronds erect, $\frac{1}{2}$–$\frac{3}{4}$ inch long, simple, entire or irregularly toothed near the base, almost sessile, linear-cuneate or cuneate-oblong, rarely spathulate, obliquely truncate at the tip, crowded, glabrous above, below clothed with minute greyish or brownish pubescence, margins never recurved. *Costa* distinctly keeled below, remaining veins very obscure. *Veinlets* free. *Sori* naked, irregular in outline, rounded or oblong, usually only one on a frond, sometimes two, in which case they are confluent, situated on the uppermost veinlet near the apex of the frond, almost terminal, composed of numerous long-stalked sporangia.

Hab.—Canterbury and Otago Provincial Districts, first collected by *Mr. J. F. Armstrong* in 1865, at 3–6,000 feet altitude.

A remarkable little fern, quite distinct from *G. australis*, H.B., readily distinguished by its diminutive size, sub-terminal, solitary sori, pubescent costa, and obscure veins. The fronds are also invariably uniserial, whilst those of *G. australis* are generally tufted. It is truly alpine, and is an exceedingly interesting little fern.

Ophioglossum minimum, J.B.A.

Rhizome creeping underground, and throwing up fascicles of fronds. *Stipes* 2–3 inches long, slender, hypogeous, often or perhaps always jointed to the rhizome. *Barren* and *fertile fronds* sometimes quite distinct. *Barren* $\frac{1}{2}$–1 inch long ovate, acute, closely appressed to the ground, usually in pairs on the same stipes, with one *fertile* rising between them, but often solitary, in which case the fertile rises from the stipes as in other species of the genus. *Costa* 0. *Veins* obsolete or faintly reticulated. Fertile frond less than one inch high, spike-like, very narrow, with 10–24 capsules in two rows.

Hab.—Canterbury plains, near Christchurch ; rare. This very rare little plant differs from all other species of the genus in its widely creeping rhizome. Its nearest ally is the South African *O. bergerianum*. I am indebted to Mr. Brown, of Christchurch, an old Scotch botanist and an excellent cryptogamist, for pointing out to me the peculiarities of this plant, which was first found in the Christchurch Botanic Garden. It is quite distinct from *O. vulgatum* var. *minimum*.

Donatia novæ-zealandiæ, Hk.f.

Dracophyllum muscoides, Hk.f.

On the herbarium sheet of *Donatia* in the Canterbury Museum, there is written a note to the effect that I referred the plant to *Dracophyllum muscoides*, and that the latter plant is confined to Otago. The plant I referred to Hooker's *Dracophyllum muscoides*, is undoubtedly the true plant of that author, and is found in many localities in the Canterbury and Nelson Provincial Districts. I append an amended description of both plants.

Dracophyllum muscoides, Hk.f. Very small, *stems* and main *branches* creeping under ground, stout for the size of the plant, woody. *Branchlets* erect or spreading, forming dense tufted masses. *Leaves* $\frac{1}{10}$–$\frac{1}{8}$ inch long, linear-oblong, densely imbricated, subulate, obtuse, or subacute, coriaceous, ciliate, with broad sheathing bases, greyish when dry. *Flowers* solitary or in pairs, terminal or subterminal, $\frac{1}{8}$ inch long. *Sepals* linear-ovate, acute. *Corolla* pubescent, white, the lobes scarcely spreading. *Capsule* not seen.

Hab.—Rangitata and Ashburton Valleys.—*J. F. Armstrong*. Various places in the Alps.—*J.B.A.*

Donatia novæ-zealandiæ, Hk.f. A small dense-growing plant, forming broad rigid patches in alpine swamps. *Branches* 2–3 inches long or less, $\frac{1}{2}$ an inch diameter (including the leaves), densely clothed with closely imbricated, rigidly coriaceous leaves. *Lower leaves* reddish brown, hidden by the *upper*, which are bright green, $\frac{1}{4}$–$\frac{1}{2}$ an inch long, suberect, linear-subulate, obtuse, nerveless, punctate or pitted, woolly at the bases. *Flowers* terminal, sunk among the uppermost leaves. *Calyx* obconic, adnate. *Lobes* five, unequal, acute. *Petals* five, white, ovate-oblong, obtuse, $\frac{1}{8}$ inch long. *Stamens* two. *Ovary* two-celled, inferior. *Styles* two. *Capsule* longer than the calyx, coriaceous, dehiscing near the top by the falling away of the summit. *Seeds* very minute, numerous, ovoid-oblong.

Hab.—Throughout the South Island abundant in alpine swamps from 2,000–6,000 feet altitude.

This plant is very closely allied to *Helophyllum*, and perhaps should be united with that genus. It may not be congeneric with the Fuegian plant on which *Donatia* was originally founded by Forster.

Art. XLIV.—*On the Occurrence of the Morel* (Morchella esculenta, *Pl.*) *in New Zealand.* By J. B. Armstrong.

[*Read before the Philosophical Institute of Canterbury, 2nd September*, 1880.]

The object of this short paper is to place on record the discovery in New Zealand of the well-known European edible fungus, popularly known as the morel, and called by botanists *Morchella esculenta*, Pers. About three years ago a number of specimens of this plant were found growing in the Christchurch Botanic Garden, under the shade of some large trees of *Eucalyptus globulus*, Lmk. At first we supposed the plant to be a recent introduction, but as so many other European fungi are found in New Zealand, and as the morel occurs in Australia and in nearly all other countries, I now feel satisfied that we may look upon it as indigenous to our colony. The morel belongs to the sub-order Ascomycetes and to the tribe Elvellacei, and is described by Berkeley as follows :—

Gen. Morchella, *Dillenius.*

Receptacle clavate or pileate, impervious in the centre, stipitate, covered with the hymenium which is deeply folded and pitted.

M. esculenta, Persoon.

Pileus ovate, conical or sub-cylindrical, adnate at the base, ribs firm, anastomosing and forming deep pits, stem even.

In woods and gardens, esculent, varying much in breadth and height, sometimes almost cylindrical.

British specimens are often 4 or 5 inches high, but all the New Zealand specimens I have yet seen were considerably smaller ; their diminutive size, however, may have been owing to the poverty of the soil in which they were grown. The colour of our specimens was a dull brown, whilst European ones are described as olive-coloured. In the arrangement published in

Hooker's "Handbook of the New Zealand Flora," *Morchella* should precede *Leotia.* I think that it is very likely that other species of *Morchella* will eventually be found in this colony.

In Germany and France the morel is much used as an esculent when fresh, and in the dried state is used for flavouring gravies, etc. It has also been used for making catsup, for which purpose it is considered superior to the common mushroom. In the forest districts of Germany the morel comes up abundantly after fires, and the collection of these plants was formerly so profitable that the country people are said to have set fire to the forests in order to hasten the production of these esculents. Whether the collection of morels will ever be profitable in New Zealand remains to be seen; but I trust that it will not be necessary to set fire to our beautiful native forests in order to obtain them.

Art. XLV.—*A Synopsis of the New Zealand Species of* Veronica, *Linn., with Notes on new Species.* By J. B. Armstrong.

[*Read before the Philosophical Institute of Canterbury, 5th August,* 1880.]

Abstract.

Introductory.—The genus *Veronica* is by far the largest New Zealand family of flowering plants, and excepting *Coprosma* (of which I am also drawing up a conspectus) it is also by far the most difficult. Although found in many countries the genus is nowhere else so abundant as in New Zealand, and in no other country does it possess so many large shrubby forms, or enter so largely into the composition of the floral scenery. Indeed I may truly say that if we had only this genus, our flora would be very far from devoid of interest and variety, so different in appearance are many of the various forms which the genus assumes.

Anyone exploring the mountains of these islands cannot fail to be impressed by the remarkable characters assumed by these plants. They abound in all situations; on the lower grassy slopes, in the beds of the numerous mountain torrents, on the steep shingly slopes of the higher peaks, and even on the most barren-looking rocks, these hardy *Veronicas* will be found struggling to maintain an existence and to beautify the scene. Many of them are indeed most beautiful plants; from the tiny *V. canescens*, a little trailing plant forming matted patches less than one inch high, to the stately *V. arborea* with a trunk three feet in diameter, there is not one but is worthy of the most careful cultivation.

Although so many fine hardy shrubs have been introduced into our gardens from Japan and other countries, none of them are equal to very many of our native *Veronicas*, and it is to be hoped that these will in the future receive the attention they so justly merit at our hands as the finest known group of hardy shrubs, and that the foolish prejudice which now prevails among amateur horticulturists against all native plants will soon be given up. I have been induced to draw up the following synopsis of the New Zealand species because, having had such excellent opportunities of studying the species in the living state in the Christchurch Botanic Garden, where my father has succeeded in forming the largest existing living collection of species belonging to this genus, I have probably been able to give more careful attention to the subject than any other New Zealand botanist. It must not, however, be supposed that my synopsis is drawn up from cultivated plants alone. On the contrary, I have examined no fewer than 4,000 or 5,000 dried specimens, from all parts of the colony, and their characters have been noted down and compared with those of the living plants, and with Sir Joseph Hooker's excellent descriptions in the "Handbook of the N.Z. Flora;" and again in my numerous botanical exploring journeys I have had ample opportunities for examining the living plants of very many of the species in the wild state.

By following this course I have been able to detect several errors in the nomenclature usually adopted in gardens and museums.

In such a genus as this, however, where so much depends on habit, etc., dried specimens are often misleading, and consequently I have found our collection of living plants of the very greatest service, and indeed I should not have attempted to form this conspectus without it. It is a matter for regret that so little attention is given to living plants by botanists, as in many cases, more especially in New Zealand plants, descriptions drawn up from dried specimens very often fail to agree with the same plant in the fresh state. It must be admitted that whenever possible living plants should be studied in preference to dried ones by all persons attempting to write on the flora of a country. In a work which I have in preparation, entitled a "Manual of New Zealand Botany," I am attempting to carry out this idea, with what amount of success will I trust be seen in the future.

The cause of the difficulty experienced in studying the New Zealand species of this genus is to be found in their extreme variableness. There is not a single character which does not vary greatly in some one or other of the species, and in many of them the whole of the parts are subject to constant variation. It is not, however, pretended that *Veronica* is the only variable New Zealand genus; on the contrary, there is not in the colony a single genus of any magnitude which does not vary greatly, but in none is there the extreme variability to be found in these *Veronicas*. In drawing up the synopsis, I have found it in many cases extremely difficult to give diagnoses embracing all the forms of the species, and consequently in these cases the description must be looked upon as representing only the most common form of the species. But the species are not all so variable—many of them are very distinct. It is chiefly in sections 2, 4, 5, 6, and 7 of subgenus II. that these variable forms are to be found. The most difficult forms will be found pointed out in the notes attached to the specific characters which I have made as complete as my materials admitted.*

The question as to what is the cause of the great variations of these plants is perhaps a difficult one to answer, and offers a very wide field for future investigation. It has been suggested that the numerous so-called intermediate forms are the results of natural hybridization, and that many of our so-called "species" are not true species but natural hybrids. But, without going into the vexed question of what constitutes a "species," I feel perfectly satisfied that the hybridism theory is quite untenable. We now know that self-fertile plants are by far the most abundant, and exhibit the greatest amount of endurance and greatest range of temperature; that, in fact, plants capable of self-fertilization are those most fitted to survive in the struggle for existence, as indeed we may see amply illustrated in the naturalization of European plants in this colony, the said introduced plants being nearly all self-fertile. Now when a plant contains within its own flower all the required elements for the reproduction of its kind, it is surely extremely improbable that it will cross with any other plant, no matter how closely allied the latter may be; and such crosses have been found by all investigators to be exceedingly rare, although, of course, they cannot be said to be impossible. Now I have ascertained, by careful experiments, that the great majority of the New Zealand species of *Veronica*, including all the variable ones, are perfectly self-fertile, that is, that the pollen of any one flower is active when applied to the stigma of the same flower, and that when the species are left in a state of nature the pollen is so applied by the natural arrangement of the parts. In most cases, indeed, it is scarcely possible for the corolla to shrivel without bringing the anthers in contact with the stigma. Thus although hybridization is perfectly possible, it must be considered as extremely improbable, and certainly it does not account for many of the phenomena shown in the genus. Moreover the varieties do not show the usual characteristics of hybrids except in their being in so many cases exactly intermediate. Hybrids raised in gardens are usually sterile, and when fertile their seedlings show a remarkable amount of variation, as

* It has only been possible to print the description of the author's new species.—Ed.

may be seen in the numerous varieties of the rose, the pelargonium, the gladiolus, and other florist's flowers which have been produced by the inter-crossing of allied species. In all these florist-flowers—the results of artificial hybridization—immense numbers of seedlings are raised every year, and I have been assured by experienced cultivators, and indeed I have myself observed, that very rarely indeed does it happen that any two of these seedlings are exactly alike.

But with our *Veronicas* the case is different. I have been enabled to observe numerous garden-seedlings of many of the forms, and they almost invariably resemble their parents. Sometimes, however, sports appear, and when this happens there seems to be a strong tendency on the part of the sport to reproduce itself, and it appears to me that it is just in this manner that the greater number of our native forms have been produced.

At some very distant date there were probably only two or three, perhaps only one, species existing within the limits of the colony; but, on account of the extreme local variations of climate and varied geological formation of surface, certain variations occurred, and the sport so produced, being self-fertile, and having within itself all the elements required for reproduction, naturally reproduced its like until another such sport occurred, and thus the forms gradually became differentiated from the type, and by a long series of such sports our large family of *Veronicas* has been formed.

I think that this theory, coupled in some cases (as in diœcious plants) with the theory of natural hybridization, will be found to apply to all large variable genera in all countries, but that in those countries which have been long inhabited by man or the larger animals the intermediate forms will be found to have been exterminated through their agency, leaving only in most cases the more widely differentiated forms.

In New Zealand, however, and particularly in the South island, where the natural features of the country had not been very materially altered by the agency of man up to the period of European colonization, very many of the intermediate forms have been preserved. The remarkably rapid destruction of our native forests, and the alteration of the features of the country brought about by European colonists, is but the reflex of what has happened in other lands, and it behoves the colonists of the present time to record carefully all the information obtainable as to the introduction and naturalization of exotic plants, and their variations under the influence of our climate, and also to carefully collect and examine all the existing forms of endemic plants before the ever-recurring changes render them extinct. I am of course aware that this theory will be strongly objected to, and I wish it to be understood that I am not in any way wedded to it, but in my opinion no other theory yet propounded so well accounts for the phenomena shown in *Veronica* and other variable genera. I have therefore been induced to accept it until some better one is proposed.

It may be mentioned as corroborative of this theory that many cultivated plants exhibit in this colony a remarkable tendency to produce sports, and that these sports in very many cases reproduce themselves. The same tendency also occurs in many naturalized plants, the great majority of which are self-fertile. My space, however, does not admit of any further reference to this interesting subject, but I hope to return to it at some future time.

Since my ideas on this subject were first written out, my attention has been called to a paper on the same subject by Mr. W. T. L. Travers.* The conclusions arrived at by that author are almost precisely similar to my own, but are probably much better expressed.

In this synopsis sixty species are included, being eighteen more than were included in Sir J. D. Hooker's "Handbook." These are, however, not all new discoveries, four or five of them being separations from species with which they had previously been confounded.

On the distribution of the species it is scarcely possible in the present state of our knowledge to give any precise information, as the flora of several of the districts has not yet been properly worked up. It, however, seems certain that the South Island has many more species of *Veronica* than the North Island, and that the Canterbury and Otago districts have more than any other part of the colony. Lists of species have been published of the Auckland, Wellington, Canterbury, and Otago districts only; of these Canterbury is the richest in species, having 46, whilst Otago has 35 or 36, Wellington 17, and Auckland 15. In the Otago district, however, there are many extensive tracts, which have not been thoroughly explored, and no doubt many of the Canterbury species will eventually be found there.

Considering what has been done during the last ten years, I think we may reasonably assume that at least some new species will be discovered, and my own opinion is that these new forms will be very numerous, especially on the western slopes of the Alps, the plants of which have been scarcely at all collected.

In drawing up this synopsis, I have found it impossible to place the species in a natural linear series, and the arrangement is therefore to some extent artificial. I recognize three distinct groups, which I have classed as sub-genera, and divided them into sections and series as seemed most convenient. In arranging species according to this synopsis, I should advise the student to discard all slight variations, and not to attempt to name any of the species of sub-genera II. until the greater majority of

* "Trans. N.Z. Inst.," Vol. I., p. 89.

them have been collected, as it is extremely difficult to furnish descriptions embracing all the numerous variations, and a considerable amount of study of the sub-genus is necessary before the student can even understand the most simple variations assumed by the species. When the first difficulties are conquered, however, it will be found that there is no other New Zealand family of plants so interesting as this.

The curious dimorphism shown in sub-genus III. deserves a very careful study. It has occurred to me that the upper lobulate leaves, so often absent, are the true leaves, and that the scale-like productions commonly called leaves are in reality not true leaves, but changed petioles. I have not, however, been able to bring forward any facts to prove this, and it offers a wide and interesting field for future study. Should this idea be substantiated, it will connect the sub-genus with the section represented by *V. haastii*, etc.

Genus *Veronica*, Linnæus.

This genus is a very extensive one, found in most temperate and in some sub-tropical countries. The sixty species found in the colony are not found in any other country, except in the case of *V. elliptica*, which occurs at Cape Horn and the Falkland Islands.

PROPOSED ARRANGEMENT.

Sub-genus I.—*Eu-veronica*. The Speedwells.

Capsules laterally compressed, didymous (rarely non-didymous). Herbs or under-shrubs.

Series A.—Flowers solitary, axillary.

Leaves $\frac{1}{12}$–$\frac{1}{6}$ inch long, hairy, ovate ... 1. *V. canescens*, Kirk.

Series B.—Flowers racemose; leaves entire.

Leaves $\frac{1}{4}$–1 inch, linear, glabrous ... 2. *V. linifolia*, H.f.

Series C.—Leaves deeply toothed; flowers racemose.

Leaves $\frac{1}{2}$–1 inch, ovate-cordate ... ... 3. *V. elongata*, Benth.

Leaves $\frac{1}{6}$–$\frac{1}{3}$ inch, ovate-spathulate ... 4. *V. spathulata*, Benth.

Leaves $\frac{1}{4}$–$\frac{1}{2}$ inch, ovate, glabrous ... ... 5. *V. nivalis*, H.f.

Creeping leaves $\frac{1}{12}$–$\frac{1}{4}$ inch, oblong, glabrous 6. *V. bidwillii*, H.f.

Decumbent leaves $\frac{1}{4}$–$\frac{1}{2}$ inch, oblong-ovate 7. *V. lyallii*, H.f.

Leaves $\frac{1}{2}$–$1\frac{1}{2}$ inch, ovate, obtuse ... ... 8. *V. diffusa*, H.

Leaves 1–$1\frac{1}{2}$ inch, lanceolate ... ... 9. *V. lanceolata*, Benth.

Leaves 3–6 inches, ovate-lanceolate ... 10. *V. cataractæ*, Forst.

Sub-genus II.—*Koromika*. The Koromikos.

Capsules dorsally compressed, ovoid, valves often splitting at the tips.

Section 1.—Leaves deeply serrate or crenate.

Series A.—Flowers paniculate.

Leaves 1–1½ inch long, ovate or oblong ... 11. *V. hulkeana*, F.M.

Leaves ⅓–1 inch, obovate-spathulate ... 12. *V. lavaudiana*, Raoul.

Leaves ½–1 inch, oblong-spathulate ... 13. *V. raoulii*, H.f.

Series B.—Flowers racemose.

Leaves ½–1½ inch, obovate or sub-orbicular 14. *V. benthamii*, H.f.

Leaves ½–1 inch, obovate-lanceolate ... 15. *V. macrantha*, H.f.

Section 2.—Leaves entire ; flowers spicate or sub-spicate ; leaves more or less densely imbricate.

Series A.—Leaves broad, obtuse, glaucous ; flowers spicate.

Leaves ⅓–½ inch long, broadly oblong ... 16. **V. amplexicaulis**, n.s.

Leaves ⅓–½ inch, sub-orbicular ... ... 17. *V. carnosula*, H.f.

Leaves ⅓–½ inch, oblong-obovate ... ... 18. *V. pinguifolia* H.f.

Series B.—Leaves not glaucous ; flowers sub-spicate.

Leaves ½–¾ inch, ovate-lanceolate... ... 19. **V. decumbens**, n.s.

Series C.—Leaves not glaucous ; flowers in sub-capitate spikes.

Leaves ⅛–¼ inch, orbicular, recurved ... 20. *V. buchanani*, H.f.

Series D.—Leaves glaucous, narrow, spikes hairy.

Leaves ¼–⅓ inch, obovate-oblong ... ... 21. **V. glauco-cærulea**, n.s.

Leaves ⅙–¼ inch, linear-obovate ... ... 22. *V. pimeleoides*, H.f.

Section 3.—Leaves densely imbricated ; flowers in terminal ovoid heads formed of an aggregation of spikes.

Leaves ¼–⅛ inch, keeled, oblong or broadly obovate ... ... 23. *V. epacridea*, H.f.

Leaves ⅓–½ inch, obovate-oblong or round 24. **V. macrocalyx**, n.s.

Leaves ¼–⅓ inch, oblong-orbicular ... 25. *V. haastii*, H.f.

Section 4.—Leaves closely imbricated ; flowers in sub-terminal racemes, often crowded.

Leaves ⅓–½ inch, obovate-oblong ... ... 26. *V. buxifolia*, Benth.

Leaves ⅓–½ inch, obovate, shining ... 27. *V. odora*, H.f.

Leaves ½–¾ inch, broadly obovate-oblong... 28. *V. lævis*, Benth.

Leaves ¾–1 inch, narrowly obovate ... 29. *V. obovata*, Kirk.

Leaves ¾–1 inch, ovate-lanceolate ... 30. **V. monticola**, n.s.

Leaves ⅓ inch, ovate or obovate ... ... 31. **V. grayii**, n.s.

Leaves ¼–⅓ inch, obovate, mucronate ... 32. **V. canterburiensis**, n.s.

Section 5.—Leaves not more than one inch long, decussate, rarely loosely-imbricated ; flowers in racemes, which are subterminal, often crowded, usually short.

Series A.—Racemes crowded, becoming a panicle by the defoliation of the upper leaves.

Leaves ½–1 inch, linear-oblong ... .. 33. **V. anomala**, n.s.

Leaves ½–¾ inch, linear-obovate ... ... 34. *V. vernicosa*, H.f.

Series B.—Flowers corymbose.

Leaves $\frac{3}{4}$–1 inch, linear-oblong, acute ... 35. *V. diosmæfolia*, Cunn.

Series C.—Flowers sub-corymbose.

Leaves $\frac{1}{2}$–1 inch, elliptic-oblong ... ... 36. *V. elliptica*, Forst.

Series D.—Flowers in sub-terminal, rather crowded, often compound racemes.

Leaves $\frac{1}{2}$–1 inch, linear-oblong ... ... 37. *V. colensoi*, H.f.

Leaves $\frac{1}{2}$–1 inch, linear-lanceolate ... ... 38. **V. rakaiensis**, n.s.

Series E.—Flowers in sub-terminal, dense, stout, obtuse racemes.

Prostrate; leaves $\frac{1}{3}$–$\frac{1}{2}$ inch, ovate-oblong, glabrous ... ... 39. *V. chathamica*, Buchanan.

Section 6.—*Leaves* 1–3 *inches long, narrow, entire; racemes* 2–5 *inches long, pubescent.*

Leaves 1 inch long, oblong, sessile ... 40. *V. traversii*, H.f.

Leaves 1–2 inches, oblong-lanceolate ... 41. *V. pubescens*, B.&S.

Leaves 1–3 inches, linear-oblong ... ... 42. *V. ligustrifolia*, Linn.

Leaves 1$\frac{1}{2}$–3 inches, linear-lanceolate ... 43. *V. parviflora*, Vahl.

Leaves 1–1$\frac{1}{2}$ inch long, linear-lanceolate 44. *V. arborea*, Buchanan.

Section 7.—*Leaves* 1–6 *inches long, broad; racemes* 2–8 *inches long, simple.*

Series A.—Racemes very long, slender, sub-pendulous, rather loose-flowered, very many-flowered.

Leaves 1–1$\frac{1}{2}$ inch long, lanceolate, acute 45. **V. kirkii**, n.s.

Leaves 2–4 inches, linear-lanceolate, acute 46. *V. myrtifolia*, B.&S.

Leaves 2–6 inches, lanceolate, acuminate 47. *V. lindleyana*, var. hort.

Series B.—Racemes sub-erect, dense-flowered, stout, very many-flowered.

Leaves 1$\frac{1}{2}$–2 inches, linear-oblong, sessile 48. *V. carnea*, var. hort.

Leaves 1$\frac{1}{2}$–2$\frac{1}{2}$ inches, oblong, lanceolate, glabrous ... ... 49. *V. macroura*, H.f.

Leaves 1–1$\frac{1}{2}$ inch, oblong-ovate, pubescent 50. **V. lewisii**, n.s.

Leaves 2–4 inches, oblong-obovate, obtuse 51. *V. speciosa*, Cunn.

Leaves 3–4 inches, linear-oblong, acute ... 52. *V. dieffenbachii*, Benth.

Sub-genus III.—*Pseudo-veronica*. The False Veronicas.

Leaves scale-like, appressed, often most densely quadrifariously imbricated, often dimorphic.

Series A.—Leaves in distant opposite pairs.

Leaves $\frac{1}{16}$ inch long, appressed, glabrous 53. *V. cupressoides*, H.f.

Series B.—Leaves densely imbricated, opposite pairs, connate at the base.

Branches square, $\frac{1}{12}$–$\frac{1}{8}$ inch diam., leaves obtuse ... ... 54. *V. tetragona*, H.f.

Branches square, $\frac{1}{12}$ inch diam., leaves sub-acute ... ... 55. *V. tetrasticha*, H.f.

Branches square, $\frac{1}{8}$–$\frac{1}{10}$ inch diam., leaves acuminate ... ... 56. *V. lycopodioides*, H.f.
Branches terete, slender, $\frac{1}{16}$ inch diam., leaves $\frac{1}{20}$–$\frac{1}{10}$ inch ... ... 57. *V. salicornioides*, H.f.
Branches terete, $\frac{1}{10}$–$\frac{1}{12}$ inch diam., leaves connate to middle ... ... 58. *V. armstrongii*, Kirk.
Branches terete, stout, leaves connate to middle ... ... 59. *V. hectori*, H.f.

Species the position of which is uncertain until fruit is obtained.

Leaves $\frac{1}{4}$ inch long, ovate-acuminate, imbricated ... ... 60. **V. loganioides,** n.s.

Descriptions of New Species.

16. *V. amplexicaulis*, Armstrong, "New Zealand Country Journal," Vol. III., page 56. 1–2 feet high, decumbent or suberect. *Branches* stout, ringed with old leaf-scars. *Leaves* loosely imbricated, amplexicaul or sub-amplexicaul, oblong, obtuse, $\frac{1}{2}$ inch long, $\frac{1}{3}$ inch broad, glaucous, coriaceous, entire, slightly concave, not keeled. *Flowers* in short conical spikes on hairy peduncles, 1–1$\frac{1}{4}$ inch long. *Spikes* $\frac{3}{4}$–1 inch long, densely hairy between the flowers, crowded together near the ends of the branchlets, dense-flowered. *Bracts* solitary, membranous, longer than the calyx, hairy, and ciliated. *Calyx-lobes* ovate or lanceolate, acute, ciliated, half as long as the corolla tubes. *Corolla* white; *tube* $\frac{1}{4}$ inch long; *limb* $\frac{1}{4}$ inch across; *lobes* lanceolate. *Stamens* longer than the style. *Anthers* blue. *Style* curved upwards, slender. *Capsule* $\frac{1}{8}$ inch long, ovoid-compressed, acute, hairy, one-third longer than the calyx.

Hab.—Provincial District of Canterbury, Rangitata, *Mr. J. F. Armstrong.* Provincial District of Nelson, Upper Waiau, *J. B. A.* A most beautiful and remarkable little shrub, readily distinguished from its nearest relative, *V. carnosula*, by the broadly oblong, very obtuse, amplexicaul leaves, and densely hairy spikes, also by the very long corolla tube, but this character may vary.

19. *V. decumbens*, Armstrong, "New Zealand Country Journal," Vol. III. A small decumbent, very beautiful shrub. *Branches* black and polished. *Branchlets* pubescent. *Leaves* loosely imbricated or decussate, spreading, entire, quite glabrous, very shortly petioled, ovate or lanceolate, $\frac{3}{4}$ by $\frac{1}{2}$ inch, obtuse, flat or slightly concave, not keeled, obscurely three-nerved, dull green in colour, with bright red edges. *Racemes* in pairs near the tips of the branches, shortly peduncled, ovoid, 1 inch long, 12–16-flowered. *Pedicels* $\frac{1}{16}$ inch long, slender, hairy. *Bracts* one-third the length of the calyx-lobes which are $\frac{1}{8}$ inch long, narrow-ovate, acute, hairy, ciliated, with pink edges.

Corolla white; *tube* ¼ inch long, much flattened on the inner side; *limb* ¼ inch across; *lobes* ovate, obtuse. *Stamens* longer than the style. *Anthers* red. *Capsules* ovate, much compressed, surmounted by the remains of the style.

Hab.—Provincial Districts of Canterbury and Nelson, *J.B.A.* A very beautiful little plant with the habit of *V. pinguifolia*, but the leaves are green, glabrous, larger than in that plant, not keeled, and the flowers distinctly pedicellate; a most distinct species.

21. *V. glauco-cærulea*, Armstrong, "New Zealand Country Journal," Vol. III. A small, stout, decumbent, or sub-erect shrub, much-branched, intensely glaucous throughout, with slightly hairy branches. *Leaves* closely imbricated, ⅓ inch long, obovate-oblong, on short broad petioles, acute, rather concave, not keeled, coriaceous (but not rigid). *Veins* obsolete above; *midrib* evident below. *Flowers* in short few-flowered spikes crowded together near the tips of the branchlets. *Peduncles* covered with soft, white hairs. *Bracts* ovate, acuminate, keeled, hairy and ciliated, shorter than the calyx-lobes. *Calyx-lobes* ovate, acute, hairy and ciliated on the margins, $\frac{1}{10}$ inch long. *Corolla* deep blue changing to purple; *tube* $\frac{1}{20}$ inch long; limb ¼–½ inch diameter; *lobes* broadly oblong, obtuse. *Stamens* as long as the style. *Anthers* blue. *Capsules* ovoid-compressed, acute, twice as long as the calyx.

Hab.—Nelson, Canterbury, and North Otago, 2,000–5,000 feet.

The intensely glaucous, closely set leaves, and dark blue or purple flowers, distinguish this from all but *V. pimeleoides*, from which it is best distinguished by the stouter branches, longer petioles, and much darker flowers. It is a most beautiful and ornamental plant, a great favourite in gardens.

24. **V. macrocalyx**, n.s.

A short-branched, straggling, decumbent or prostrate shrub, 4–8 in. long. *Branches* stout, leafy above, below densely clothed with the broad sheathing bases of old leaves, which are generally hairy and ciliated. *Leaves* bright green when fresh, brown when dry, densely quadrifariously imbricated, often much reflexed, broadly obovate-oblong, ⅓–½ inch long, ¼–⅓ inch broad, obtuse, sessile by a membranous amplexicaul base, concave above, slightly keeled below, slightly revolute, glabrous above, except a few scattered white hairs, puberulous below, coriaceous, rigid when dry, thinned on the margin, minutely lacerated, particularly towards the base, often minutely ciliated; *midrib* sunken above, keeled below; other *veins* very indistinct. *Flowers* very shortly pedicelled in 8–10-flowered racemes, collected into shortly-stalked terminal or sessile sub-terminal heads. *Heads* ovoid or oblong, 1–1½ inch long, ¾–1 inch broad, very dense. *Pedicels* extremely short, stout, rarely absent. *Bracts* ⅓ inch long, linear or linear-lanceolate, acute, sessile or very shortly-stalked, keeled, minutely pubescent and ciliated, particularly on the keel. *Calyx-lobes* linear, $\frac{1}{4}$–$\frac{1}{3}$ inch long, sub-acute, keeled, ciliated or glabrous. *Corolla* white, $\frac{1}{4}$–$\frac{1}{3}$ inch across ; *tube* short. *Capsules* ovoid, acute, $\frac{1}{6}$–$\frac{1}{5}$ inch long, slightly pubescent, much shorter than the calyx, the valves splitting longitudinally.

Hab.—Waimakariri Valley, 5–6000 feet, *J. B. Armstrong*, March, 1867. Rangitata Valley, 4,500 feet, *Mr. J. F. Armstrong*, March, 1869. Rakaia, *Mr. T. Phillips* (perhaps a different plant), 1878.

This is closely allied to *V. haastii*, but differs much in the sepals and capsules. The leaves are narrower, greener, pubescent, and smaller than in that species, and are without the red edges. This species has longer sepals than any other New Zealand one, except *V. elongata* and *V. macrantha.*

30. *V. monticola*, Armstrong, "New Zealand Country Journal," Vol. III. p. 58 (erroneously printed *montana*). About 2 feet high. *Leaves* imbricated, smooth, thick and leathery, spreading, ovate-lanceolate, about 1 inch long, acute, gradually narrowed into a short stalk, concave, not keeled, *midrib* sunken above. *Racemes* in pairs at the ends of the branches, longer than the leaves, about 20-flowered. *Peduncles* clothed with short glandular hairs. *Bracts* linear, acute, $\frac{1}{12}$ inch long, hairy and ciliated. *Calyx-lobes* ovate, acute, $\frac{1}{10}$–$\frac{1}{8}$ inch long, with a white membranous border. *Corolla* white ; *tube* $\frac{1}{6}$ inch long, compressed ; *limb* $\frac{1}{4}$ inch across ; *lobes* ovate, acute. *Anthers* brown. *Capsules* twice as long as the calyx, sub-ovoid, much compressed.

Hab.—Nelson, Canterbury, and Otago, common at 3–4,500 feet. In most New Zealand herbariums this fine little species has been generally confounded with *V. lævis*, from which it differs widely in the leaves being longer, the midrib sunken, not keeled, gradually narrowed into the petioles, in the membranous bordered calyx-lobes, and in the dull, dark colour, smaller size and pubescent peduncles.

31. *V. grayi*, Armstrong, "New Zealand Country Journal," Vol. III. A small upright shrub, 2–3 feet high. *Leaves* closely imbricated, glabrous, entire, flat, ovate or oblong or obovate, sub-erect, $\frac{1}{3}$ inch long, acute, rather suddenly narrowed into short foot-stalks, the lowermost leaves cordate at the base ; *veins* obsolete. *Racemes* slender, hairy, 4–6 together near the tips of the branchlets, many-flowered. *Bracts* linear, acute, fringed, $\frac{1}{12}$ inch long. *Pedicels* $\frac{1}{12}$ inch long, stout, hairy. *Calyx-lobes* $\frac{1}{12}$ inch long, ovate, acute or obtuse, hirsute, ciliate. *Corolla* white ; *tube* very short, $\frac{1}{16}$–$\frac{1}{10}$ inch long ; *limb* $\frac{1}{2}$ inch across ; *lobes* ovate, acute. *Anthers* blue. *Capsules* compressed-ovoid, acute, more than twice as long as the calyx.

Hab.—Canterbury and Nelson Provincial Districts.

In the original description the name was inadvertently written *greyi*, and the mistake was repeated in my "Sketch of the Flora of Canterbury." This pretty and curious little shrub is named in honour of Mr. W. Gray, of Ohinitahi, an ardent and efficient collector of New Zealand plants. It is a neat little shrub, flowering abundantly and early, and a very desirable garden plant.

32. *V. canterburiensis*, Armstrong, "New Zealand Country Journal," Vol. III. A small prostrate or erect slender shrub, 1–2 feet high. *Leaves* entire, smooth, rather closely imbricated, spreading and recurved, obovate, mucronate, concave, membranous, $\frac{1}{4}$ inch long, on short slender stalks, which in those leaves on the lower side of the branches are twisted, so as to bring the upper side to the light. *Racemes* in pairs at the ends of the branches, 4–8-flowered, hairy. *Bracts* $\frac{1}{6}$–$\frac{1}{8}$ inch long, linear, acute, hairy, with white membranous ciliated margins. *Calyx-lobes* $\frac{1}{6}$–$\frac{1}{8}$ inch long, linear-oblong, obtuse, with delicate white, membranous, ciliated margins. *Corolla-tube* shorter than the calyx; *limb* $\frac{1}{4}$ inch diameter, white; *lobes* obovate, obtuse. *Anthers* blue. *Capsules* ovoid-compressed, glabrous, acute, twice as long as the calyx. *V. lucens*, Kirk, in Canterbury Museum.

Hab.—Canterbury and Westland, 3,000–5,000 feet.

A handsome little shrub, very distinct in characters from any other; readily distinguished from all others of its section by the small foliage and twisted footstalks.

33. V. anomala, n.s.

A dense-growing shrub, 3–6 feet high, 4–8 feet through. *Branches* long, slender, purplish or reddish towards the tips. *Leaves* decussate, $\frac{1}{2}$–1 inch long, $\frac{1}{5}$–$\frac{1}{4}$ inch wide, linear or linear-oblong, patent, often reddish-coloured, coriaceous, quite glabrous on the upper surface, sometimes ciliated on the margin, concave, entire, shortly petiolate; *midrib* obscure above, distinctly keeled below. *Racemes* crowded together, 5–10-flowered, sub-terminal, ultimately becoming a terminal panicle by the defoliation of the upper leaves. *Flowers* white, very shortly pedicellate or sessile. *Bracts* sessile, acute, nerved, keeled, $\frac{1}{8}$–$\frac{1}{6}$ inch long. *Calyx-lobes* 3, linear-oblong, acute or obtuse, distinctly nerved, scabrid, pubescent or glabrous. *Corolla-tube* $\frac{1}{4}$ inch long; *limb* $\frac{1}{4}$–$\frac{1}{2}$ inch broad; *lobes* nearly equal, 3, or 2 unequal, spreading, narrow. *Stamens* shorter than the style. *Capsules* ovoid-oblong, compressed, obtuse, pubescent, $\frac{1}{5}$ inch long, always longer than the calyx.

Hab.—Canterbury Provincial District, Rakaia Valley, Mount Cook, and Mount Peel. A curious plant differing from all other species in the number of the corolla-lobes, but very closely resembling *V. vernicosa* in appearance, and doubtless a very recent offset from that species.

38. **V. rakaiensis**, n.s.

A slender, bright-green shrub, 3–6 feet high. *Branches* upright, extremely slender, marked by black leaf-scars. *Leaves* decussate or laxly imbricated, linear-lanceolate, or linear-oblong, shortly petioled, $\frac{1}{2}$–1 inch long, acute, quite entire, glabrous and shining above, pubescent below, concave above, flat not keeled below; *veins* obscure. *Flowers* in many-flowered pubescent racemes in pairs near the tips of the branches. *Racemes* 1–2 inches long, curved. *Pedicels* $\frac{1}{6}$ inch longer, very slender. *Bracts* very short, concave and ciliated. *Calyx-lobes* $\frac{1}{12}$ inch long, oblong, obtuse, ciliated, and pubescent. *Corolla* pure white; *tube* shorter than the calyx; *limb* $\frac{1}{4}$ inch diameter; *lobes* nearly equal, obtuse, reflexed. *Stamens* spreading widely. *Anthers* brown. *Style* as long as the stamens, curved upwards. *Capsule* $\frac{1}{6}$ inch long, ovate-oblong, acute, pubescent.

Hab.—Canterbury Alps 2,000–4,000 feet, scarce.

This is the *V. colensoi* var. *gracilis* of gardens; it must not be confounded with the Australian *V. gracilis*, Br., which is a very different plant.

This species appears to be self-sterile, and is, I believe, fertilized by a very small hymenopterous insect. The flowers smell strongly of honey. It is best distinguished from *V. colensoi* by the extremely slender branches and smaller narrower leaves.

45. *V. kirkii*, Armstrong, "New Zealand Country Journal," Vol. III., p. 58. A tall handsome shrub 6–12 feet high, with dark brown polished branches, which are ringed by old leaf-scars. *Leaves* 1–1$\frac{1}{2}$ inch long by $\frac{1}{3}$ inch wide, lanceolate, decussate or loosely imbricate, entire, smooth, acute, sessile by a broad base, slightly concave, recurved; *midrib* rather prominent below, sunken above. *Flowers* shortly pedicelled in long slender racemes in the axils of the uppermost leaves. *Racemes* 4–8 inches long, 50–100-flowered, very slender, curved, very densely flowered, pubescent. *Bracts* lanceolate, acuminate, ciliate, much shorter than the calyx. *Calyx-lobes* $\frac{1}{10}$ inch long, lanceolate or ovate, ciliated, acuminate. *Corolla* pure white; *tube* $\frac{1}{5}$ inch long; *limb* $\frac{1}{4}$ inch diameter; *lobes* nearly erect, ovate-oblong, obtuse, concave. *Stamens* as long as the style. *Anthers* blue. *Capsule* rounded, ovate, sub-acute, much compressed, hoary, twice as long as the calyx.

Hab.—Canterbury Provincial District. First collected by *Mr. J. F. Armstrong* in 1868 in the Upper Rangitata valley, which is very rich in species of the genus. This plant seems sufficiently distinct, but is closely related in many characters to *V. macroura* and *V. stricta*; from the former it is best distinguished by the sessile narrower leaves and much longer racemes, and from the latter by the shorter leaves and denser flowers.

47. *V. stricta* var. *lindleyana*, hort., Armstrong. A shrub, 6–10 feet high. *Leaves* 3–4 inches long, 1 inch broad, oblong or oblong-lanceolate, shortly

petioled, entire or obscurely serrate, acuminate, distinctly veined, glabrous or slightly pubescent. *Racemes* long peduncled, in pairs near the tips of the branchlets, curved, rather stout, 4–8 inches long, pubescent, not very dense-flowered; *pedicels* $\frac{1}{3}$ inch long, very slender, curved. *Bracts* extremely short, oblong, ciliated. *Calyx-lobes* about $\frac{1}{12}$ inch long, pubescent and ciliated, acute. *Corolla* pale blue or white; *tube* $\frac{1}{8}$ inch long, swollen; *limb* $\frac{1}{4}$ inch across; *lobes* narrow, concave, obtuse. *Stamens* curved upwards, spreading. *Anthers* brown. *Style* shorter than the stamens, curved upwards. *Capsules* broadly ovate, obtuse, more than $\frac{1}{8}$ inch long, glabrous or pubescent.

Hab.—Both islands, common in lowland forests. Differs from the type in the larger foliage, always petiolate, and the spreading habit and much larger capsules which are often much recurved.—*V. lindleyana*, hort.

This is often almost indistinguishable from *V. myrtifolia*, and perhaps should be united with that plant. Young plants have sharply serrate leaves.

48. *V. carnea*, hort., Armstrong. A large spreading shrub, with rather slender, pubescent branches. *Leaves* decussate, closely set, $1\frac{1}{2}$–2 inches long, linear-oblong, about $\frac{1}{3}$ inch wide, bright green, obtuse or acute, quite entire, with ciliated pink margins, pubescent below, glabrous above, except the midrib which is pubescent, sessile by a narrow base, concave above, scarcely keeled below. *Racemes* in sub-terminal pairs, 2–3 inches long, sub-erect, rather stout, pubescent, not very dense-flowered. *Pedicels* straight, stout, $\frac{1}{8}$ inch long. *Bracts* linear-oblong, $\frac{1}{12}$–$\frac{1}{10}$ inch long, acute, pubescent. *Calyx-lobes* $\frac{1}{12}$–$\frac{1}{10}$ inch long, linear-lanceolate, acute, ciliate. *Corolla* rose and white; *tube* about $\frac{1}{8}$ inch long, swollen; *limb* $\frac{1}{4}$–$\frac{1}{3}$ inch across; *lobes* spreading, unequal. *Stamens* stout, curved upwards, rather longer than the style, which is curved downwards. *Capsules* twice as long as the calyx, pubescent or glabrate, acute, much compressed.

Hab.—Otago? I have had great difficulty in obtaining any authentic information regarding the habitat of this plant, which is commonly cultivated in gardens as a native. Mr. Kirk, I believe, considers it to be from New Caledonia, but I think this extremely improbable as the plant is perfectly hardy in Christchurch, whereas all New Caledonian plants require stove heat. This is one of the handsomest species of the genus, differing from *V. speciosa* chiefly in the much narrower, shorter leaves, narrower, shorter racemes, and much smaller *calyx*. I have been assured by several persons that they have seen this plant growing wild on the coast near the South-west Cape, but I failed to find it on my visit to that neighbourhood in 1873.

50. V. lewisii, n.s.

A very handsome close-growing shrub, 3–6 feet high or more. *Branches* stout, scarred, covered with minute dense greyish pubescence, which is thinner towards the tips. *Leaves* pale green, spreading, decussate in rather distant pairs, ovate or oblong-ovate or oblong, 1–1½ inch long or more, ¾–1 inch wide, on very short extremely stout petioles, quite entire, acute, almost glabrous above, pubescent below and on the midrib, coriaceous, ciliated; *midrib* excurrent, concave above, prominent below, the other *veins* faintly reticulated. *Racemes* in sub-terminal pairs, very stout and dense, erect, 2 inches long, 1 inch through. *Peduncles* stout, pubescent. *Bracts* linear-oblong, acute, $\frac{1}{12}$ inch long, ciliated, sometimes ¼ inch long, leafy, lanceolate. *Calyx* pubescent and ciliate; *lobes* ⅛ inch long, ovate-oblong, keeled, ciliated, acute. *Corolla* pale purple, white or blue; *tube* $\frac{1}{10}$–⅛ inch long, very broad, angled; *limb* ⅓–½ inch diameter; *lobes* concave, spreading, nearly equal, obtuse. *Stamens* very stout, spreading widely, curved upwards, longer than the straight stout style. *Anthers* brown, very large. *Capsules* ¼ inch long, ovate-oblong, glabrous or hoary, obtuse or surmounted by the base of the style, much compressed.

Hab.—Downs near the sea in the south of Canterbury.

I have been much puzzled with this plant which is exactly intermediate in character between *V. elliptica* and *V. speciosa*. It resembles *V. elliptica* in the colour and size of the flowers and the colour of the leaves, and *V. speciosa* in the stamens and shape of the foliage. In size it is exactly intermediate between these two, and those authors who favour the hybridism theory as accounting for the variations of species would probably class this as a hybrid, but such an idea is exceedingly improbable in this case, as no plants of *V. speciosa* have been found within 200 miles of the district where this plant was found, although the whole district has been very carefully botanized. Besides hybrids usually show very great variations in the characters of their flowers, but this plant is one of the most constant species in the colony. It is a very beautiful shrub, with larger flowers than any other New Zealand one except *V. macrantha.*

Besides the above species, I have two other species belonging to this section, without flowers or fruit.

No. 1. A small, decumbent, or sub-erect shrub, about 1 foot high. *Leaves* imbricated, dimorphic, the young state spreading, obovate, acute, deeply lobed or pinnatifid, the old state sub-erect, not closely appressed, not connate at the bases, ovate-lanceolate, acute, keeled, gradually narrowed to the point, sessile, ciliated, ⅛–¼ inch long. *Branches* obscurely tetragonous, tomentose or pubescent between the leaves.

Hab.—Rangitata, Ashburton, and Rakaia valleys; differs from *V. lycopodioides*, in the larger size, and the leaves not connate, and gradually narrowed into the acute points.

No. 2. A very small shrub a few inches high, like *V. tetragona*, but the leaves are longer, narrower, and spreading, not appressed to the twig, but connate at the base.

Hab.—Near Dunedin.

60. *V. loganioides*, Armstrong, "New Zealand Country Journal," Vol. III. A small shrub, six inches high, decumbent and rooting at the joints. *Branches* hairy towards the tips. *Leaves* densely imbricated, appressed to the branch with spreading tips, ovate, acuminate, glabrous except the ciliated margins, usually entire, sometimes with 1–3 small teeth on each side, $\frac{1}{4}$ inch long, sessile, very sharply keeled below. *Flowers* in short few-flowered racemes in pairs near the points of the branches. *Peduncles* hairy, short. *Bracts* $\frac{1}{8}$ inch long, ovate, acuminate. *Pedicels* hairy. *Calyx-lobes* lanceolate, acute, keeled, ciliated. *Corolla* white with pink stripes, very fugaceous; *tube* $\frac{1}{12}$ inch long; *lobes* broadly ovate, obtuse; *limb* $\frac{1}{3}$ inch across. *Stamens* as long as the style. *Anthers* brown. *Capsule* not seen.

Hab.—Rangitata valley, *Mr. J. F. Armstrong*. Clyde valley, *Mr. W. Gray*, 5,000–6,000 feet.

A most singular plant, quite different in appearance from any other known *Veronica*. Until the fruit is obtained the position and relationship cannot be determined. The corolla seems to approach that of *V. linifolia*, but the aspect of the plant is more that of *V. tetragona*, though the leaves are not connate at their bases.

ART. XLVI.—*A natural Arrangement of the New Zealand Ferns founded on the System of Smith's "Historia Filicum," with critical Notes on certain Species.* By J. B. ARMSTRONG.

[*Read before the Philosophical Institute of Canterbury, 2nd September*, 1880.]

[Extract.]

CRITICAL NOTES.

Gymnogramma rutæfolia, Br. *G. alpina*, Potts, is certainly referable to this species. Specimens collected on the Upper Rangitata and kindly given to me by Mr. Potts, do not present any characters differing from those of *G. rutæfolia* sent from other parts of the colony. I have it from several localities in Canterbury and Otago, but have seen no North Island specimens. The New Zealand plant is, however, quite distinct from *G. pozoi* with which it was united in the "Syn. Filicum."

Lastrea invisa. The *Nephrodium thelypteris* var. *squamulosum* of the "Handbook" is undoubtedly the *Aspidium invisum* of Forster, and the specific name must therefore be changed as I have no doubt whatever as to its distinctness from the British plant. It has not, so far as I am aware, been found in the Southern Provinces.

Cystoptoris novæ-zealandiæ. This plant is certainly distinct from *C. fragilis*, Bernhardi, to which it has been referred by most authors. The plant is always much smaller and more fragile with an erect underground miniature branching caudex, and is always less divided than the European plant. The indusium is often entirely absent from Canterbury specimens, and nearly always becomes obsolete with age. I have examined large numbers of British specimens together with living plants of the true *C. fragilis*, Bernhardi, and have found none approaching this. Some states of it, however, are much like *C. dentata* in aspect, but differ much in the rhizome and sori. The description in the "Handbook," copied from the "Species Filicum," was drawn up from European specimens, and does not apply to the New Zealand plant. It is found from near the sea-level (close to Christchurch) up to 4,800 feet or higher, but presents scarcely any variations, thus offering another point of difference from the British plant, which is exceedingly variable if I may judge from the numerous specimens in my own herbarium.

Dicksonia fibrosa. I am glad to find that *Mr. Baker* is disposed to admit this old species of Colenso's. We have cultivated the Tasmanian *D. antarctica*, and this for many years, and I have no hesitation in pronouncing them distinct if examined in the living state, as all ferns ought to be before any opinion is given as to their distinctness.

D. antarctica is the fastest growing tree-fern we have as yet experimented with. Plants only seven and a half years old from spores have made trunks varying from 3 to 10 inches high and 3 to 4 inches through. It is therefore likely that the rapidity of growth of tree-fern stems has been very much under-estimated by most writers on ferns.

Cheilanthes kirkii. An examination of cultivated plants of the true *C. tenuifolia*, Swzs., has convinced me of the distinctness of the New Zealand plant referred to that species by Mr. Kirk.* In my Sketch of the Flora of Canterbury† I considered this to be a variety of *C. sieberi*; but on further consideration I am disposed to acknowledge it as a distinct species and to attach to it the name of Mr. T. Kirk, who has done so much to increase our knowledge of New Zealand plants. Very good descriptions of this and *C. sieberi* will be found in the volume of the "Transactions" referred to above. *C. kirkii* is rather a common plant in Canterbury, but appears to be somewhat rare in the North.

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* "Trans. N.Z. Inst.," Vol. VI., p. 247.

† "Trans. N.Z. Inst.," Vol. XII., pp. 325-353.

Asplenium, sp. Probably another species of this genus, found in the lower Canterbury Alps, will yet be added to our list of New Zealand ferns, and admitted to specific distinction. It is intermediate in appearance between *A. flaccidum* and *A. hookerianum*, and frequently produces dense masses of sori covering the whole under-surface of the frond. It has been erroneously referred to *A. richardi* by collectors of living ferns.

Hymenophyllum. The great increase in the number of species of this genus is noteworthy. In the "Handbook" only fifteen species are given, whilst I here acknowledge twenty-six, and I am by no means sure but that I ought properly to have admitted several more. This is undoubtedly the most difficult New Zealand genus of ferns, and requires to be carefully studied in the living state. I think that most of the species here given will be generally admitted in the future, seeing that most of the New Zealand species suppressed in the first edition of the "Synopsis" have been re-admitted in the second. Probably also several new ones remain to be discovered. It will be seen that I have restored Mr. Colenso's old species *H. revolutum*, which I consider quite as worthy of specific standing as *H. unilaterale*, *H. montanum*, and others. *H. cheesemanii* is closely allied to *H. minimum*, but differs in the ciliated margins and costa. It is the least satisfactory of all the species adopted here.

H. armstrongii is also allied to *H. minimum*, but differs essentially in the remarkable border, and in the columnar receptacle being frequently exerted, which led Mr. Baker to place it in the genus *Trichomanes* (see Synopsis Filicum, first edition in appendix). It is, however, more naturally allied in habit to *Hymenophyllum*, and was first referred to this genus by Sir. J. D. Hooker on its discovery in 1867.

Of Mr. Colenso's *H. erecto-elatum* I have not yet seen specimens, but he is such a careful observer, and is so well up in New Zealand plants, that I have little reason to doubt its distinctness. The same author's *H. pusillum* is certainly very near to *H. tunbridgense*, but I accept it for the present. I have placed *H. lyallii* in this genus, although it was referred to *Trichomanes* in the "Synopsis," because it appears to me to have more of the habit of *Hymenophyllum* than of *Trichomanes;* but it cannot be denied that the New Zealand species of the two genera present a graduated series of forms, and the limits of these two genera are anything but clearly defined. Still, it is convenient to keep up both generic names, and I think it will be found best to refer those species with long, distinctly-exerted, columnar receptacles and densert issue to *Trichomanes*, and the remainder to *Hymenophyllum*. *H. malingii* is a difficult plant to place, but apparently it comes nearest *H. æruginosum*.

Trichomanes venustulum. This new species of Mr. Colenso's is, I believe, not uncommon in the south, but has hitherto been confounded with *T. venosum.*

Osmunda. I have here departed somewhat from Smith's arrangement, and united *Todea* with *Osmunda* of Linnæus. This genus has given me more trouble than any other, and consequently I do not expect New Zealand pteridologists to agree with my views at once, but I have little doubt that many of them will do so when they have studied the question as much as I have done. There is really no natural character to separate the typical species of *Todea* from *Osmunda.* The character usually given is that the fronds of *Osmunda* are contracted in fruit, but the fronds of *Todea* are often partially contracted, though never so much as those of *Osmunda regalis.* Consequently this character is of no value, as we cannot distinguish genera by the amount of contraction of their fertile fronds. In the variation, texture, and in the sori and venation, we find no difference beyond what is sufficient to distinguish them as species of one genus. In the case of the two species of the sub-genus *Leptopteris,* however, we find characters of more importance, such as the membranous texture of the fronds and the scattered sori; but these characters are not now considered by authors to be of sufficient importance for defining genera, or even for separating *Leptopteris* from typical *Todea,* and therefore I feel justified in placing all three plants in *Osmunda.* I find that Sir J. D. Hooker has, in the "Handbook," given an opinion that *Todea* should merge into *Osmunda,* thus anticipating my action.

In conclusion, it is necessary to remark that I have made a very free use of Smith's generic descriptions;* but I do not suppose that the author would object, as his descriptions are so admirably drawn that it would be quite impossible for me to improve upon them, and I shall conclude with a hope that this paper will be the means of bringing before the New Zealand student the least difficult and most natural system of fern classification ever presented to the public.

ARRANGEMENT OF GENERA AND SPECIES.

Filices.

Division I.—**Eremobrya.**

Tribe I.—*Polypodeæ.*

Gen. I.—Niphobolus, *Kaulfuss.*

1. *N. serpens* (Fst.), J. Sm. *Polypodium rupestre,* Hk.

Gen. II.—Phymatodes, *Presl.*

1. *P. pustulata* (Fst.), Presl.; slender.
2. *P. billardieri,* Br.; stout, glaucous.

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* All descriptions omitted, the subject of the paper being "arrangement."—Ed.

3. *P. cheesemanii*, Baker.

4. *P.*, sps. (Westland); sori not seen.

Gen. III.—Dictymia, *J. Smith.*

1. *D. lanceolata*, J. Sm. *Polypodium cunninghami*, Hk.

Division II.—**Desmobrya.**

Tribe II.—*Acrasticheæ.*

Gen. IV.—Lomariopsis, *Fee.*

1. *L. heteromorpha*, J. Sm. *Lomaria filiformis*, **A. Cunn.**

Tribe III.—*Hemionitideæ.*

Gen. V.—Gymnogramma.

1. *G. leptophylla*, Des.

2. *G. rutæfolia*, Hk.

G. alpina Potts. Note.—In the *Synopsis Filicum* this is wrongly united with the South European *G. Pozai.* It is confined to Australia and New Zealand.

Gen. VI.—Platyloma, *J. Smith.*

1. *P. rotundifolia* (Fst.)

2. *P. falcata*, (Br.)

Tribe IV.—*Pleurogrammeæ.*

Gen. VII.—Grammitis, *Swartz.*

1. *G. australis*, Br. *Polypodium australe*, Hk.

2. *G. Pumila*, Armstrong.

Tribe V.—*Ctenopteridea.*

Gen. VIII.—Ctenopteris, *Blume.*

1. *C. grammitidis* (Br.)

Tribe VI.—*Phegopterideæ.*

Gen. IX.—Goniopteris, *Presl.*

1. *G. pennigera*, Presl.

Gen. X.—Nephrodium, *Schott.*

1. *N. molle*, Br.

2. *N. unitum*, Hk.

Gen. XI.—Lastrea, *Presl.*

1. *L. glabella* (Cunn.)

2. *L. decomposita* (Br.)

3. *L. velutina* (A. Rich).

4. *L. hispida*, Swartz.

5. *L. invisa* (Forst.) *Nephrodium Thelypteris.* var., *Hk.f.*

Gen. XII.—Polystichum, *Schott.*

1. *P. vestitum*, (Swartz).

2. *P. richardi* (Hk.)

3. *P. oculatum* (Hk.)
4. *P. cystostigium* (Hk.)

Gen. XIII.—Arthropteris, *J. Sm.*

1. *A. tenella*, J. Sm. *Polypodium tenellum*, Hk.f.

Gen. XIV.—Nephrolepis, *Schott.*

1. *N. tuberosa*, Schott.

Gen. XV.—Hypolepis, *Bernhardi.*

1. *H. tenuifolia*, Bern.
2. *H. distans*, Hk.
3. *H. millefolium*, Hk.f.
4. *H. rugulosum* (Lab.)

Tribe VII.—*Physemateæ.*

Gen. XVI.—Cystopteris, *Bernhardi.*

1. *C. novæ-zealandiæ*, Armstrong. *C. fragilis* of authors non Bernhardi.

Tribe VIII.—*Cyatheæ.*

Gen. XVII.—Cyathea, *Smith.*

1. *C. cunninghamii*, Heward.
2. *C. dealbata*, Swartz.
3. *C. medullaris*, Swartz.
4. *C. polyneuron*, Colenso.
5. *C. smithii*, Hk.f.

Gen. XVIII.—Alsophila, *Br.*

1. *A. colensoi*, Hk.f.

Tribe IX.—*Dicksoniae.*

Gen. XIX.—Dicksonia, *L. Héritier.*

1. *D. squarrosa*, Swartz.
2. *D. fibrosa*, Colenso.
3. *D. lanata*, Colenso.
4. *D. sparmaniana*, Colenso.

Tribe X.—*Saccolomeæ.*

Gen. XX.—Microlepia, *Presl.*

1. *M. novæ-zealandiæ*, Col.
2. *M.* (?) *forsteri*, Carr.

Gen. XXI.—Loxoma, *Br.*

1. *L. cunninghamii*, Br.

Tribe XI.—*Lindsayæ.*

Gen. XXII.—Lindsæa, *Dryander.*

1. *L. trichomanoides.* Dry.
2. *L. lessoni*, Bory.
3. *L. viridis*, Col.
4. *L. linearis*, Swartz.

Tribe XII. *Adianteæ.*

Gen. XXIII.—Adiantum, *Linn.*

1. *A. hispidulum*, Swartz.
2. *A. setulosum*, J. Sm.
3. *A. assimile*, Swartz.
4. *A. formosum*, Br.
5. *A. affine*, Willd.
6. *A. fulvum*, Raoul.

Tribe XIII.—*Cheiantheæ.*

Gen. XXIV.—*Nothochlæna*, Br.

1. *N. distans*, Br.

Gen. XXV.—Cheilanthes, *Swartz.*

1. *C. sieberi*, Kunze.
2. *C. kirkii*, Armstrong. *C. tenuifolis*, Kirk non Swartz. *C. sieberi*, var. *deltoidæ*, Armstrong.

Tribe XIV.—*Pteriedæ.*

Gen. XXVI.—Litobrochia, *Presl.*

1. *L. comans* (Fst.).
2. *L. macilenta* (A. Rich.).

Gen. XXVII.—Histiopteris, *Agardh.*

1. *H. incisa*, Thun.

Gen. XXVIII.—Pteris, *Linn.*

1. *P. tremula*, Br.

Gen. XXIX.—Ornithopteris, *Agardh.*

1. *O. esculenta* (Fst.)
2. *O. scaberula* (Rich.)

Tribe XV.—*Blechneæ.*

Gen. XXX.—Lomaria, *Willd.*

1. *L. elongata*, Blume.
2. *L. alpina*, Spreng.
3. *L. banksii*, Hk.f
4. *L. pumila*, Raoul.
5. *L. nigra*, Colenso.
6. *L. discolor*, Willd.
7. *L. lanceolata*, Spreng.
8. *L. rigida* (J. Sm.), *L. dura*, Moore.
9. *L. membranacea*, Col.
10. *L. rotundifolia*, Raoul. *L. fluviatilis*, Hk.f., non Spreng.
11. *L. vulcanica*, R. Br.
12. *L. noma*, Colenso.
13. *L. minor*, Spreng.

14. *L. procera*, Spreng
15. *L. duplicata*, Potts.
16. *L. fraseri*, Cunn.

Gen. XXXI.—Doodia, *Br.*

1. *D. caudata*, Br.
2. *D. media*, Br.

Tribe XVI.—*Aspleneæ.*

Gen. XXXII.—Asplenium, *Linn.*

* Lucidum group.

1. *A. lucidum*, Fst.
2. *A. obtusatum*, Fst.
3. *A. obliquam*, Fst.
4. *A. soleraprium*, Hombrau.

* * Trichomanes group.

5. *A. trichomanes*, Linn.

* * * *Rhizophorum group.*

6. *A. flabellifolium*, Cav.

* * * * *Flaccidum group.*

7. *A. bulbiferum*, Fst.
8. *A. appendiculatum*, Lab.
9. *A. flaccidum*, Fst.
10. *A. colensoi*, Moore.
11. *A. richardi*, Hk.f.
12. *A. Hookerianum*, Col.

* * * * * *Falcatum group.*

13. *A. falcatum*, Lamarck.

Gen. XXXIII.—Athyrium, *Roth.*

1. *A. brownii*, J. Sm. *Asplenium umbrasum, Baker.* Syn. Fil.

Tribe XVII.—*Gleicheneæ.*

Gen. XXXIV.—Gleichenia, *Smith.*

1. *G. semi-vestita*, R. Br.
2. *G. hecistophylla*, A. Cunn.
3. *G. dicarpa*, R. Br.
4. *G. alpina*, R. Br.
5. *G. cunninghamii*, Heward.
6. *G. flabellata*, R. Br.
7. *G. dichotoma*, Hk.

Tribe XVIII.—*Hymenophylleæ,*

Gen. XXXV.—Hymenophyllum, Sm.

1. *H. polyanthas*, Swartz.
2. *H. narum*, Br.
3. *H. nitens*, Br.

4. *H. demmissum*, Swartz.
5. *H. scabrum*, A. Rich.
6. *H. crispatum*, Wallich.
7. *H. pulcherrimum*, Col.
8. *H. erecto-elatum*, Col.
9. *H. dilatatum*, Swartz.
10. *H. villosum*, Colenso.
11. *H. montanum*, Kirk.
12. *H. tunbridgense*, Sm.
13. *H. unilaterale*, Willd.
14. *H. revolutum*, Col.
15. *H. pusillum*, Col.
16. *H. ciliatum*, Swartz.
17. *H. multifidium*, Swartz.
18. *H. bivalve*, Swartz.
19. *H. æruginosum*, Carm.
20. *H. minimum*, Rich.
21. *H. cheesmanii*, Hk.f.
22. *H. armstrongii*, Hk.f.
23. *H. lyalli*, Hk.f.
24. *H. rufescens*, Kirk.
25. *H. malingii*, Hk.f.
26. *H.* sps. *Aff. H. æruginosum.*

Gen. XXXVI.—Trichomanes. *Linn.*

1. *T. reniforme*, Fst.
2. *T. humile*, Fst.
3. *T. venustulum*, Colenso.
4. *T. venasum*, Br.
5. *T. strictum*, Menzies.
6. *T. elongatum*, Cunn.
7. *T. colensoi*, Hk.f.

Tribe XIX.—*Schizeæ.*

Gen. XXXVII.—Lygodium, *Swartz.*

1. *L. articulatum*, Rich.

Gen. XXXVIII.—Schizæa, *Smith.*

1. *S. dichotoma*, Swartz.
2. *S. bifida*, Lab.
3. *S. fistulosa*, Swartz.

Tribe XX.—*Osmundeæ.*

Gen. XXXIX.—Osmunda, *Linn.*

1. *O. barbara*, Moore.

Sub-genus *Leptopteris.*

2. *O. hymenophylloides*, Presl.
3. *O. superba*, Colenso.

Division III.—**Scaphiobrya.**

Tribe XXI.—*Marattiaceæ.*

Gen. XL.—Marattia, *Smith.*

1. *M. fraxinea*, Smith.

Tribe XXII.—*Ophioglosseæ.*

Gen. XLI.—Ophioglossum, *Linn.*

1. *O. costatum*, Br.
2. *O. gramineum*, Willd.
3. *O. lusitanicum*, Linn. (?)
4. *O. minimum*, Armstrong.

Gen. XLII.—Botrychium.

1. *B. dissectum*, Muhlenberg.
2. *B. cicutarium*, Swartz.

Note.—Doubtful genus *Deunstaedia*, Bern.

sps. *D. Dubia*, J. Sm.

Dicksonia dubia of many authors. *Davallia dubia* of gardens and some New Zealand herbaria. Barren fronds of a fern referred to this have often been obtained in Canterbury and Otago, but I have not been able to obtain any native specimens in fruit, and perhaps the plant may turn out to be *Microlepia forsteri.* Many other ferns are said to grow in New Zealand, but their occurrence requires authentication.

Art. XLVII.—*Description of a new species of* Metzgeria; *also a brief notice of the finding of* Bæoniyces heteromorphus, Nyl., *in New Zealand.*

By W. Colenso, F.L.S.

[*Read before the Hawkes' Bay Philosophical Institute, 12th July*, 1880.]

Metzgeria (Symphyogyna) *rugulosa*, n.s.

Plant terrestial, sub-erect, of close half imbricate growth, forming little beds; *root* creeping, densely tormentose, colour light brown; *stipe* 2–3 in. long, sub-flexuose, whitish, translucent, semi-succulent, two-nerved downwards from the fork (four-nerved above), nerves very distinct; *frond* darkish green, very membranaceous, drooping outwardly, flabellate and kidney-shaped in outline, 10–12 lines broad, 5–7 lines long, forked, symmetrical, each main division trichotomously divided and two-nerved, semi-rugulose on upper surface glabrous; *segments* linear, 2–3 lines long, 1 line broad, bifid, emarginate, transparent, midrib very apparent and extending to margin at emarginate apex, margins entire; *fructification* 3–5 on one frond, from below at the fork of main division of frond, and again at each fork of the secondary divisions; *calyptra* tubular, 3 lines long, very slightly incised at top (somewhat resembling the tubular capsule of *Cerastium vulgatum*), at first white, but after flowering bearing a pale reddish tinge; *involucre* crisped and fimbriate; *capsule* (immature) at first linear-elliptic, dark coloured, enclosed in tubular calyptra, 1 line long, afterwards seated on long whitish succulent fruit-stalk, 10–12 lines long, bursting into four red-brown valves, cohering by their apices.

This interesting and curious little plant has very much of the appearance of a stipitate *Symphyogyna*, to which genus I should undoubtedly have referred it had I not fortunately (after much research) found it in fruit. It is very like *S. flabellata* in general appearance, though quite distinct, and without fruit, and at first sight might easily be confounded with it. It has many natural characters in common with that genus, but from the position of its ventral fructification it is placed (provisionally) under *Metzgeria*. It seems, however, to serve to unite those two genera. Although closely resembling *Symphyogyna flabellata* in some particulars, it differs from it not merely in the situation of its fructification, but also in its involucral scale being much more crisped and even fimbriated (which, in that species, has plain margins), while the top of its calyptra is very much less incised (which, in that species, is largely cut and fimbriated), and the segments of its fronds, instead of being obtuse, as in that plant, are emarginate. It also largely differs in its habit of growth. Another peculiarity is its bearing two manner of fronds from the same rhizome: one, the larger and often fruitful one, as described; the other is much smaller, and, though forked, is less cut, and more palmate or sub-flabellate in outline, with the upper part of the stipe winged, its colour a light green, quite glabrous and smooth, and highly transparent. At first I had supposed it to be another species, but subsequent and frequent examination has confirmed its forming with the other and larger frond only one plant.

Hab.—On the banks of a watercourse in a deep, secluded, damp glen, on the west side of the main road, about four miles south from Norsewood, in the "Seventy-mile bush," May, 1880, with immature fruit; and again in October, 1880, with fruit fully ripened, and passing. Hitherto I have only detected it growing in one small spot, though there plentifully.

Bæomyces heteromorphus, Nyl.

Thallus constaceous, spreading, thin, greyish or dull-white; *apothecia* reddish flesh-coloured, orbicular, flat or very slightly depressed, with a finely crenlated margin, 1–5 together, separate rarely confluent, on a thick short stipe *(podetium)*, which is generally cylindrical in the lower part and sub-branched in the upper, each branchlet terminating in an apothecium.

Hab.—On sub-vertical clayey banks, in the forest ("Seventy-mile bush"), between Norsewsod and Daneverk, forming large patches, and growing with *B. rufus.*

I was much pleased in detecting this pretty little plant, especially in finding it growing together with its allied species *B. rufus;* the contrast between them was great, in the thallus as well as in apothecia, and showed advantageously. Hitherto, I believe, this species has only been found in Tasmania.

Art. XLVIII.—*The Ferns of Scinde Island* (Napier).

By W. Colenso, F.L.S.

[*Read before the Hawke's Bay Philosophical Institute, 11th October,* 1880.]

I have often thought that it would not be undesirable to bring to your notice the ferns of Scinde Island; that is, I regret to say, those which *were* here until lately, for many of them are no longer to be found within its limits.

And this fact of some of them having already become extinct (like much of the old, striking, and curious indigenous vegetation of the extensive flats and plains adjoining) is another reason, with me, for putting on record those ferns that formerly existed here, which I myself have often seen and, with one solitary exception, gathered. For, in times to come, it might well be doubted whether any ferns—save, of course, the common ubiquitous *Pteris esculenta*—could have ever inhabited this small high, dry, and isolated islet-like limestone mound, destitute of fresh-water.

And there is yet another valid reason, viz., that among them were two, if not three, peculiar ferns, which are also local and comparatively rare in New Zealand.

In the "Handbook of the New Zealand Flora," by Sir J. D. Hooker, 31 genera of ferns, containing 120 species (exclusive of varieties), are described; some of those however have not yet been detected within the area of New Zealand proper, but only in far-off outlying localities—as Chatham, Auckland, and Kermadec Islands. Here, within this small area of Scinde Island, containing only 660 acres (and now comprised within the Borough of Napier), there were no less than eleven of those 31 genera, or one-third of the whole; and of the said 120 species, fourteen, together with, at least, one new species, not known to Dr. Hooker, making a total of fifteen.

Those several genera I will take in the order in which they run in the "Handbook" of our New Zealand flora.

1. *Cyathea.* Of this fine genus of tree-ferns the beautiful new species, lately described by me *(C. polyneuron)*,* was first found in 1865, young and small, growing among the common fern *(Pteris esculenta)*, on my land on the hill-side. I removed it into my garden, where it has thriven remarkably well, although it suffered severely during those two very dry summers in succession of 1878 and 1879; it is now 7 feet high.

2. *Adiantum hispidulum.* This fern has been found growing sparingly in cliffy spots on the west side of the "Island." It is rather rare in all this district.

3. *Adiantum affine.* This pretty little fern formerly grew densely in beds on ledges of the clayey cliffs on the north side of Hyderabad road, at the south end of the "Island."

4. *Cheilanthes tenuifolia.* This fern I have often found in various parts of the hills growing among the common fern. Also, a very large and undescribed variety (or a distinct species of a fern of this genus) of diffuse rambling growth, of which I may have something more of say hereafter, as I fortunately possess specimens.

5. *Pteris esculenta,* formerly all over the "Island," in some parts attaining to a large size, 6–7 feet high.†

6. *Pteris tremula.* This elegant species also grew strongly here. I have still good thriving plants in my garden brought in from the adjoining hill.

7. *Lomaria procera*—a small common variety—grew sparsely scattered in damp shaded spots and gulches on the hill-side; also, a larger variety on the flat below.

8. *Doodia.* A very fine species or variety of this genus also grew sparingly here, which differed largely from the northern species. I have both known and cultivated this fine fern for upwards of thirty years, having in 1848 removed plants of it from this hill to my old residence at Waitangi, near West Clive. Did I not believe that the various plants of *Doodia* found at the north (where also they are very common) are all varieties of one species,‡ I should be inclined to consider our Scinde Island plant as form-

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* "Trans. N.Z. Inst.," Vol. XI., p. 429.

† I know that twenty years ago, before the place was cleared of fern, my mule (a tall animal) was often lost in it, and could only be detected by her big ears just peering above it!

‡ In a description of some (then) newly-discovered New Zealand ferns, published by me in 1843 (in the "Tasmanian Journal of Natural Science," Vol. II., p. 162), I said:—"The number of the species of New Zealand ferns published by A. Cunningham in his 'Precursor" amounts to eighty-five, from which I venture to hazard an opinion at least

ing another and distinct species, inasmuch as it varies considerably from those northern plants (*D. media* and *D. caudata*, of Dr. Hooker's "Handbook"), and does not agree with their separately-published specific characters. It is much the finest of all our New Zealand varieties or species *Doodia*. I shall, however, in a separate paper* give a description of this plant, *D. squarrosa*, mihi.

9. *Asplenium flabellifolium*. I have formerly gathered fine specimens of this elegant little ferm among herbage in gravelly spots; even now it is to found in cliffy nooks on the west side of the "island,"

10. *Asplenium obtusatum*. This common sea-side fern grew on the cliffs near to the Bluff, on its north-east side.

11. *Aspidium richardi*.—This plant grew sparingly in fine tufts on the hill-sides among the common fern. I removed some plants into my garden a few years back, where they have grown very well.

12. *Polypodium billardieri*.—I have found this below at the base of the hill, growing well on, and among old drifted wood, above high water-mark, spring and flood tides, where it had become established.

13. *Polypodium serpens*.—This fern formerly grew in the groove or thicket of karaka trees (*Corynocarpus lævigata*), which stood near the south end of the "island." I think that grove was originally a tabooed spot (probably a burial-place) of the old aborigines, who formerly dwelt here. On my arrival in 1843, and long after, the cormorants (*Graculus varius*) both roosted and built their nests thickly in those trees, so that the spot had the appearance of a small rookery. It was both a pleasing and a curious sight to see them attending assiduously to their young in the breeding season, the white breasts and bellies of the parent-birds contrasting so strongly with the dense dark green foliage of the trees. Very soon after the purchase, by the Government, of this block of land the few early white residents (and especially the military) cut down the whole grove! and also

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two species—*Niphobolus bicolor*, and *Doodia caudata*—will have to be deducted, as I believe these will be found to be merely varieties of *N. rupestris* and of *D. aspera*." At that time I did not know the true *Doodia aspera*, which was then, on the authority of the two brothers Cunningham, and of the French botanist, A. Richard, all of whom had "gathered the plant in New Zealand," said to be a New Zealand fern, but which is now considered an endemic Australian one. Nearly twelve years after my publication, Sir W. J. Hooker, in his "Species Filicum," when writing on *D. aspera*, says:—"Our herbarium, though eminently rich in New Zealand plants (including Sir J. D. Hooker's collections formed there, mainly too in the same spot where those three botanists had formerly collected, viz., the Bay of Islands), does not possess a single specimen of *D. aspera* from that country; and I am hence led to believe that all writers on the botany of New Zealand have mistaken a state of *D. media* for it."—*L.C.*, Vol. III., p. 72.

* See paper "On some new and undescribed ferns" (Art. XLIX.)

nearly all the other small and few scattered trees* of the "Island," merely for the small poles, etc., for rude fencing and for tents. To some of those trees (Ngaio=*Myoporum lætum*) that grew, picturesquely fringing and overhanging the sea (of the inner harbour) at high water, I have known the Natives frequently to make fast their canoes, and, in the summer season, to bivouac under their shade. No Maori of the olden time would have cut down one of those ancient and useful trees! and, when the whites did so, they complained bitterly against it.

14. *Gymnogramme leptophylla.*—This sweet little annual fern still grows here in a few undisturbed spots on the hill-side, where, every spring, I have the pleasure of noticing and welcoming it. I first detected this fern in 1842, growing in sheltered grassy spots among scoria on the dry hills at the head of Manukau Bay, near Auckland, which is the only other locality of its habitat known to me in New Zealand.† Believing it to be a new species, I published it as *G. novæ-zealandiæ*,‡ but, according to Dr. Hooker, it is identical with a British (Jersey) species, which is also found in Australia and Tasmania. Nevertheless there are (as I view it) striking differences between our New Zealand plant and the British one, judging from the ample descriptions, and also the many botanical plates in my possession of that species.

15. *Botrychium cicutarium.*—Fine plants of this species of fern I formerly found here on the hills, but I have not noticed any for fifteen years.

Addendum.

I write this (the fruit of study and research), for the especial benefit of future New Zealand Pteridologists.

Gymnogramme leptophylla. Having the good fortune to possess several drawings and dissections of the European plant, *G. leptophilla*, with ample descriptions, (viz., in Hook and Greville, Ic. Filicum; Hook, British Ferns, Species Filicum, etc.; T. Moore, Index Filicum; Bentham's Brit. Flora; Beddome's Ferns, South India; with others by S. Hibberd, T. Moore, J. Smith, J. G. Baker, etc.) and having also received since writing the foregoing paper, some British specimens of *G. leptophyilla* from Jersey,—I am inclined to say a little more about our New Zealand plant bearing that name, and to point out wherein it differs from the British and European one.

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* As *Entelea arborescens*, *Coprosma bauriana*, *Myoporum lætum*, and *Cordyline australis*.

† During this year (1880) it has also been found, by a member of our Institute, grow ing inland, west from Hawke's Bay, on the hills near the River Mohaka.

‡ In "Tasmanian Journal of Natural Science," Vol. II., p. 165, I find that Sir J. Hooker, in his description of this fern in his "Handbook of the N.Z. Flora," p. 383, has quoted me as having published it as a *Grammittis*. This, however, is an error.

1. In all those drawings and dissections (except in the plate of *G. leptophylla* in Beddome's South India Ferns), though made by different persons. and at widely different times, and not being mere copies from each other, there is a great common likeness—as indeed there should be; but they all show a very much larger, stouter and more leafy and many-fronded plant than our New Zealand one. Sir W. J. Hooker says of the British fern, that "its fronds are *all* bi-tri-pinnate," with their "vachises winged above"; (in his large folio drawing, with dissections in the Icones Filicum, the rachis is largely winged *below* also); such, however is not the case in our New Zealand plant. I have collected scores—perhaps hundreds—of the New Zealand fern (the entire little tufted plant in all its stages) in its two localities *(supra)*, but I have never found one that approached in size or appearance the European one. In fact the New Zealand plant has no such outer (" barren ") pinnated fronds as the British one possesses. The upright fronds of the New Zealand fern are commonly very small, often under 1 inch, and never exceeding $1\frac{1}{2}$ inches, while those of the British plant generally run to 3–4 inches.

2. The New Zealand plant, including its first leaves or small early fronds, has rarely ever a barren one; its first fronds are very small, and often merely kidney-shaped with crenate edges, or small incised lobes, and when tri-lobed or parted, are simply once so, and are then differently lobed to those of the European plant, never being regularly pinnated like the barren fronds of that one; they are also generally all fertile, however small. The texture of its fronds is also more stout and herbaceous than that of the British one, which is always described as being "membranaceous."

3. The larger and more upright fronds of the New Zealand plant are not only very much smaller with fewer pinnæ, but their segments are all smaller and more acute and pointed, often sharply bifid; while those of the British plant are rounded and obtuse. Their stipes are also much longer in proportion to the size of their fronds. The stipe is also of a bright red colour, glossy and deeply channelled on the upper surface; while the stipe of the British plant is always described by all authors as being "black."

4. The sori in our New Zealand plant are much more diffuse and confluent, generally covering the whole of the undersurface of the segment, never disposed in clear lines on the veins as in the British one. The veinules, too, are longer approaching nearer to the margin, and not extending beyond the sori as in the British plant. Often on the small reniform first fronds the sori are regularly disposed in almost circular spots, free, and distinct at the apices of the venules just within the margin of the frond. The sporules also are more angular, black, glossy, and pitted, characters which are wanting in those of the British plant.

Dr. Hooker, in his "Handbook," says of our New Zealand plant,—"Fronds 1–8 inches, veins dichotomous;" and in his "Flora of New Zealand" (where it is more largely described), it is also said to possess a flexuose midrib ("Costa flexuosa"); characters, however, which I do not find pertaining to our New Zealand plant. In my first published description of it *(supra)* I said,—"Frond 6–20 lines long; veins simple, forked;" and I had plenty of specimens.

Curiously enough the first or smaller fronds of Beddome's South India plant *(l.c.,* tab. 270) more resemble some of our New Zealand ones, in simple outline and in being fertile; although the long flexuose stipe is altogether dissimilar being very much longer and more wiry. Beddome also remarks (in opposition to Sir W. J. Hooker's observation on the British plant), that,—"All my specimens have all their fronds fertile." From its appearance however, as shown in the drawing (by no means a good one), I should infer its being distinct from the European *G. leptophylla*, though nearly allied.

There are also two or three other well-known closely allied yet distinct annual species described by Sir W. J. Hooker in his "Species Filicum," as *G. chærophylla* (from South America) and *G. ascensionis* (only found in the small islet of Ascension); and it seems to me that the difference between those two allowed distinct species (of which I also have both drawings and dissections in the Botanical works above mentioned, and the European *G. leptophylla* is not greater than that between it and our New Zealand plant.

G. leptophylla is also said to be found in Australia and Tasmania (*vide* Hook. f., Fl., Tasmania, and Bentham's Fl. Australiensis), but I have not seen a specimen nor a drawing of either of them. They may more closely correspond with the European one than ours of New Zealand do; or they may be more closely allied with ours (which I am inclined to believe from the descriptions of them), or, as it were, be intermediate. I note that Bentham says of the Australian plant, "often under two inches high," etc., and Dr. Hooker, of the Tasmanian one, says, "Fronds an inch to a span high; pinnules 2–4 inches long; stipes and rachis usually red-brown," etc. All this agrees more with the New Zealand plant than with the British one, excepting the span high. It seems to be excessively rare in Tasmania, having been only found by one person, and that once only, and many years ago, and in a cave.

Evidently, however, by all those distinguished European botanists, who could only have seen the Australian, Tasmanian, and New Zealand plants in their dried state, and, I fear, without their characteristic first or early fronds, which soon wither (often before the large upright ones are fully developed) by them, one synthetic description, more particularly framed from the handy living British plant, serves for all. I very much fear that this systematized amalgamation of ferns from all countries, however opposite in climate and geology (although a very good thing in itself, and when not pushed to extremes), will be hereafter found to have been injuriously carried too far with not a few of our New Zealand ferns. To this subject I hope to return anon.

Art. XLIX.—*On some new and undescribed New Zealand Ferns.*

By W. Colenso, F.L.S.

[*Read before the Hawke's Bay Philosophical Institute, 8th November,* 1880.]

Hymenophyllum pygmæum, n.s.

Rhizome capillary, creeping, spreading, much-branched and entangled, tomentose with fine red hairs; *plant* of densely matted growth; *stipe* 1–2 lines long, erect, solitary, 2–3 lines apart, sometimes two together springing from a node of the root-stock, filiform, terete, naked, sometimes bearing a few scattered minute weak reddish scales; *frond* 2 lines long including involucre, 2–4 lines broad, fan-shaped in outline, colour light green, glabrous, pinnate, generally one pair of pinnæ (very rarely two pairs, or three single ones, or a single pinna), which are petiolate, sub-opposite, and inclined upwards; *pinnæ* 1–2 lines long, membranaceous, broadly oblong, narrowest downwards, costa stout, not reaching to the margin, apex very obtuse and margin there entire, sides of pinnæ laciniated or slashed, teeth 3–5 on a side, long, acuminate, falcate, and only of the cellular substance of the pinnæ; *involucre* ob-conical, free on apex of short rhachis, 1½ lines long, 1 line broad at top, bearing a few scattered soft spinulose processes; *valves* scarcely rounded, divided less than half-way down, fimbriated with 14–17 translucent flexuose and subulate long green teeth or cilia wholly composed of cellular tissue (a truly beautiful object under a microscope); *receptacle* included, or slightly protruding in age.

Hab.—On cliffs, Preservation Inlet; on rocks, Resolution Island; and on rocks at the Bealey, *J. D. Enys;* hills round Lyttelton Harbour, Westland, coast south of Hokitika, etc.

This very minute fern (probably the smallest of the many small comforms of *Hymenophyllum*, and perhaps the smallest of all truly pinnate ferns) has been long known to me, but only through kind friends and correspondents; for, although I have received a copious supply of specimens both dried and living, I have never gathered it myself. It has always been sent to me, from various sources, bearing the name of "*H. minimum*;" the correctness of which name I have ever doubted, but as I had never seen an authentic specimen or botanical drawing of that fern I did not greatly care to controvert, although I never could make my specimens to agree with the several published descriptions in my possession of *H. minimum*. Desirous however of deciding the point, I have recently obtained from Paris a copy of the Botany of the voyage of the "Astrolabe" (Admiral D'Urville) by Lesson and Richard, with its folio atlas of plates, in which that New Zealand fern is fully described by its discoverer, together with *several* drawings of the whole plant with dissections; and I very soon found that my conjecture was true, and that this little fern which I have here described has scarcely any affinity with A. Richard's plant *H. minimum*, which is altogether distinct, belonging to a widely different natural section of the genus Hymenophyllum.

Indeed, I can scarcely understand how this fern came to me so commonly, and for so long a time, too, considered as A. Richard's plant, except perhaps from its possessing a single terminal involucre, its small size, and its specific name (!) which, combined, seem to have led collectors astray. (I believe that this plant has been also published, name only, in some preceding volume of the "Transactions," as the real *H. minimum!*) That plant I have never yet seen, and I almost venture to doubt of its having been again found in New Zealand since D'Urville's visit in the "Astrolabe," who discovered it.* Dr. Hooker, however, did find it at the Auckland Islands, and has given a full and particular account of it in the "Botany of the Antarctic Voyage," Vol. I., p. 103.

It has been the fate of the true *H. minimum* to be very unfortunate (like not a few others of our New Zealand ferns)! More than fifty years have passed since its discovery in New Zealand, it was soon however published at Paris to the scientific world, and well, too—both in descriptions

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* I am aware that Dr. Hooker, in his "Handbook of the New Zealand Flora," under *H. minimum*, says,—"Middle Island, Otago, *Hector* and *Buchanan*;" but I am not certain whether that information was obtained from specimens or from a letter. Be this as it may, Dr. Hooker also says (*l.c.*),—"North Island, on roots and stumps of trees, *D'Urville, etc.*;" which is, I think, an evident error, and it is almost certain that the French Botanists must have obtained their specimens in Tasman's Bay ("*Hâvre de l'Astrolabe*") on the south side of Cook Straits, where they spent some time and obtained many novelties. Moreover, who the other Botanists or collectors can possibly be (included in the "*etc.*" of Dr. Hooker), who found the *H. minimum* (A. Richard), in the North Island, I cannot imagine. I know that the Cunninghams did not detect it (Allan, C., in the specific description of it in his "Specimens of the Botany of New Zealand," merely copying from A. Richard); and, as I have already mentioned, I never found it, although I always sought it most assiduously.

and drawings with dissections. Notwithstanding Sir W. J. Hooker, in his celebrated "Species Filicum," (published some fifteen years after), included it under *H. tunbridgehense*, as a mere synonym of that plant, not even allowing it to be a variety ! And more lately, Baker (of Kew), in his "Synopsis Filicum," has only tardily admitted it to a place, as a species, in the Appendix to that work. Bentham in the last volume of the "Flora Australiensis," has included it therein—but only as having been found on one spot, on Lord Howe's Island. Can it be, that this little fern *(H. minimum)*, is both a littoral plant and a lover of rocky islets? All present book evidence tends that way. D'Urville may have originally found it on one of the many islets or cliffy headlands in Tasman's Bay. And here it is to be noted, in passing, that while the precise spot is given of not a few of the New Zealand plants discovered by the French on that occasion, all mention of such is omitted under the full description of this one :—*Crescit in Nova Zeelandia*—is all that is said.

Another error occurs concerning it in the "Hand Book," which it may be well to notice. *(Amicus Plato, amicus Socrates, sed magis amica veritas.)* There it is said to have a "frond 1–2 inches high," which is further described as if possessing (several) "involucres." Baker, however, (*l. c.*) rightly describes its "frond as being $\frac{1}{2}$–$\frac{3}{4}$ inches long," but "with several close-spreading distinctly-toothed *pinnæ* (?), the upper simple ligulate, the lower often forked ;" and so Bentham (*l. c.*)—"frond $\frac{1}{4}$–$\frac{1}{2}$ inch long, deeply divided into 5–8 simple or bifid segments," adding, however, "sori, usually one only to each frond,"—as if he had seen more.

Therefore, seeing there is such great disparity between those descriptions, as well as omission of some of its more peculiar specific characters (and as *H. minimum, vera*, is still unknown to me as a New Zealand fern, and wishing to direct the attention of collectors in the Southern Island to it), I will just give (in English) the main part of A. Richard's original description of it (the original type specimens) from his botanical work *(supra)* :—

"Plant very small; root creeping; frond scarcely $\frac{1}{2}$ inch long, erect, solitary, stipitate, pinnatifid; colour lurid red; lowermost pair of segments greatly divided, obtuse, much serrated; segments folded lengthwise; involucre solitary, terminal, oblong, obtuse, semi-bivalve ; margins of valves toothed *(dentatus)*."

And then the several drawings of his plant accompanying his description fully bear him out; for he has carefully given no less than five full-sized fronds, four of them singly arising from the same rhizome, and all remarkably alike, and quite symmetrical. And not only so, but from them we gain other important characters, each pinnatifid frond possessing five pairs of involute segments, the lowermost pair being deeply and falcately cut nearly to the base, each of these forked segments being also deeply serrated on both sides, and having also a costa are very much recurved all the segments have sharply-serrated margins and apices, each having 6–8 teeth on its side and three at the apex, with the midrib extending through to the margin and terminating in the central tooth, while the involucræ possesses very short, sharp, rigid teeth. The whole appearance, at first sight, strongly reminding one of a small spiny holly leaf *(Ilex aquifolium)*.

Hymenophyllum scabrum *var. nov.* hirtum.

Rhizome long, creeping, stout, densely clothed with red shaggy fine hair; *stipe* stout, 3–3½ inch long, thickly hirsute, also the main rhachis, with light-coloured (scarcely reddish) flexuose hairs 2–3 lines, long, flattened, and finely and regularly jointed, 20–22 joints to 1 line; *frond* deltoid-ovate 5–6 in. long, 5–5½ in. broad near base, curved, pinnate below, elastic, and possessing a very similar strong odour to that of *H. sanguinolentum;* every secondary rhachis, costa vein, and veinlet thickly covered below with red adpressed hairs; *pinnæ* bi-pinnatified, sub-opposite, falcate, thickly set on rhachis, overlapping; *segments* broader, larger, and more profuse than in *H. scabrum*, with their apices entire; *secondary rhachises, costæ,* and *veins* prominent; *involucres* broadly deltoid, finely and closely toothed, free to base, inflated, open, of a lighter coloured green than the frond. *Young fronds* and stipes, before unrolling, densely shaggy, with long light brown hairs.

The whole appearance of this fern is widely different from *H. scabrum (vera)*, it is not only shorter—having a dwarfed form, and is much more shaggy, but it is more dense in its vernation, and much less rigid. Its colour, too, is a lighter green.

Hab.—On the ground in the "black birch" *(Fagus solandri)* forests, east spurs of the Ruahine range, where it grows pretty uniformly in thick beds, but is not often found bearing fruit.

I have long known this fern (indeed, Sir W. J. Hooker had some inferior first specimens of it, which I had sent him, when he compiled Vol. I. of his *Species Filicum* in 1846), and I have again of late—during the summers of 1879–1880—enjoyed myself among it in its native forests, and have diligently compared its living specimens with those of the larger and coarser variety, *H. scabrum.* And having also lately been studying *H. scabrum* (*vera*) of A. Richard (on seeing a plate of it with dissections in his "Botany Voyage de L'Astrolabe," already mentioned under *H. pygmæum* (*supra*), and comparing therewith the modern descriptions of *H. scabrum*, as given by our more eminent English pteridologists, Sir W. J. Hooker, Sir Jos. Hooker, Mr. Baker, and Mr. J. Smith, in their various works on ferns), I have noticed how greatly this plant varies, not merely from the original type specimen as first published by A. Richard, but also from what is recorded of it by our English botanists.

Therefore, I have concluded to bring it forward, and so make it known to botanists and also to collectors, for without doubt it would form a choice and elegant garden fern, provided the proper culture could be given it.

Dr. Hooker, in his "Handbook New Zealand Flora," says of *H. scabrum*: "Stipes and rhachis brisily, frond dark green, involucres orbiculate, etc.;" and Mr. Baker, in his *Synopsis Filicum*, where he has placed it in the section of Hymenophyllum, having "glabrous fronds," says of it: "Stipes and main rachis ciliated with long brown brisily hairs, involucres small," etc.; and in an additional remark mentions its "*hairy rhachis* as forming a link between the glabrous and truly hirsute species;" and Mr. J. Smith (who had often and that for a long period had the great advantage of seeing *H. scabrum* in a living state at Kew) places it, in his most recent work on ferns (*Historia Filicum*) in the section of Hymenophyllum, having their "fronds glabrous and stipes and rhachis *rarely pilose*." All this, however, does not agree with the characters of this very villous variety; and just so it is with the descriptions and botanical plate of *H. scabrum* by A. Richard (*supra*).

Its copious large-jointed hairs form such a striking object, even to the naked eye (while under a microscope they are most beautiful!), and together with its densely hirsute ribs, veins, and veinlets, extending all over the frond, and large light-green open involucral valves, give this variety a most striking appearance.

? Pteris Lomarioides.

Stipe (upper part only) 5 in. long, ? erect, straight, slender, naked, smooth, channelled above, straw coloured; *frond* 6½ in. long, 5 in. broad, symmetrical, broadly round cordate (in outline), pedate, smooth, glabrous, very membranaceous, semi-transparent, colour (dry) a light olive-green, pinnate, two pairs only, and one long terminal segment 5¼ in. long, 10 lines broad, petiolate, linear-lanceolate (together with pinnæ) decreasing but little and very gradually downwards, sub-accuminate acute; *pinnæ* opposite, linear-lanceolate oblique obtuse, the two pairs 1 in. apart on rhachis, upper pair sub-sessile and slightly decurrent on lower side, 3 ¾ in. long, 9 lines broad; lower pair petiolate and pedate, slightly decurrent on upper side 3½ in. long, and 8 lines broad, lowermost pedate segments 1¾ in. long, 6 lines broad, sub-sessile, dimidiate, and curved upwards, all four pinnæ inclined inwards and upwards; *veins* regular and parallel, conspicuous, fine, pretty close (about 2¼ to a line), free and simply forked with clavate apices terminating within the margin, which is slightly cartilaginous and crenulate, and closely and finely serrulate, particularly towards and at apices of pinnæ and terminal segment; *midrib* finely channelled above, and very conspicuous on under-surface, slightly puckered, evanescent towards apices of pinnæ, very light straw coloured; *hairs* (*debris* of, remaining in lacunæ in axils and bases of pinnæ) bright red-brown. ? *Pteris lomarioides*, MIHI.

Hab.—In a wood close to the coach road near Tapuaeharuru, between Napier and Taupo.

This fern, of which (I regret to say) I possess only one barren specimen, has given me no little trouble. I obtained it in 1872, from an acquaintance who had travelled overland from Taupo to Napier, and who, on passing through a wooded spot on foot, had carelessly gathered it, and afterwards, on remounting the coach, had brought it on to Napier and gave it to me; he said its *habitat* was near Tapuaeharuru. It was quite perfect, save the lowermost part of its stipe, fresh, and in very good condition. I have subsequently, on several occasions, endeavoured to get more and better specimens, by writing to residents in that locality (even enclosing drawings), but have always failed. Until lately, I did hope to visit the locality and to seek it myself, but that hope has been some time abandoned, and therefore I now have made it known in hopes of some one finding it. Not being certain of its genus I have merely provisionally named it *Pteris lomariodes*, (from those two genera being so commonly and largely represented in New Zealand, and from its possessing the venation of the more simple species of *Pteris*, with a faint likeness in colour and form of pinnæ to some species of *Lomaria)*, although it may turn out to be a *Gymnogramme.*

One great peculiarity of this fern is, that it does not remind one at first sight of any other of our New Zealand ferns; although each of its pinnæ in single outline and appearance slightly resembles those of some states of *Lomaria procera*, yet in habitat, texture, oblique form and venation, they widely differ, not to mention its sub-pedate figure. In analogy it seems near to some of the simpler species of *Pteris* (§ Eupteris), particularly *Pt. pellucida*, *stenophylla*, *dactylina*, and *cretica*; a plate of *Pt. cretica* in Beddome's ferns of South India (Pl. XXXIX., the smaller right-hand figure) has a tolerably good partial resemblance, still it differs materially. Besides, in all our living plants of *Pt. cretica* (which species is pretty largely cultivated here), there are no such fronds as this one represented by Beddome. Nevertheless *Pt. cretica* is a Polynesian fern, as it is said to have been found in Fiji and the Sandwich Islands. In its simple clavate venation this fern certainly has affinity with *Nephrolepis* (a simple species of that genus having been also found at the hot lakes in the interior, not very distant from the *habitat* of this fern), but it wants the cretaceous spots of that genus. In its venation, hair, texture, and general form, it also has affinity with some species of *Gymnogramme* (§ 1. Eugymnogramme), particularly with *G. javanica*, which is also said to have been found in the Sandwich Islands. In fine, when hereafter discovered in fruit, I have little doubt of its belonging to one of those four mentioned genera—*Pteris*, *Lomaria*, *Nephrolepis* or *Gymnogramme*.

Doodia squarrosa, n.s.

Caudex short, thick, oblique, sub-ascending ; *roots* many, stout, long, black, and wiry, densely clothed with shaggy black shining patent hairs ; *plant* of densely cœspitose close, sub-erect, and squarrose habit, many fronds springing from one stock ; *stipe* rather slender, 6–8 in. long, scabrous yet glossy, straight, and sub-flexuose, deeply channelled on upper-surface, clothed (especially below) with black chaffy acuminate hair-pointed scales, 3–3½ lines long and 1 line broad at base, striated and minutely reticulated, reticulations oblong, stipe sub-muricate in distant dots where the scales have fallen ; *rhachis* slender, brittle, channelled throughout on upper surface, pale-coloured in the upper part, brownish in the lower, with scattered long brown tortuous weak and shrivelled scarious scales ; *fronds* pale green, sub-membranaceous, glossy yet minutely roughish and harsh to feel, dry, sub-rugose and rigid ; the very young circinate and undeveloped ones 2–3 in. high, clothed with long black subulate and pointed scales ; *fertile fr.* lanceolate, very acuminate, 18–19 in. long, with a very long terminal segment ; breadth (mid.) 4½–5¼ in., pinnate, length of pinna (mid.) 2¼–2½ in., breadth 4 lines, margins of pinnæ and segments sinuous, cartilaginous, sharply and irregularly spinuloso-serrate with white sharp teeth ; *costæ* deeply channelled above ; *pinnæ* opposite, 24–28 jugate, sub-falcate, linear, broadest at base, obtuse and truncate ; 4–6 *lowest pairs* sub-petiolate, free, largely hastate, and largely auricled upwards, 10 lines long, 4–5 lines broad at base ; *upper pinnæ* sessile, free upwards and auricled, decurrent downwards ; 3–4 pairs *uppermost pinnæ* slighsly pinnatifid ; 5–8 pairs *lowermost pinnæ* very distant, 1 inch apart on rhachis, with the distance between them gradually decreasing upwards ; *terminal segment* very long, 4½–5 in. long, 3 lines broad, linear, strap-shaped, obtuse, sometimes sub-flexuose and sub-crenulated, not unfrequently auricled below and coadunate with adjoining segments, occasionally bifid at apex, each segment 8–14 lines long ; *veins* as in the genus, but coarse and much produced ; *sori* biserial, crowded yet not confluent (save through age in very old fronds), distant from costa, those in row nearest to costa longest, 1–2½ lines long, outer row shorter, often composed of mere dots, biserial on auricles and wings of pinnæ both upwards and downwards, sub-triserial on some long terminal segments, when fully ripe dark-brown and semi-confluent ; *involucre* linear, narrow, pale-coloured, scarious, margin sub-erose, in outer row often sub-lunate and mere dots, but still the same kind of involucre ; *barren frond* much as fertile, only shorter and texture a little thinner; *pinnæ* linear-oblong, broader, 3–4 lines broad, obtuse; *terminal segment* somewhat shorter and broader, 4–6 lines broad.

Some semi-barren fronds present a peculiar appearance; a few pinnæ having single rows of scattered sori, in very small linear and semi-lunate dots, each scarely one line long, which are again sometimes biserial and distant on the terminal segment, and on a few of the larger pinnæ. If these peculiar fronds were not found growing from the same root or caudex with the larger and fertile ones, they would be set down as forming a different species or variety.

Six species of *Doodia* are very fully described by Sir W. J. Hooker in his *Species Filicum*, including those known to him from New Zealand; I possess botanical drawings with dissections of them all, with none of which as well as with their descriptions) does this plant agree. To our New Zealand "*D. caudata*," of which, though possessing copious specimens from several botanists, Sir W. J. Hooker says, "All these from New Zealand border too closely upon *D. media* (*Sp. Fil.*, Vol. III., p. 76); it approaches in its long terminal segment and narrow (fertile) pinnæ; but that Australian species, though a very much smaller plant, is said to be "pinnate nearly to the summit," with the "sori in a single series," its "indusia sub-lunate, stipes naked at base," and "its rachis quite smooth," etc. It also has pretty close affinity with *D. media*, but differs still more from this common New Zealand species. In its regular double lines of closely-compacted sori, and in their great excess, extending both upwards and downwards on the auricles and wings of its broadly-adnate pinnæ (as it were *sursum currens* and *decurrens*), which give a kind of winged appearance to the rhachis, though still truly pinnate, every pinna being separate, and also in its black paleaceous stipes and scales, it seems te have affinity with *D. dives*, a Ceylon species, especially with the variety *β zeylanicum*, Hook., of that species, of which Sir W. J. Hooker says,—"The wings of the rachis bear sori as well as the segments and pinnæ" (*l.c.*, p. 74), but the involucres in the Ceylon plant are all lunulate and broader, and the pinnæ and venation different. (A fine free drawing, with dissections of this plant, is given in *Beddome's Ferns of S. India*, p. 222, all showing its very great distinctness from the Napier plant.) It seems also to be equally distinct from five newer and additional Polynesian "varieties," briefly described by Baker in his *Synopsis Filicum* (appendix, p. 482), nearly all of which have their sori uni-serial.

I have given, I may say, some amount of extra examination at various times extending throughout many years, to this plant, having it here growing around me—as may be inferred from my full description of it; and while I advance it as a distinct species, I do so with some hesitation, and mainly from the fact of its disagreeing in several important characters with those of the other described species of *Doodia*, not a few of which, I think, will hereafter prove, when examined and compared together in a living state (the only way of true comparison), to be but varieties. Sir W. J. Hooker truly enough said (though he only knew of those six species first mentioned above)—"All our species of the genus are singularly variable." (*l. c.*, III. 75.) See, also, my remarks on the genus *Doodia*, in my preceeding Paper "On the Ferns of Scinde Island (Napier)."

Art. L.—*Descriptions of new Plants.* By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 4th December,* 1880.]

Olearia angulata, n.s.

A much-branched shrub, 8–12 feet high; branches grooved, short; leaves $1\frac{1}{2}''$–$2\frac{1}{2}''$ long, broadly elliptic, rounded at the apex, truncate at the base, waved at the margins, clothed with appressed white tomentum below, veins forming nearly a right-angle with the midrib; flowers in axillary panicles, peduncles equalling the leaves or longer, branches short, spreading, angled, pubescent, heads shortly pedicelled, involucral scales linear-oblong, laxly imbricated, ciliated; florets 3–5, one or two with a broad ray, achenes strigose, pappus in two series.

Hab.—North Island, North Cape, Spirits Bay. In habit and foliage this species approaches *O. fosterii*, while it is closely allied to *O. albiflora* by the inflorescence. It appears to have been confused with *O. albiflora*, and has a still more restricted range than that species.

Dracophyllum prostratum, n.s.

A small prostrate species, stems 3″–12″ long, with short branches; leaves $\frac{1}{8}''$–$\frac{1}{10}''$ long, ovate subulate, with a broad sheathing base, glabrous; flowers solitary, terminal, sepals ovate, obtuse, shorter than the corolla.

Hab.—South Island; mountains above Lake Harris, Otago, 4,000 feet, *T. Kirk*; Mount St. Bathans; and Stewart's Island, *D. Petrie.*

A variable plant in habit, although constant in its leaves and floral characters. The branches are never so densely crowded as in *D. muscoides* Hook.f., although Mr. Petrie's specimens approach that species in this particular. The Lake Harris specimens, owing to their exceptional habitat, creeping amongst sphagnum, were very lax and glaucous, but in other respects agree with those from Mount St. Bathans and Stewart Island.

Schænus moorei, n.s.

Tufted, leaves shorter than the culms, filiform, slender, grooved, with reddish brown sheaths. Culms 4″–6″ high, slender, grooved; panicle solitary, lateral spikelets, 2–3 one always pedunculate, 3-flowered glumes imbricated, ovate-lanceolate, margins scarious. Bristles 6 shorter than the style, stigmas 3 ; nut triquetrous.

Hab.—North Island—at remarkable saline springs, Glenburn, East Coast. Forming large masses in the immediate vicinity of the springs. Allied to *S. pauciflorus*, Hook, f., but a much smaller, less tufted plant, with narrower, shorter spikelets, and broader glumes.

AGROSTIS MUSCOSA, n.s.

A small grass forming wide patches, not more than one inch in height. Root creeping. Leaves longer than the culms, filiform, flaccid, more or less recurved, ligule minute lacerate. Panicle hidden among the leaves, recurved, $\frac{1}{4}''$–$\frac{1}{2}''$ in height, few flowers. Empty glumes, equal, scabrid at the margin. Flowering glumes, ovate, truncate. Pale O. Ladicule acute. *Agrostis canina* and *B. subulata;* "Hand Book N.Z. Flora," *in part. Agrostis subulata*, t. XX. "Buchanan N.Z. Grasses."

Hab.—South Island. Broken River basin, and other places in Canterbury. Lake district of Otago. Probably not uncommon in mountain districts in the South Island, but easily overlooked. In the "Hand Book of the N. Z. Flora," this species is confused with *Agrostis subulata*. Mr. Buchanan has fallen into the same error in his "Indigenous Grasses of New Zealand," where he figures the present plant as *Agrostis canina, L. B. subulata*, and unaccountably identifies it with the *Agrostis subulata* of "Hooker's Flora Antartica," t. LIII., a much larger grass with erect panicles.

This species is probably common in the South Island, although I have only collected it in the districts mentioned. So far as I am aware it has not been observed in the North Island.

Agrostis subulata, Hook, f. "Fl. Antartica," t. LIII., differs from our plant in the erect keeled leaves, which are narrow and slightly keeled, never filiform; the panicle is much larger, erect, never recurved, and although hidden amongst the leaves at first, yet when fully matured it slightly exceeds them in length.

ART. LI.—*Description of a new species of* Thysanothecium *collected by Mr. Buchanan during his recent expedition to the Southern Alps.*

By CHARLES KNIGHT, F.R.C.S., F.L.S.

[*Read before the Wellington Philosophical Society, 12th February*, 1881.]

Plate XVII.

AMONG Mr. Buchanan's plants, lately collected in the Southern Alps, there is a remarkable Lichen gathered on Mount Aspiring Range at an elevation of about 4,000 feet. It belongs to the genus *Thysanothecium* of which there were only two species previously known, both of which were found in Western Australia by Mr. Drummond, the Colonial Botanist. It is worthy of notice that the New Zealand plant was gathered on a glacier, while those in Western Australia grew on burnt-up timber. As these Lichens are exceedingly interesting to botanists I have made drawings and drawn up description form Mr. Buchanan's specimen, and have named it *Thysanothecium Buchanani* in recognition of that botanist's valuable contributions to the botany of the Southern Alps.

Thysanothecium buchanani, sp. n.

Thallus in duabus partibus formatus. 1° Pars horizontalis lobulato-squamulosa e viride lurida, squamulis in crusta granulosa areolata congestis. 2° Podetia erecta brevia in apothecia foliacea dilatata (alt. circa 6 mm.).

Apothecia sciphi compressi instar plicata, nonnihil in limbum planum producta, rigida apice inflexa et granulosa, disco testaceo-rufescenti receptaculum thallinum reticulatum omnino tegenti; hymenium incolor excipulo proprio luteolo strato gonimico imposito enatum, paraphysibus rectis capillaribus septatis adglutinatis apice non dilatis. Sporæ 8næ una serie dispositæ sphericæ incolores diam. ·013 mm.

Corticale receptaculi stratum ex elementis filamentosis directis ad laterem constitutum.

Supra molem nivium frigoribus conglaciatam in summis montibus (" Aspiring Range "), alt. 4,000 pedes.

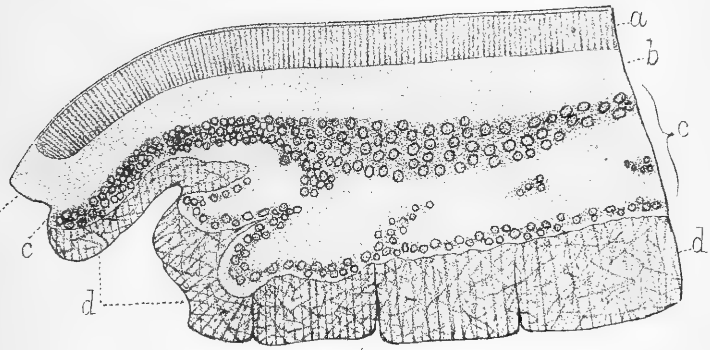
EXPLANATION OF PLATE XVII.

Fig. 1. Spores and Paraphyses × 470.

2. Gonidium × 470.

3. Foliaceus apothecium—Hymenium within the pseudoscyphus, × 2.

4. Longitudional section of apothecium, showing hymenium (*a*); proper excipulum (hypothecium) (*b*); white medullary layer with gonidia (c); colourless corticular layer (*d*), × 30.



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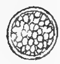

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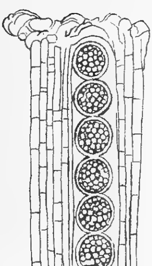

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C. Knight, del. THYSANOTHECIUM BUCHANANI, Knight. J.B. lith.

IV.—CHEMISTRY.

Art. LII.—*On an Allotropic Form of Zinc and Cobalt Salts.*

By William Skey, Analyst to the Geological Survey Department.

[*Read before the Wellington Philosophical Society*, *4th December*, 1880.]

In testing some ores for certain metals, I obtained reactions with both the ferro- and ferri-cyanide of potassium, which, according to our present knowledge, indicated the presence of lead and copper, although further analytical processes showed both metals to be altogether absent.

Upon taking a retrospect of my operations throughout, I found that the solution which I had prepared for my tests were either uniformly alkaline or, if acid, *had been at one time in an alkaline condition.* The idea therefore occurred to me that alkalies modify the basic portion of these salts—that is, their metallic oxides, and that the forms to which they are thus modified possess sufficient stability to enable them to withstand the disintegrating effect of acid; and upon testing the matter, facts were elicited which, as will be seen, conclusively prove that this idea is correct. Thus I found—

1. That a solution of any zinc-salt alkalized with a fixed alkali, even at a common temperature, and then acidified with nitric, sulphuric, hydrochloric, or acetic acid, gives, upon the addition thereto of potassic-ferri-cyanide, a yellow precipitate, which shortly turns white, or else a white precipitate at once, instead of the brownish one which all text-books on chemistry teach us to expect.

2. That the solution thus prepared with either hydrochloric or sulphuric acid afford the brownish precipitate with a ferri-cyanide after being boiled for a short time, or after being kept two or three weeks in the dark or in light.

3. That the solution with nitric acid, after boiling, gives a yellow precipitate with the ferri-cyanide.

4. That the solution with acetic acid, when boiled, still gives the white precipitate with this salt.

5. That the white precipitate produced in the above operations is the ferro-cyanide of zinc; not the ferri-cyanide, as would be anticipated.

6. That a solution of cobalt when boiled with ammonia in excess affords with potassic ferro-cyanide, a precipitate which is of a rich brown colour

instead of being yellowish green, as our present knowledge upon the matter would lead us to expect.

7. That if the ammoniacal solution prepared as above is acidified *before* the application of the ferro-cyanide thereto, the precipitate which then ensues is of the colour we should look for that is yellowish-green.

8. That as far as I have yet examined this dark precipitate, it appears to be the ferri-cyanide of cobalt.

It thus appears that both zinc and cobalt oxides may, when in contact with certain salts, give us reactions which are altogether different to those which we have hitherto been cognizant of; consequently these oxides are capable of, and actually do in these cases, assume an allotropic form.

The characteristic of these oxides when in this form, is that they change the quantivalence or degree of basicity of ferro- and ferri-cyanic acids, so that they are transformed the one into the other (the acids themselves being, as you may remember, isomeric). Thus accomplishing that for which an oxidation or de-oxidation process has hitherto been deemed necessary.

I should in this connection inform you that manganese oxide, in solution, when boiled with ammonia in excess refuse to afford a precipitate with potassic ferri-cyanide. We only get this by acidifying the solution.

It seems therefore that careful cognizance should be taken of these facts by anyone making a qualitative analysis for the metals referred to, and using for this either of the tests above-named. The urgent necessity there may be for "acidifying" and then "boiling" the solution in the one case and of acidifying in the other, is clearly shown. If these precautionary operations are not taken zinc may be mistaken for lead, and cobalt for copper.

Art. LIII—*On a Periodide and an Iodo-Carbonate of Lead.*

By William Skey, Analyst to the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 4th December,* 1880.]

If to a solution of a lead-salt and borax iodine dissolved in an aqeous solution of potassic-iodide is added a crystaline precipitate copiously forms, and which differs from the only plumbic-iodide which we now know in being of a brick-red colour (instead of yellow), and in being far less soluble in water than it.

I have not had time to fully analyse this new compound, but it is undoubtedly the per-iodide of lead. I merely note it here and the manner of its production, as it forms the basis of the salt which I desire especially to bring before your notice.

When this periodide is exposed to the air it gradually acquires a blue colour, but if allowed contact with sodic-bicarbonate in quantity this colour is produced instantaneously and voluminously with a beautiful and striking effect. In shade it is not to be distinguished from that of the compound of iodine with starch.

The new salt thus produced is almost, if not entirely, insoluble in water, hot or cold, also in potassic-iodide or alcohol, nor is its appearance changed by these liquids.

Treated with any ordinary acid, even with the acetic, it is instantly decomposed, carbonic acid and iodine being liberated. Any free alkali also decomposes it; carbonic acid, even, in conjunction with water, decomposes it, but very slowly, iodine being liberated in a free state. By spontaneous evaporation, it can be had in acicular crystals.

It appears to be composed of iodine and carbonic acid with lead and oxygen.

The effect of a long-continued contact of this salt with carbonic acid and water is to produce another compound of quite a different kind. This is insoluble in acetic acid and quite colourless.

There are two points in connection with this subject which I would particularly desire to bring to your notice; they are—first, that this reaction of per-iodide of lead with carbonic acid is a very delicate and beautiful test for this acid; thus when shaken up in a finely granular form (as precipitated) with ordinary spring or rain water, mixed with a little borax if need be, or if breathed upon, the presence of this acid is revealed by a greenish colour being instantly communicated to the water, which colour soon passes to a blue if the acid is present in more than a very minute quantity. This is a striking demonstration for the lecture-room, and the only chromatic test as yet known for the presence of the acid cited.

The next point I wish to note is the striking resemblance of the colour of this new compound to that of iodine with starch. This is strongly suggestive of the idea that in both compounds the iodine is in the same molecular state, and consequently that the compounds themselves possibly are in some fundamental points analagous.

ART. LIV.—*The Dimorphisim of Magnesia.*

By WILLIAM SKEY, Analyst to the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 4th December,* 1880.]

WHILE trying to electro-deposit gold from sea-water, so as to verify Sonstrad's observation regarding gold in sea-water, and if possible to estimate it, I applied iodine to the supposed auriferous deposit, when a highly coloured substance formed. This I at first took for palladium-iodide, but soon found it to be magnesium oxy-iodide, or at least a substance made up of the three substances—mag-nesia, oxygen, and iodine.

Afterwards I found that magnesia, prepared at a certain temperature, behaved just like this electro-deposited magnesia, that is in absorbing iodine. At a high temperature, about 1,000° F. both these forms of magnesia lose this absorbent property.

Certain aniline dyes and cochineal, also, are absorbed by this modified magnesia.

From these facts I make the deduction that magnesia can exist in two forms, and this receives confirmation by the fact that it is made denser by ignition.

Further I find that magnesia may be exhausted out of ammonaical solutions by an electric battery of two cells, and this really forms a capital way for separating and estimating it in analysis. The alkalies are then in due course left pure for easy estimation. The phosphoric acid, which is now used to effect this, and which complicates the process so much, being thus rendered unnecessary.

But not only is quantitative analysis thus aided in this case, but the detection of magnesia by means of the battery and iodine becomes a very simple matter, and especially to be recommended for use when but small quantities of test substances are to be had. I find that by these means the $\frac{1}{10000}$ of a grain of magnesia can be recognized in but $\frac{1}{2}$ a grain of liquid. It is therefore far more delicate than the old tests.

I should state that lime, baryta, alumina, do not when electro-deposited, give a chromatic reaction with iodine.

The compound iodide described, is easily decomposed by acetic acid, or an alkali. And very slowly decomposed by water. The iodine being in each case detectable in the solution by means of the starch test.

V.—GEOLOGY.

Art. LV.—*Description of a remarkable Dyke on the hills near Heathcote.*

By A. D. Dobson.

[*Read before the Philosophical Institute of Canterbury, 1st April*, 1880.]

On the west side of the Heathcote valley a remarkably sharp peak forms the crest of the hill, the almost vertical sides of which are in marked contrast with the rounded slopes immediately below it.

This peak is formed by the outcrop of a volcanic dyke, which, flowing over the edges of the original chasm, forms a cap about 550 feet long, 200 wide, and from 70 to 80 feet high.

On the north side of the peak the dyke is first visible about 90 feet below the lower edge of the cap, at which point it is just traceable as a narrow band, chiefly noticeable by a hard selvage on the west side passing through a coarse-grained Porphyritic dolerite, of which No. 1 is a specimen.

Proceeding upward the dyke rapidly widens, and, 20 feet above the point where it first appears, it is 10 feet wide, and well defined. Specimens No. 2 and 3 are from the dyke at this point; No. 2 being from the selvage on the west side, and No. 3 from the centre. A little higher up the stone becomes more compact, as shown by specimen No. 8.

The dyke here passes through about 20 feet of basaltic tufa, shown by specimens 4, 5, and 6. To the westward this bed becomes intercalated by bands of a harder stone, specimen No. 7; changing further westward into or replaced by No. 7a. Above this up to the cap, a height of about 55 feet, the dyke can be traced, but indistinctly, owing to the superincumbent mass of loose rock.

The rocks passed through are hard porphyritic basalt, about 30 feet (shown by specimens Nos. 9 and 10), and a soft dolerite lava, about 25 feet (specimen No. 11). This is the rock on which the cap rests. The junction of the dyke and cap at the north end is obscured by the mass of loose rock lying on the northern slope, but at the southern end it forms the crest of the spur, is about 20 feet thick, and can be readily traced to the top of the crater-well. At this end it is mostly of a much harder material than at the north end, being very similar in character to the rock forming the cap, but in places it passes into a soft freestone.

Like the dykes in the viciuity, it is divided into polyhedric form—at right-angles to the cooling surfaces, and is also jointed parallel to the direction of flow.

The rock forming the cap comprises many different qualities, varying from a workable stone, like No. 13, to a hard slaty rock, as shown by specimens Nos. 14 and 15. It was evidently of much greater extent, the existing portion being the central mass, which has survived the general denudation the outer portions having been undermined from time to time by the wasting away of the softer underlying rocks.

At the junction of the cap with No. 11 both rocks appear to be slightly altered, and at some places, especially on the west side, a hard slaty selvage occurs.

The most striking feature in the case is the great change which takes place from the soft freestone (specimen No. 8), which occurs to the northward of the cap, to the hard dark rock in the cap itself.

No. 8 is like the brown stone at present being worked in Thompson's quarry on the opposite side of the valley; whereas the stone of the cap is very similar to that occurring in the dykes which crop out along the Sumner road, between Heathcote ferry and Sumner.

Dr. von Haast, in Chapter XII. of his "Geology of Canterbury and Westland," mentions the fact that the chemical constituents of dyke stones taken from different localities, vary very considerably, although their appearance is in every respect the same; but in this case the stone varies in appearance to such an extent that it is difficult to believe it to be part of the same dyke without personally tracing out the continuity; and doubtless the chemical composition varies as much as the general aspect.

It would be very interesting to analyse a set of specimens, taken in ascending order, from different parts of the dyke and cap; and also to examine, with the microscope, thin slices from the same places. These two series of observations would throw much light upon the chemical change and action of the rock, both when under and when free from pressure.

In this case it would appear that the rock is hardest when it was subjected to the least pressure.

The enormous pressure the dyke rock must have been subjected to when being forced up the chasm, is readily seen by estimating the weight of a column of stone an inch square. For sake of comparison, it may be assumed that a column 1 inch square and 10 feet high weighs 120 ℔s; thus supposing the dyke-stone to be in a fluid state, the pressure 10 feet below the surface would be 120 ℔s. per square inch; at 100 feet below the surface, 1,200 ℔s.; and at 1000 feet, 12,000 ℔s. Now even assuming that, when in a state of ebulition, the action of the entangled gases would relieve a certain amount of the pressure, still it is quite certain that all the lower portions of the dykes must have been formed under great pressure; but yet,—so far as I have been able to judge, with the exception of the dyke under consideration,—the stone has the same appearance whether taken from the upper or lower part of the dyke.

The commercial value of this dyke, with its cap, is very considerable. From the number of parallel joints stones with two beds can be obtained of almost any size, and the softer portions can be used for all purposes for which cut stone is required.

Description of Rocks.

1. Porphyritic dolerite lava stream with crystals of labradorite.
2. Trachyte from dyke at west edge.
3. Trachyte from dyke at centre decomposed.
4., 5., 6. Basaltic tufas red and grey.
7. & 7a. Compact basalt showing somewhat globular structure
8. Trachyte dyke partly decomposed.
9. Porphyritic basalt.
10. Ditto
11. Dolerite lava with crystals of labradorite.
12. Trachyte.
13. Trachyte with crystals of sanidine.
14. From the top of the cap.
15. " " "

Art LVI.—*On the* Foraminifera *of the Tertiary Beds at Petane, near Napier.* By A. Hamilton.

[*Read before the Wellington Philosophical Society*, 24*th July*, 1880.]

During the past year I have been collecting the fossils which occur so plentifully in the tertiary beds to the north of the inner portion of Napier harbour to determine their true age and position. When the fossils have been examined and tabulated, I hope to lay the results before you, but as Mr. G. R. Vine, junior, of Sheffield, has kindly forwarded to me some very interesting and valuable information concerning the Foraminifera occurring in these beds, I hasten to communicate the result of his examination of a small fragment from these beds that I sent to him by post; the more readily as Mr. Vine's high reputation as a palœontologist vouches for the precise identification of such very variable and difficult objects.

Mr. Vine adopts Dr. Carpenter's classification, viz.:—

Imperforate.		Perforate.		
Miliolidæ.	*Litnolidæ.*	*Lagenidæ.*	*Globigermidæ.*	*Nummulinidæ.*

Grouping them as five families under two groups.

Although the amount of material was not larger than a walnut, the species and varieties were numerous, four out of the five families being represented. Amongst them occurred a solitary specimen of Entomostraca, probably a form of Carbonia.

LIST OF SPECIES AND VARIETES.

Sub-order, IMPERFORATA. Fam. Miliolida.

Fig. 1, 2. *Miliola seminulum*, var. *(Biloculina) ringins*, Linne.

In England the Foraminifera are being arranged all under different types. Thus of the Miliola, 2 seminulum is the type. The variety follows, preceeded by its sub-generic title as above.)

This variety is very widely distributed; it is found common and large in the Arctic Ocean (off Norway), at at from 30 to 160 fathoms. In North Atlantic, rare on marginal plateau. British: off the Shetlands, rare in 120 fathoms. Very rare in River Dee. Common in Tasmanian and Australian seas. Fossil in Boulder clays of Cheshire (drift). Miocene, Yarra Yarra, Victoria. The specimens from the material, are the largest and finest that I ever saw.

Figs. 3, 4. *M. seminulum*, var. *B. ringens*, sub. var. *elongata*, D'Orb.

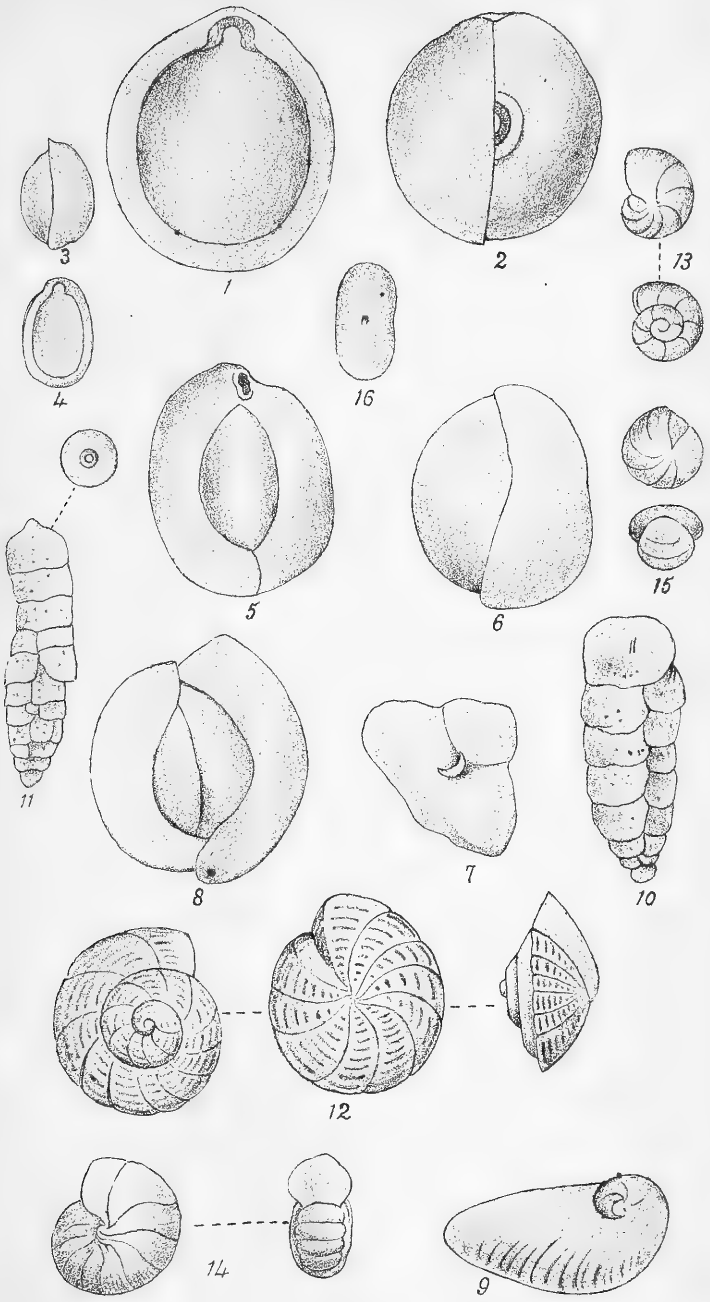
Much smaller here than the *B. ringens*, it is more elongate and less globose in form; it is simply a sub-variety of variety *ringens*, and cannot be really called a species. Rare and small in North Atlantic, in 1450, 1950, 2050 fathoms. British: River Dee, frequent. Fossil: Boulder clays, Cheshire; Yarra Yarra, Victoria.

Figs. 5, 6, 7. *M. seminulam*, var. *(Quinqueloculina) triangularis*. D. Orb.

This is a triangular form of the type which takes its place in some localities. Here the type is not found, but is represented as above. Very rare and small in North Atlantic at various depths. Fossil in Miocene as before. Recent also in Mediterranean, Tasmanian seas, Indian Occean, etc. Is very rarely recorded as a distinct variety, generally classed under the typical name, *Seminulum*. Here it is rather common in various sizes.

Fig. 8. *M. seminulum*, var. *(spiroloculina) planulata*. Lamarck.

This differs in some respects from the forms called "planulata" by authorities, but I know of no other name for it. It is large, flat, much



FOSSIL FORAMINIEERA.

Hamilton, del.

worn, irregularly striated, and rare. I may have to call it by a different name. Recent in Atlantic, Arctic, British Seas; fossil in London clay, Sheppey.

Sub-Order PERFORATA. Fam. LAGENIDA.

Fig. 9. *Nodosaria (Cristellaria) crepidula.* Fichted and Moll.

Very rare and choice here. Middle size, flat worn, septæ indistinct. Recent, Atlantic, and Arctic; rare. Fossil, boulder clays, Cheshire; London clay. Miocene, Yarra Yarra, trias, lias, and chalk.

Fam. GLOBIGERINIDA.

Fig. 10. *Texularia agglutinans.* (Type) D'Orbigny.

Here this species varies considerably from the forms described by Parker and Jones in Phil. Trans., 1865 (N. Atlantic and Arctic Foraminefera), and again the forms there figured differ much from the figures given by Mackie and Jones in "Geologist." * * * It is found in Arctic and Davis Straits, 20 to 30 fathoms, rather common; also off Norway, 30 to 200 fathoms. Fossil in chalk, eocene, miocene, etc., and its representatives *T. eximiæ* and *T. gibbosa* in carboniferous limestone of England and Wales.

Fig. 11. *Texularia agglutinans*, var. *(Bigenerina) nodosaria.* D'Orb.

This form begins with a Texularian, and passes into a Nodosarian growth. The transition between the variety and the type can be easily traced in the material sent. Occurs, recent, all over the world. It has its representative in the carboniferous shales of England and Scotland.

Fig. 12. *Rotalia beccarii*, var. *craticulata.* Parker and Jones.

I think that this is the first time that this variety has been found fossil. It was described by Parker and Jones in Phil. Trans., Royal Soc., Lond., 1865.

Here it is the commonest form, and rather large. It is one of the highest of the Rotalinæ, having a rough outline of a "canal system," characteristic of the Nummulinidæ. Recent in the Fiji Islands.

Fig. 13. *Planorbulina arcta*, var. *(Truncatulina) lobatula.* W. and J.

A plano-convex form of the type, having the chambers embracing on the upper side; under side flat, showing primordial. Recent in all seas.

Fossil in London clay, chalk; represented in the carboniferous limestone by *T. carbonifera*, Brady, and *T. Boueana*, D'Orb.

Fam. NUMMULINIDA.

Fig. 14. *Polystomella crispa*, var. *Nonionina umbilicatulu*, Montague.

Rare and small. A variety of *P. crispa*, in which the canal system processes are obsolete. Rare to common in various depths of North Atlantic and Arctic Oceans. Rare as British.

Fossil—Boulder clays, London clay, miocene, chalk.

Fig. 15. *Pullenia sphæroides.* D'Orb.

Also belonging to the family Globigerinida. I have two small specimens coming near to *Pullenia sphæroides*, D'Orb. It is very rare here, equally rare in miocene, Yarra Yarra, Victoria. Recent. Very rare in North Atlantic. Rather common on the Norwegian coast; 20–200 fathoms.

DESCRIPTION OF PLATE.

1-2. Biloculina ringens, *Lamarck.*
3-4. ,, elongata, *D'Orb.*
5-7. Quinqueloculina triangularis, *D'Orb.*
8. Spiroloculina planulata, *Lamarck.*
9. Cristellaria crepidula, *F. et M.*
10. Texularia agglutinans, *D'Orb.*
11. Bigenerina nodosaria, *D'Orb.*
12. Rotalia craticulata, *P. et J.*
13. Truncatulina lobatula, *W. et J.*
14. Nonionina umbilicatula, *Montague.*
15. Pullenia sphæroides, *D'Orb.*
16. Carbonia ——?

Art. LVII.—*On the Genus* Rhynchonella. By Alex. McKay.

[*Read before the Wellingtou Philosophical Society, 10th October*, 1880.]

It is by the permission of the Director of the Geological Survey that I have the pleasure of placing this paper before the Society.

Of the mollusca *Rhynchonella*, although it is represented by but two living species, is, if the fossil species be taken into consideration, numerically the most important genus belonging to the Brachiopoda.

In Woodward's "Manual of the Mollusca," the genus is said to include 332 fossil species; some 60 species obtained in New Zealand have to be added, thus bringing the total to something like 400 species.

At the present time *R. nigricans* alone survives in the southern seas, and is found on the New Zealand coast.

This species is the only one found in our upper and middle tertiary strata. In the upper Eocene rocks of New Zealand, represented by the Mount Brown and Hutchinson quarry beds, another form appears, but this with its close ally *R. nigricans* is the only species yet known from our tertiary strata.

From our upper secondary rocks two more species are added to the list, *Rhynchonella Squamosa*, Hutton, and a species not yet described, which is found in cretaceous rocks of the East Coast of Auckland.

Fossils belonging to this genus abound in the cretaceous rocks of England, and most other countries in the Northern Hemisphere. About twenty species have been described from the English deposits of this age. The contrasting scarcity of Rhynchonellidæ in the New Zealand cretaceous rocks appears something like evidence in favour of the opinion, that the decline of the genus commenced earlier in the southern than in the northern hemisphere. Whether or not this speculation has the importance which I would thus attach to it, curiously enough, it finds partial confirmation in the fact that the molluscous fauna of our cretaceous seas assumed a tertiary type of character considerably prior to the period of such change in the Northern Hemisphere, within the European area.

In the middle and lower-secondary rocks of this country *Rhynchonella* is represented by a great increase of the number of species, and in many strata the rocks are crowded with such shells. With this increase in number there appears to be a restriction of the vertical range of the different species, and a consequent increase of their value for determining different geological horizons. *Rhynchonella nigricuns* can only tell us that we are dealing with tertiary strata, and its presence indicates no particular division or group of strata—as eocene, miocene, or pliocene; and *R. squamosa* does not do more for our cretaceous strata; but in our oolitic, liassic, triassic, and permian rocks, the case is different, and each particular fossiliferous horizon may generally be determined by the presence of a peculiar species of *Rhynchonella.*

Hence the increased importance of the genus in these formations, and the necessity for studying those characters by which it may be identified. Some of the species from these older rocks appear as if considerably different from the ordinary types of the genus *Rhychonella* in outline and other external characters, and one or two species are readily mistaken for Terebratulidæ, more especially if the specimens are found as casts, thereby loosing the means for determining such forms by the impunctate structure of the shell.

Specimens thus liable to be mistaken are abundant in the triassic strata of the Kaihiku Range, Otago; and not until the discovery of testiferous specimens was it apparent that these did not belong to the genus *Terebratula*, which they closely resemble.

On making the discovery that the shell-structure of this species was impunctate, I at the same time observed that the hinge-teeth were minutely crenulated, or more properly denticulate, a character not seen in *Terebratula.* Further examinations showed that specimens, which without doubt belonged to *Rhynchonella*, had teeth marked in the same manner.

This discovery led to an examination of other and distinct species of *Rhynchonella*, in which this character was also seen.

When snfficiently well preserved to show it, this character proved present in every form of *Rhynchonellæ* which has been collected from the Secondary and Palæozoic rocks of New Zealand.

The recent forms *R. nigricans*, and *R. psittacea*, also show this character, and it has been detected in an English specimen from the lower greensand, at the base of the cretaceous system.

From the constancy of this character, I think there is sufficient grounds for regarding it as of generic value ; as it has been found in all the species which afford the means of detecting it, and is seen in at least two of the living types of the genus.

I am not aware that hitherto attention has been called to the presence of this character as distinguishing the genus *Rhynchenella*.

From "Woodward's Manual of the Mollusca," p. 376, I take the following description of the genus :

"Shell trigonal, acutely beaked, usually plaited ; dorsal valve elevated in front, depressed at the sides, ventral valve flattened, or hollowed along the centre, hinge-plate supporting two slender curved lamellæ, dental-plates diverging." and I add teeth crenulated or minutely denticulated.

Art. LVIII.—*On some Indications of Changes in the Level of the Coast Line in the Northern Part of the North Island.*

By S. Percy Smith.

[*Read before the Auckland Institute, 15th November*, 1880.]

Incidental reference to this matter is to be found in various works on New Zealand, more especially in "Hochstetter," the 12 vols. of "Transactions of the New Zealand Institute," and the annual reports of the Geological Survey ; but nowhere, as far as I can learn, has the evidence ever been gathered into one point of view, or dealt with comprehensively. It has been thought therefore, if the information extant is put together, it will be more convenient for reference in the future, and will also perhaps interest the Members of this Institute. With this view I have, in the following notes, collated and summarised from different authorities all that can be found, and propose to supplement it by my own observations, extending over several years, as far as relates to this Northern part of the Island ; though it will be necessary to adduce evidence bearing on the question as affecting the whole of the North Island. I have excluded from consideration the evidence relating to the South Island, although it is more voluminous and clear, the reason of which is in a great measure accounted for by the fact of that island having glaciers, which this has not, or at least only to a very limited, and perhaps doubtful, extent on Ruapepu. The origin and period of greatest extent of such glaciers has given rise to more than one controvery in which this question of elevation or depression bears an important part. It is also premised that these notes will relate only to the latter or recent period, not to the vast geological ages that have passed, during which our hills and mountains rose out of the sea, and in using the term recent it should be understood that it is in its geological sense it is referred to, that is, to the period including the traditions, but extending backwards far beyond it, during which the present outline of the country remained not materially different to that we see at the present day.

In a question of this kind it is of importance that we should understand what kind of evidence we may expect to find, either of elevation or depression. Of the former, raised beaches, terraces, inland cliffs, or lines of sandhills, are the principal and may be more easily read, whilst depression is to be looked for in the prolongation of the valleys under the sea, by finding land surfaces in sinking to depths now below the sea-level, and in some cases perhaps, by the character of the vegetation on the mountains in particular spots, by the plants and animals inhabiting the islands off the shore, by the depth of water along the coast line, and other indications, few of which are however so capable of direct demonstration as the facts of elevation. It requires, indeed, a practised eye to detect and interpret most of these hidden records of the past, but when once the attention has been drawn to them, it is marvellous how numerous they are, and the interest it gives to many an otherwise tedious journey, to follow them out, and recognize in each new feature some further evidence of the truth of the interpretation placed upon them. There are occasional difficulties, however, in separating the effects of sub-aerial denudation—which has been the active agent in carving out the greater part of our hills and valleys—from those due to the action of the sea; but setting these doubtful cases on one side, there is still a residium of proof sufficient to demonstrate the facts of elevation or depression, though it can scarcely be expected that in the long ages to which such records have been subjected to the war of elements, that they should appear as fresh, or as easily deciphered as the result of forces in action at the present time. Therefore in speaking of raised beaches, it must not be supposed that these present a similar appearance to the beaches of our present coast line, or that the sands, shells, or rocks are to be seen as cleanly washed as by the daily tide. It is often a mere line, a fragment of a terrace, or isolated mound covered with vegetation, that indicates the coast line of the past. Whilst allowing fully for the immense, and almost inconceivable power required to elevate or depress the solid land, we could hardly expect to find, in an extended coast line like that of this province, that each effort of the force should be simultaneous, or of a like nature over extended areas. It is more natural to suppose that the action would be partial, here an elevation, there a depression—and this is found to be so, though on the whole these notes will prove, that the tendency has been in its latest manifestation an upward one, and that of a very general nature.

The first extract to which attention is called is to found in the proceedings of the Wellington Philosophical Society, under date July 28, 1868, when the chairman read a short paper "On indications of changes in level of the coast line of the southern portion of the North Island as deduced from the occurrence of drift pumice." Mr. Crawford remarked, "That pumice, having a small specific gravity, floats on the water, and in rivers flowing from the volcanic plateau in the interior of the island it may be seen descending in great quantities and at all hours towards the sea. When there, it is of course liable to be washed up at any part of the shore, and if there is no cause again to carry it away, it necessarily remains stranded. Pumice is found on the flats of the peninsula, near this city (Wellington) at a height of about eight or ten feet above the present high-water mark. He had not observed it on any of the coast terraces, consequently it is probable that the land had attained within 10 or 20 feet of its present level before the volcanic chain sent pumice to the sea; and this will give an age to the present coast line, or to one from 10 to 20 feet lower (supposing a steady rise of the land), enough to satisfy a very ardent lover of antiquity." He concluded by saying, "It may therefore be held that the probabilities are against any great oscillation of the present sea-level in this part of the North Island since the commencement of the vast period which must have elapsed since the central volcanic group of Tongariro and Ruapehu (and Mount Egmont inclusive) began to send down pumice to the sea."

Dr. Hector said, "That pumice was a mechanical variety of obsidian, the most perfectly fused product of volcanic eruptions, and did not indicate any particular era in volcanic eruption or elevation of a chain of mountains as Mr. Crawford seemed to require for his theory. * * * Mr. Crawford did not prove by his paper that the sea had not been relatively lower; or, in other words, that the land had not been undergoing submergence. The sea could never have been at a much higher level, or the pumice would have been drifted up, but there is every reason to believe that the country was much higher formerly, and in the interior contained larger lakes, by which the pumice would be drifted up at great heights above the sea."

In an essay on the geology of the North Island by the Hon. J. C. Crawford, printed in the appendix to the first volume of "Transactions," that gentleman, referring to terraces and raised beaches, says,—"These form a characteristic feature in New Zealand geology. * * * Terraces are found in the south part of the island, as previously stated, at about 1,000, 400, and 250 to 300 feet, and decided raised beaches at about 15 and 4 to 9 feet. That these extend round the island at similar levels is probable, but more information is required to establish the fact. Between these principal terraces are many smaller ones. Although fossils are in general absent, it is likely that the terraces mark successive rests of the land during its rise. To account for them as lake terraces would require the supposed erection. or rather demolition of a vast number of barriers. At the height of about 15 feet above the present sea-level a very well-defined sea-beach is found all along the southern coast, worn into cavities and bored by pholadae. The latest raised beach is that which marks the rise of the land during the great earthquake of 1855. The upheaval appears to have been greatest at the Mukamuka rocks—nearly 9 feet, and is supposed to have sloped off to nothing at Manawatu."

The same gentleman, in a paper "on the Geology of the Province of Wellington," read 2nd October, 1869, says,—"A raised beach may be observed all along the coast, except at the foot of the Wairarapa Valley, where the sea encroaches on soft rocks."

I would remark that these terraces are particularly distinct as seen from the steamers in passing Cape Palliser; they are referred to in Mr. McKay's report on "the Southern part of the East Wairarapa District," dated July, 1879, from which I extract the following:—"Returning to the coast line terrace formation, the loosely compacted gravels already mentioned form a level plain stretching round the head of Palliser Bay, which, at one time, appear to have stretched seaward much further than at present, the soft clay beds underneath the gravels yielding rapidly to the encroachment of the sea. At the north-east corner of the bay this terrace is now all but destroyed, and here the first terrace (about 200 feet above the sea) terminates. Along the east side of the bay, gravels cap the pareora beds unconformably, and form terraces at much greater heights than 200 feet. According to Mr. Crawford the higher inland terraces attain to a height of 1,000 feet above the sea; and it may be a questionable classification which thus places them as belonging to the same period as the lower-terraces. The reasons for their being so placed are that these terraces are evidently nothing more than ancient beaches, marking the different stages of the rising land; while at much lower levels (at the level of the sea at the outlet of the Lower Wairarapa Lake) we have deposits accumulated during the period of depression; so that if these high-level terraces are to be regarded as older than pleistocene, they must still be considered as younger than any of the fossiliferous pliocene rocks in this vicinity, and to have been deposited after the land had begun again to emerge and recover itself from the depression which took place over a large part of the North Island in early pliocene times."

The above extracts show pretty clearly that as far as the southern part of this island is concerned, that elevation has been the latest phase of the forces, and if enquiry is pursued into the case as relating to the Southern Island it will be found to be the same. I would particularly refer to a most interesting paper by Captain Hutton, "On the last Glacier period of New Zealand,"* which, whilst dealing with a period prior to that under consideration, goes more fully into the question than any other, and contains also some references to the North Island during the later period; as for instance at page 386: "I will, therefore, in the first place give the reasons that have lead me to an opposite conclusion, namely, that during the whole of the pleistocene period, elevation has been more or less continuous over the greater part of New Zealand." He then enters fully into the question, but I must refer those interested to the paper itself, merely giving here two short quotations. On page 390 he says: "Raised beaches of pleistocene, or of almost recent age are found at Motunau in Canterbury, and on the north-west side of Cape Kidnapper, Hawke's Bay, but I do not know their altitude. On the north-west side of Hick's Bay, near the East Cape, there is a very distinctly marked line of inland cliffs; and the same thing is seen in Cook Strait, near Wellington." At page 392: "Indeed, there can be no doubt that the elevation has been very unequal in different districts. The central portion of the North Island appears to have risen most, and next to that the centre portion of the South Island, while the whole of the northern portion of the Auckland provincial district does not seem to have risen more than twenty to thirty feet, but we are almost without data at present to estimate these differences correctly." He adds: "I don't think, therefore, that the reasons brought forward by Dr. Hector by any means prove that subsidence has been going on during the pleistocene period; on the contrary, I believe that nearly the whole of the evidence is in favor of elevation."

One of the clearest cases of elevation, as shown by an inland coast line, which I have met with is that at Miranda, in the Gulf of Hauraki, opposite Grahamstown. Any one who has stood on the hills above the Thames river, and looked up its broad valley over the level swampy plain lying between that river and the Piako, would at once be struck by the fact that the dry land is a mere continuation of the bed of the gulf, and that the foot hills on either side are the remains of an old coast line once washed by the waves of the sea. The plain of Te Aroha is not more than 75 feet above

* "Trans. N. Z. Inst." Vol. V., p. 384.

the sea level, whilst Morrinsville is only 86 feet. Consequently a depression of 100 feet would again bring the sea up to those places, or within 20 miles of Hamilton, thus extending the gulf by an area of 250 square miles. Traces of the old coast line may be detected here and there far inland, but at Miranda it is more than usually distinct. Here we have a low flat, generally swampy, extending back from the coast line for a mile to the foot of the hills, which fall steeply to its level, where they form contours exactly like the sinuosities of an ocean beach, whilst at one spot, close to the foot of the hills, is found an isolated rock jutting out from the swamp, pinnacled with wave-beaten sides, through which is a cave or passage so clearly the result of water action as to cause surprise at the absence of the waves which made it. Near, too, lying along the foot of the hills, are to be seen large masses of clay slate rocks, just as one sees along a modern beach. The level of the flat here is about 15 feet above high-water mark, and therefore corresponds with the raised beach mentioned by Captain Hutton as existing on the opposite side of the gulf at Shortland. He says, after referring to a submergence which is proved by finding at a depth of 30 feet kauri gum, pieces of wood, and rotten raupo, and nearer Shortland an old Maori paddle.

" It would thus appear that when the alluvium full of boulders found on the top of the hills was forming, the land was 1,000 feet lower than at present, that it then gradually rose until it was at least 100 feet higher than now; and at that time the Thames ran further north than Shortland. The land then sunk to about 10 or 12 feet lower than now, and subsequently has again risen to its present level."

I have been informed that in the great swamps lying between the Thames and Piako are to be found shell banks and sand banks, now several miles from the sea, which formerly marked the high water line at the level the land then stood at.

Following the coast northwards from Miranda, the same line of old beaches can be occasionally detected, and in some cases even the old shingle, as rolled by the tide, is visible, but now separated from the sea by long stretches of low-level land and swamps. At Umupuhia, near the mouth of the Wairoa, at about 15 feet above present high water-mark, is a level plain extending through from Waiheke channel to the Wairoa River, which, before the elevation, separated the western head of that river from the mainland, forming an island. Approaching Auckland the line of old sea-level is seen here and there, as at Brown's Island, in Hobson's Bay, the north shore at the Victoria wharf, and at places up the harbour. It is probable that when the sea formed these old beaches there was another entrance to the harbour —namely, by the shallow arm running from Shoal Bay, behind the flagstaff on Mount Victoria, which is only separated from the sea now by a low sandy neck, which has no doubt been formed as the land gradually rose. This channel now filled with mud and mangrove flats, and only navigable for small boats at high water, bears on its cliffs the evident impress of much larger waves than ever can arise there now. At Motutapu in several places, but particularly on the east side of Drunken Bay, is a well preserved raised beach, about the same general level as the others, which was formed when there was a deep water-channel between it and Rangitoto, and which owes its preservation to its sheltered position. The steep cliff on the right hand of the path leading down from the Supreme Court to Mechanics' Bay is the work of the sea when it stood at a higher level, and when the Bay extended up to near Fraser and Tinne's foundry.

If we continue our survey northwards from Auckland, the same evidence of elevation will be found. Time was when Whangaparaoa was not, as now, a peninsula, but an island, the old channel separating it from the main is still clearly visible, its floor being at about the same level of 15 feet above high water-mark. The flat north of Orewa, and that on which the Waiwera Hotel stands, are old sea beaches, whilst the small island off that place, the native name of which is Mahurangi (whence the name has been transferred by the settlers to the harbour to the north of it. The proper name of which is Waihe), has probably only become such by the action of the sea since this elevation. Native tradition speaks of this island as having been a large pa in comparatively modern times, though but a mere rock now. The flats between Waipu and Whangarei Heads, and extending up that harbour for some distance, are another illustration of a sea-bottom, now dry land. Here we learn of a probable depression going on in quite recent times. It is stated that within the last generation some of the mangrove flats in the harbour had dry flats on them, used by the Maoris as cultivations, but now washed by the spring tides. Further northwards again the same thing is seen. The flat on which the Town of Russell is built was at one time covered by the sea, which then separated the hill standing to the south-west of the town from the mainland, forming an island. At Whangaroa, at Mangonui, at Rangaounu Bay, the evidence is everywhere the same. At the latter place, the flats of the Awanui and Victoria River rise gradually up as a continuation of the sea-bottom, which a submergence of a very few feet would again convert into a channel running across to the West Coast, thus forming again, as it has done before, the northern termination of this island, and leaving the North Cape and Mount Carmel as separate islands.

The west coast shows the same line of elevation, with probably others more ancient than the 15 feet one. At Hokianga there are several well-marked beaches, notably the flats inside the heads at Pakia, whilst in

Kaipara they are more numerous and extensive still. The low-lying swampy flats on the Wairoa River, south of Tokatoka, elevated but little above tidal flow, are bounded to the east by a distinct old coast line, which, in its southerly extension towards Otamatea, shows signs of having been an ocean coast line before the barriers of consolidated sand-hills forming the north and south Kaipara heads were in existence. The origin of these, however, dates further back than since the 15 feet elevation.

Manukau has its raised beaches, as also its signs of local depression as demonstrated by the tree trunks standing in places now washed by the tide. Hockstetter, describing the long, low strip of sandy waste lying outside the north head of Manukau, says :—" Behind the sandy beach basins of fresh water are frequently found, and at the base of the rocks deep caves are seen washed out, in the back ground of which generally large masses of boulders are deposited. This would indicate a former period, when the surge washed the rocks themselves and piled up those masses." Captain Hutton, also speaking of the north head, says :—" On the inner or eastern side of Paretutai the cliff is being undermined or worn away at low water-mark, while at high water-mark, or at a little above it, another and older undermining of the sea can be observed forming a terrace, the difference of height between the two being about 10 feet, showing that the land has risen that distance since the higher one was formed. This closely corresponds to the height of the raised beach at the Thames, on which Shortland and Grahamstown are built. On the outer or western side of Paretutai a similar terracing exists." * * * I would add that this inner terrace now forms a most convenient natural wharf for shipping the timber from the Whatipu saw-mills.

To one standing on the bald hills near Mauku, and looking over the swampy tract lying between there and the Waikato heads, the steep hills abruptly terminating in the swamp, with their indented and sweeping contour line, present the appearance of a well-worn coast line from which the sea has receded, leaving the former bay to be filled with alluvium before the river cut its way down to its present level. Hockstetter says, in reference to the mouth of the Waikato :—" It is remarkable that at the mouth of the Waikato there is not an estuary similar to that at Manukau, Kaipara, and Hokianga in the north, or as at Whaingaroa, Aotea, and Kawhia in the south. With regard to this point, I have repeatedly heard the opinion expressed that the Waikato River had formerly emptied into the Manukau, and that its present mouth is comparatively of recent date ; yet I cannot corroborate this opinion. I believe myself right in assuming that the river also had in former periods a similar estuary, and that the extensive swamps beginning two miles from the mouth and now partly covered with bush, through which the Awaroa Creek meanders, are part of the former estuary, which the river has gradually almost filled up with masses of sand, mud, and pumice stone, which it always carries along," to which I add, aided by the gradual rising of the land.

This period was subsequent to the depression referred to in Mr. James Stewart's interesting paper "On the evidence of recent changes in the elevation of the Waikato district," and the old shingle beach therein referred to as having been found in sinking for the cylinders of Ngaruawahia bridge is probably of date coeval with, or prior to the grand elevation which took place when Tongariro and Ruapehu first exerted their powers. The evidence of changes in the physical geography of the Waikato and Thames valleys are so numerous and so interesting from the surface and geologists' point of view that a whole volume might be written on the subject, but as this paper only deals with coastal changes, I will merely quote from the "Transactions" and Hochstetter, two extracts, as bearing out the view that the Thames valley was recently occupied by the sea. The latter says, in referring to these two valleys,—"This whole basin was previous to the last elevation of the North Island, which was probably connected with the volcanic eruptions in the centre of the island, a bay of the sea, extending from Hauraki Gulf far into the interior. The steep margins of the surrounding ranges has continued to this day displaying the sea-shore of old, and the singular terrace formation on the declivities of the hills and the river-banks within this basin, is the result of a slow and periodical upheaving;" and again, at page 313, he says,—"These and similar strata seem to point to the fact that the whole of the Waikato basin was, but recently, a shallow bay of the sea, or a far extending estuary, at the bottom and on the margins of which these layers of shale were formed." Mr. Kirk supports this opinion of the sea having recently occupied the Waikato basin by reference to the maratime plants found there. Captain Hutton, however, in a paper "on the alluvial deposits of the Lower Waikato and the formation of islands by the river," rather combats this idea, at all events as respects the Lower Waikato. He says,—"There appears therefore no geological evidence of the sea having been in the lower basin of the Waikato since the upheaval of the Waitemata series, that is, since it had any existance. I therefore think that the fact of the pressure of several littoral plants in the Lower Waikato basin, brought forward last year by Mr. Kirk, may be best explained by supposing that they have spread down the river from the middle Waikato basin, after the formation of the Taupiri Gorge."

Passing now to the southwards of Cape Colville in our coastal survey, we shall find the same evidence of elevation of about 15 feet, with, in addition, an older line of elevation, averaging from 80 to 100 feet. Those who know Mercury Bay will recognise in the extensive flats to the west of the mouth of the river of that name, the work of elevation aided also by the formation of land by the sea itself, an operation which is the very reverse of its usual action. Here, along the Buffalo beach, we find a series of slightly raised parallel sandhills, divided from one another by lines of swamps, following closely the contour of the present coast. These are caused by the wind drifting the sand off the beach at low-water into low hillocks above high-water mark, which, after a time, become covered with vegetation, when others are formed in front of them, the intervening hollows being gradually filled with swamps. Another raised beach is to be found to the east of Shakespeare's cliff; indeed, in several places along the coast towards Katikati.

Tauranga Harbour presents some interesting changes due to elevation. Prior to the upheaving of the present coast-line the sea probably washed the southern shores of the harbour all the way from Katikati to Te Papa, leaving the higher parts of Matakana Island as low islands off the shore. On the elevation taking place, the sands have gradually accumulated sufficient to form Matakana Island some twenty miles long, to which is due the present harbour. At that time Mangonui mount was an island, as was also Matapihi, which latter formed part of the sea-bottom prior to the older elevation referred to. From Tauranga to Maketu the old coast-line can be readily traced, where the steep hills sloping down from Otanewainuku end abruptly on the level and swampy foreshore. At Maketu the coast-line receded sufficiently far back to form a deep bay, in which that place stood as a flat island, which it also was before the ancient elevation took place, and at which time the flat surface of Motiti Island formed part of the floor of the ocean.

The evidence is everywhere the same as we follow along to and beyond Opotiki Cliffs, which have been worn by the sea, are now separated from it by low flats generally sandy and swampy, whilst at Matata there was a deep bay running inland, now filled with swamps and sands, due partly to river action, aided by elevation. The isolated slate-rock at Whakatane, close to the township, under the shade of which Te Kooti's men slept off the effects of their potations after the sack of that place, clearly demonstrates this elevation. No one, looking at the rock, can doubt the fact of the sea having separated it from the main, when the waves rose some 15 feet higher. The fertile flats of Opotiki are due to the alluvium brought down by the two rivers Otara and Waioeka, deposited in an estuary of the former sea. The so-called table-land of Opotiki is part of a much more ancient sea-beach or bottom, which can be traced from the East Cape to Katikati. It is everywhere on a much larger scale than the one hitherto described, and forms extensive flats, cut up by streams. Nearly everywhere in the Bay of Plenty it is covered more or less with pumice, and is about 100 feet above the present sea-level. From a little east of Opotiki to the east Cape the coast is formed by the northern end of the main range of the island, or, I may say, by the continuation of the Southern Alps. They average in height near the coast from 1,500 to 3,000 feet, culminating in the interior in Mount Hikurangi, 5,606 feet high, the highest peak in this province. These ranges appear from the sea to end abruptly at the water's edge. Upon approaching the coast, however, a long level line of low cliffs is seen, from the top of which the land slopes gradually but slowly upwards to the base of the mountains, the slope being in general covered with native cultivations and villages, and the cliffs fringed with pohutu kawa trees. In the season when the yellow maize is ripe these flats form a pleasing contrast in colour to the sombre hue of the precipitous mountains rising behind them. This slope forms part of the more ancient sea-bottom alluded to. It is very distinctly seen in the steep cliffs a little to the north-west of Hick's Bay. Being out of the route of the coastal steamers, this part of the Bay of Plenty is rarely seen, and its beauties generally unknown, but the time will come when it will be visited on that account, and for its delightful climate.

As bearing on the question of elevation of this part of the coast, Dr. Hector says in his "Notes on the Geology of White Island,"* "I may here remark that I observed no signs of marine or beach drift within the crater wall, such as must have existed if the island had been undergoing a process of elevation. On the other hand, the evidence seemed to point to a steady submergence of the volcanic cone." In reference to this, I would observe, that the above extract, whilst setting forth a direct contrary opinion to that I have expressed with respect to the contiguous main land, refers to an active volcano, which might be more subject to alternations of level, within shorter periods, than the main land, and it is by no means improbable that submergence is going on there, whilst the shores of the Bay are rising.

From the East Cape southwards to Gisborne, I am not aware whether the same evidence of elevation is discernable, but I find Mr. A. M'Kay, of the Geological Survey states,† "On reaching the coast at McDonald's woolshed (a few miles north of Gisborne), one cannot help remarking the beautiful raised beach behind the present sand hills, as level and smooth as a carriage way, with its seaward slope just as the sea left it. The beach at the present high water has a very different appearance, the finer materials having been acted on by the winds, which have made sand hills. Here and there among these, and in the depression between them and the raised

* "Trans. N.Z. Inst.," Vol. VI., p. 281.

† "Geological Reports," 1873-4, p. 120.

beach, are relics of old Maori encampments. This raised beach continues as far as Makarori rocks, which are comparatively horizontal, and belong to the sandstone formation of the Leda marl series."

The extensive flats of Poverty Bay are no doubt due partly to elevation, the richness of the soil being accounted for by the deposition of alluvium in a former estuary.

Coming now to the southern boundary of this provincial district, we find that the thirty-ninth parallel of latitude strikes the sea at Te Mahanga, about four miles north of Te Mahia peninsula, on a low swampy and sandy flat, evidently an old sea beach, as the coast line may be traced running round some three miles inland, where the steep hills suddenly end on the flat. This plain which is of considerable extent, is generally not more than fifteen or twenty feet above high water mark, and were a depression to that amount to take place the Mahia would again become an island.

From what has been said, it is tolerably clear that the balance of evidence is in favour of elevation going on during the later geological ages, and that it has been pretty general all over this northern part of the Island; that there are two tolerably distinct lines of possibly sudden elevation, whilst others no doubt exist, and that the intermediate period between the two has probably been one of slow gradual rising, with perhaps some local oscillations of an opposite character. The more ancient level is most distinct in the Bay of Plenty, and was most likely coeval with the time when the sea occupied the valley of the Thames, and when the Waikato River emptied itself into that estuary instead of taking its present unnatural course right through two ranges of mountains, and then to the west coast as now. A somewhat similar sea-bottom (perhaps not so high above present high water-mark) can, I think, be traced even here near Auckland. At this period there was a channel through to Kaipara. It is obvious that owing to the length of time that has elapsed since this ancient coast line was in existence that the evidence of it must be much more obscure. During the ages that have passed, the power of running water has had time to exert its influence in cutting out deep gullies, or in planing the former level sea-bottom into slopes of different degrees, leaving only here and there some slight indications still to be found, but yet sufficient to warrant the probability of the supposition, more especially as the shape and contour of the ground in many places is explicable only on the theory of a plane of marine denudation.

As to whether the land is still rising, I would observe that the action of the elevatory forces is usually so exceedingly slow that the time we have been in occupation of the country has hardly been long enough to allow us to form an opinion. Lyell, in his classical work "The Principles of Geology," quotes the case of Norway as a country rapidly rising, and this is at the rate of only 4 feet in the century. To show, however, that the question has engaged the attention of the colonists before, I will quote from a paper read before this Institute by our worthy President in 1868, entitled "Is the Land about Auckland Rising."* Dr. Purchas said:—"He might mention a very curious circumstance in reference to the rise that occurred in the land about Auckland. He thought it afforded positive proof that the land about Auckland was rising sufficiently to be quite measureable. Messrs. Thornton and Co. got a supply of water from the harbour. They had a pipe fixed at some distance down the wharf with a rose at the bottom. They have had to alter that rose three times at intervals of three years. Mr. Firth had told him of the circumstance, and he believed that special pains had been taken with the fixing of the pipe the last time, in order that the matter might be settled. He had been assured by a settler that the harbour of Mahurangi was 2 feet less in depth than it was two years ago. If the bottom of the harbour was rising, it was a matter of vital importance to the people in the neighbourhood of the city. He had no doubt about the accuracy of the information, as was shown by the fact that the rose had to be altered three times in order to get a supply at low-water. A discussion ensued, in which Mr. Weymouth, Captain Hutton, Mr. Wark, Mr. Buckland, and Mr. Stewart, took part. Most of the speakers seemed to be of the opinion that there was not sufficient evidence to show that the land was absolutely rising."

I also quote from the "New Zealand Herald" part of a report by Captain Burgess, dated 3rd January, 1878. After referring to the changes in the character of the weather and the alterations in the harbour due to the silting-up for the last thirty years, he says,—"With reference to the above remarks, I may mention that there is but 3 feet of water at the end of the Breakwater instead of 7 feet, as reported in 1868; also, that the rocks off St. George's Bay are evidently rising." I think we may infer from the last remark, that Captain Burgess believes that the land is rising in addition to the harbour silting-up. If it is so, and that at anything like the rate that Norway is rising, the day is not so far distant when the commercial part of the city of Auckland will have to shift its quarters considerably to find depth of water for its shipping.

Art. LIX.—*Description of an Artesian Well sunk at Avonside.*

By T. A. Mollet.

[*Read before the Philosophical Institute of Canterbury, 30th December,* 1880.]

The information contained in this short paper, though of little or no importance to the ordinary observer, is of interest to the geologist, as helping

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* "Trans. N.Z. Inst.," Vol. I., p. 38.

him, with other like evidence, to elucidate the formation of the Canterbury plains. This matter has been treated of by Professor von Haast in his recent work on the geology of this province, and he there points out the value of collecting all possible information to enable maps and sections to be prepared, showing the geological nature of the country.

I trust that many persons may be found willing to bring forward any communications of a similar kind, as by that means a mass of facts will be collected, which, taken together, will be of immense value. It is important that this should be effected as soon as possible, there being now no means of ascertaining what the pipes (the lower ends of which are invariably closed with an iron plug) are driven through. In former times, as is well known, the wells were bored, and thus afforded a section of the strata passed through; but the number of such wells is comparatively few, and therefore particulars regarding them (which would otherwise be irretrievably lost sooner or later) should be put on record at once.

The well to be described is situated about 15 chains south-east from the junction of the New Brighton road and Dudley Creek, and about 2 chains from the road bordering on the creek, and fronting on the property on which it is sunk. It is on lot 32 (at present occupied by Mr. Hebden) of Rural Section 231 (originally in the possession of Mr. T. L. Laine),

This well was bored for the gentleman (Mr. T. L. Laine) who, at the time, owned the property, and from him I obtained, a few years ago, the particulars (which I noted down) concerning the sinking of it. Not thinking at the time that the information would ever be of any value he had not committed it to writing, so that he gave it me from memory; but as he had taken very great interest in the matter, I have not the slightest doubt of the correctness of the measurements.

Starting from the surface, $1\frac{1}{4}$ feet of black soil was first met with, beneath which was a layer of clay $1\frac{3}{4}$ feet thick, followed by a bed of sand 12 feet deep. The next stratum of 15 feet consisted of river-worn shingle, which reposed on one of bluish sand, considered to be of sea deposit, and was only passed through after hard driving for 60 feet. Peaty soil was next encountered, beneath which was found fragments of wood, cockle shells and clay, all this occupying a depth of $2\frac{1}{2}$ feet. A $1\frac{1}{2}$ feet layer of shingle was the last pierced before water was reached. At this point the well was abandoned by the sinkers, who had taken six weeks to attain a depth of 94 feet. The lower end was now so much bent that it was hardly possible to clear the pipe; and the water, the supply of which was very meagre, was not of good quality.

Two months after the well-sinkers returned, and finding the pipe had sprung back to its normal condition, proceeded to drive it without difficulty. It now passed through 3 feet of sand, followed by 1 foot of peat, and 2 feet of clay, when a plentiful supply of water was tapped, which brought up a considerable quantity of sand. Some idea of the quantity issuing from the pipe may be gathered from the fact that, though the extremity was three feet above the surface, the water was forced up in a solid mass five inches higher (pipe 2¼ inches in diameter).

The well had then reached a depth of 100 feet, but as it frequently brought up sand, and as the taste of the water was not so good as was expected, the owner, about ten years after, had it sunk another 8 feet. It was easy to drive, eight to ten blows to the inch, through a bed of shingle. Some of this, brought up by the force of the water, was of so great a size, that the burred edge of the pipe had to be cut off to allow it to pass out. The water was now entirely free from sand and much improved in taste.

It will be seen by referring to the list of strata passed through, that the well, when bored the first time, ended in a bed of shingle, with a deposit of clay above. When sunk deeper, the second time, it again passed through clay with shingle beneath, which was further penetrated in the third boring. The above agrees with the following statement made in Professor von Haast's work:* "The bottom of the water-bearing stratum consists invariably of a bed of shingle, mostly of small size, upon which a deposit of sandy clay reposes.

I might mention that when the well was left, after the third boring, 10 feet of shingle was present in the lower end of the pipe.

TABULATED LIST,

Showing the depth of the various strata, borings, etc.

Depth.	Description of Strata.	Thickness of Strata.		
		I. Boring.	II. Boring.	III. Boring.
	Black Soil	1¼ feet	..	..
1¼ feet	Clay	1¾ ,,	..	..
3 ,,	Sand	12 ,,	..	..
15 ,,	Shingle..	15 ,,	..	..
30 ,,	Blue Sand	60 ,,	..	..
90 ,,	Peaty Soil .. / Wood, Shells, and Clay	2½ ,,	..	..
92½ ,,	Shingle	1½ ,,	..	..
94 ,,			..	..
	Sand		3 feet	..
97 ,,	Peat		1 ,,	..
98 ,,	Clay		2 ,,	..
100 ,,				..
	Shingle..			8 feet
108 ,,				

* "Geology of the Provinces of Canterbury and Westland, New Zealand." By Julius von Haast, Ph. D., F.R.S., etc., 1879.

Art. LX.—*On the Venous System of the Skate* (Raja nasuta).

By T. Jeffery Parker, B.Sc., Lond.,
Professor of Biology in the University of Otago.

[*Read before the Otago Institute*, 1st *February*, 1881.]

In making a series of injections of the Skate's vascular system a few months since, I was struck with one or two instances in which the facts, as I made them out, were either directly contradictory of the statements usually made about the vascular system of Elasmobranchs, or showed very interesting deviations from the normal state of things. In bringing forward my observations, I think it will be as well to give a general connected account of the whole venous system in the Skate, since, as far as I know, this has not yet been done. Many of the more important veins are, however, figured by Monro in his classical monograph on "The Anatomy and Physiology of Fishes," and, as I shall have occasion to point out, the veins in connection with the kidneys are described in detail by Jourdain. It may also be as well to mention, for the benefit of any who may be interested in the matter, that the arteries of the Skate are described by Hyrtl,* his paper being illustrated by a series of very beautiful coloured plates.

The heart consists, as usual in elasmobranch fishes, of sinus venosus (fig. 1, *s.v.*), auricle (*au.*), ventricle (*v.*), and truncus arteriosus (*c.a.*, *b.a.*). The sinus venosus with which we are especially concerned, as it receives the venous blood from all parts of the body, is a transverse vasiform chamber, situated in the postero-dorsal region of the pericardium, to the walls of which it is attached by a strong sheet of fibrous tissue. At each end, just outside the pericardium, it becomes connected with a chamber (*pc. s.*) situated at the anterior end of the abdominal cavity, and in close relation with the coracoid portion of the shoulder-girdle. The chamber receives all the chief veins of the body; it answers evidently to the vessel called *Ductus Cuvierii* in bony fishes, which again is known to be hormologous with the anterior vena cava, or precaval vein of the higher animals; it may therefore be called the *precaval sinus*.

The precaval sinus is an irregularly ovoidal chamber, about two centimetres long by a trifle over one centimetre in width; when laid open from

* Wien. Sitz. Ber., XXV., 1857; and Wien. Denkschr., XV., 1858.

the ventral side, its walls are seen to be perforated with a number of apertures, by one of which (*s.v′*), situated at its anterior end, it pours its blood into its sinus venosus, while by the remaining six it receives either blood or lymph from the various parts of the body. One, on the inner wall and somewhat dorsal in position, leads into the jugular vein, by which the blood is brought back from the head (*ju′*): a small aperture just anterior to this leads into the inferior jugular vein (*i.ju′*) : a large one just posterior to that of the jugular is connected with the cardinal veins, by which the blood is returned from the hinder parts of the body (*cd′*); on the ventral wall is the entrance of the hepatic sinus (*h.s′*) ; and on the outer wall that of the brachial vein (*br′*). Lastly, on the dorsal wall is a transverse slit, guarded by a pair of valves, and leading into a large lymph sinus (*ly′*).

The jugular *(ju.)* is a large vein lying to the dorsal side of the gills, and receives the greater part of the blood from the head, the small inferior jugular *(i.ju)* receiving mainly that from the floor of the mouth and the pericardium. The brachial *(br.)* is a large vein, and receives all the blood from the great pectoral fins ; at its distal end it is connected with the veins belonging to the posterior part of the body, in a way presently to be described.

The portal vein returning the blood from the abdominal viscera (fig. 2) is made up of two chief factors, the *gastric* (fig. 2*g.*) from the stomach and the *mesenteric* (*ms.*) from the intestines. The latter is made up of a main trunk *(ms′)* from the colon—*i.e.*, that part of the intestine in which the spiral valve is contained, a *duodenal vein (du.)* from the *bursa entiana* or duodenum, a *splenic vein (spl.)* from the spleen, and about three small veins *(pn.)* from the pancreas. The main portal vein *(p.)* enters the liver, and the blood taken by it to that organ, along with that from the hepatic artery, is poured by several veinlets into the *hepatic sinus* (fig. 1, *h.s.*), a large transverse chamber, just anterior to the liver, and opening at either end into the precaval sinuses.

So far, everything, with the exception of the inferior jugular vein, is just as I have learned it from Prof. Huxley's lectures, and as it is, if my recollection serves me, described by Monro.

The unpaired caudal vein (*c.*), bringing the blood from the tail, divides immediately on leaving the hæmal canal of the caudal vertebræ into two vessels, the *renal portal veins (r.p.)* which pass, one to each kidney, running up to the greater length of its inner border. Into each renal portal vein open a number of lesser trunks *(r.p.′)* from the pelvic and lumbar regions as well as from the region of the vertebral column as far forward as the anterior end of the kidneys ; while from it numerous offshoots *(r.p.″)* pass into and break up in the substance of the kidneys ; so that all the blood from the tail, as well as part of that from the hinder part of the body, is taken to the kidney and passed through the renal capillaries on its way back to the heart.

From the kidneys the blood is returned by numerous small *renal veins (r)* into the two large *cardinal veins (cd)*, which lie, one on the ventral face of each kidney, and, uniting with one another by a cross-branch *(cd″)* posteriorly, pass forwards and outwards to the aperture *(cd′)* already mentioned in the precaval sinus. After leaving the kidneys the two cardinal veins run together, and form a spacious *cardinal sinus (cd. s)*, capable of containing fully an ounce of blood, and connected on either side with two almost equally extensive *spermatic sinuses (sp. s.)*, which receive the blood from the reproductive organs.

The general diposition of the cardinal veins, as here described, is perfectly well known, but their relation to the caudal vein is, I think, not generally recognized. In fact, it is distinctly stated in Huxley's "Anatomy of Vertebrated Animals," in Gegenbaur's "Elements of Comparative Anatomy," and in Claus's "Grundzüge der Zoologie," that both in Marsipobranchii and in Elasmobranchii, the two branches of the caudal vein are directly continued into the cardinals. I therefore thought, at first, not unnaturally, that the true condition of the renal circulation in the skate had been overlooked, but on consulting M. Jourdain's memoir on the renal portal system, in the "Annales des Science Naturelles,"* I find that he has described and figured the real state of things with great exactness, except for the fact that he gives a wrong account of the relations of the veins from the hind limbs.

The skate has thus a true "renal portal system," quite of the same nature as that of Amphibia and Reptilia: in these latter the renal portal veins receive not only the blood from the tail and pelvis, but also that from the hind limbs, and in the skate also the veins of the hind limbs or pelvic fins are described by Jourdain as opening into the renal portal vein. But I find that he has mistaken the principal pelvic vein for the femoral. The latter takes a quite different and very remarkable course.

The femoral vein *(fm)*, in fact, debouches into a spacious trunk *(il. h., epg)*, which lies, for a considerable part of its course, in the ventral wall of the abdomen, near its outer boundary. Both anteriorly and posteriorly it passes dorsalwards, becoming connected in front with the distal end of the brachial vein, and behind, curving along the posterior wall of the pelvic cavity, then passing on to the lateral wall of the cloaca, along which it takes its course as far as to the rectal gland, where, with its fellow of the opposite side, it enters a hinder prolongation of the cardinal sinus, first receiving numerous

* Ser. IV., Tom XII., 1859.

small veins *(hæ)* from the cloaca and rectum. These latter, I have no doubt, although I have not actually proved it, anastomose with factors of the portal vein.

It is by no means easy to find a correct nomenclature for this vein, as it differs so markedly from anything hitherto known. The part between the entrance of the femoral vein and the cardinal sinus *(il. h)* seems to correspond in all essential respects to the iliac vein ; or, as it also receives the hœmorrhoidal veins (*hæ*) from the rectum and cloaca, it may perhaps be best called the *ilio-hœmorroidal* vein. The part continued forwards, from the junction of the femoral (*ep.g*) receives veins (*ab.*) from the abdominal walls, and therefore answers functionally as well as topographically to the epigastric or anterior abdominal vein. Similarly, the anterior part (*m*)—that continuous with the brachial vein, seems to answer to the mammary vein of the higher animals. So that it may be said, that the mammary and epigastric veins are of great size, as large in fact as the subclavian and iliac, into which they respectively pour their blood, and that they are continuous with one another, instead of merely anastomosing.

But it is obvious that there is another and more natural way of describing these vessels, namely, by considering the veins I have called brachial, mammary, epigastric, and ilio-hœmorrhoidal, as forming—as they actually do—one continuous lateral trunk, into which debouche the veins from the fore and hind limbs and abdominal walls, as well as from the rectum and cloaca.

Certain theoretical considerations invest this mode of interpretation with great interest. The theory of vertebrate limbs, now very generally received, is that of Mr. Balfour, who regards the limbs as being detached portions of an originally continuous lateral fin.

It seems to me that an argument distinctly in favour of this theory, is afforded by the case now under consideration. The ancestral vertebrate possessing the continuous lateral fin must presumably have had a large lateral vein, into which opened numerous veinlets from the fin, and it is reasonable to suppose that, as certain portions of the fin developed at the expense of the rest, the anterior and posterior ends of the vein, in relation with them, would take on a greatly increased size, the intermediate part becoming proportionately reduced, and supplying finally, only the body-wall between the fore and hind-limbs.

According to Professor St. George Mivart, the skate presents us with a nearer approach than any known type, to the primitive form of limb-skeleton—the archipterygium. If this view be correct it is very interesting to find the limb possessing what we may consider as an almost primitive venous supply. But it must be remembered that, the skate being in many

Place for illustration XV.

respects an extremely specialized fish, certainly far more specialized than the sharks or dog-fish, it may be that the primitive arrangements of its limb-skeleton and veins should be looked upon as re-acquired, rather than as retained.

There is one general point about the skate's venous system to which I may, in conclusion, direct attention, and that is the extraordinary number of transverse anastomoses it presents, the result being to produce numerous "venous circles," comparable to the circle of Willis in the arteries of the mammalian brain, and the *circulus cephalicus* in the arterial system of bony fishes. Thus there is a direct passage from the sinus venosus and back again, in four different ways, namely: (1) by the the hepatic sinus; (2) by the anterior part of the cardinal vein and the cardinal sinus; (3) by the whole length of the cardinal veins and their posterior anastomosis; (4) by the lateral veins (brachial, ilio-hœmorrhoidal, etc.) and the prolongation of the cardinal sinus, into which they open. Other *circuli venosi* can, of course, be made by taking the hepatic sinus, or the cardinal sinus, as a starting point; and lastly, two great paired circles are formed by the lateral veins, each in connection with the corresponding precaval sinus, anterior portion of cardinal vein, and cardinal sinus.

EXPLANATION OF PLATE XV.

Fig 1. General view (somewhat diagrammatic) of the veins of *Raja nasuta*, from the ventral side (half nat. size). The portal vein is not shown; the renal portal vein *(rp)* is supposed to be removed on the left side (right in the figure), and the femoral *(f.m.)* ilio-hœmorrhoidal *(il.h.)*, etc., veins as well as part of the cardinal *(cd.)* on the right. The right precaval sinus *(pc.s.)* is cut open, so as to show the apertures in its walls. The outlines of those portions of the auricle *(au.)* and sinus venosus *(s.v.)*, which lie behind (dorsal to) the ventricle *(v.)*, are dotted.

ab., veins from abdominal walls.
au., auricle.
b.a., bulbus anteriosus.
br., brachial vein.
br'., opening of brachial vein into precaval sinus.
c., caudal vein.
c.a., conus arteriosus.
cd., cardinal vein.
cd.', opening of cardinal vein into precaval sinus.
cd.'', posterior anastomosis of cardinal veins.
cd.s., cardinal sinus.
epg., epigastric vein.
fm., femoral vein.
h.s., hepatic sinus.
i.ju.', opening of inferior jugular into precaval sinus.
ju., jugular vein.
ju.', opening of jugular vein into precaval sinus.
ly., opening of lymphatic trunk into precaval sinus.
m., mammary vein.
pc.s., precaval sinus.
r.p., renal portal vein.
r.p.', factors of renal portal vein from pelvic and lumbar regions.
r.p.'', branches of renal portal veins entering kidney.
sp.s., spermatic sinus.
s.v., sinus venosus

h.s.', opening of hepatic sinus into precaval sinus.
hœ., hœmorrhoidal veins.
i.ju. inferior jugular vein.
s.v.', aperture leading from precaval sinus into sinus venosus.
v., ventricle.

Fig. 2. The portal vein of *Raja nasuta* (half nat. size).
du., duodenal vein.
g., gastric vein.
m.s., mesenteric vein.
m.s.', main factor of mesenteric vein from colon.
p. main trunk of portal vein.
pn., pancreatic veins.

Art. LXI.—*On a new Holothurian* (Chirodota dunedinensis, n.sp.).

By T. Jeffery Parker, B.Sc., Lond.,
Professor of Biology in the University of Otago.

[*Read before the Otago Institute, 1st February*, 1881.]

This representative of a genus and family hitherto unknown in New Zealand appears to be extremely common in Otago harbour. I found it first between Logan's Point and Ravensbourne, and afterwards, in great abundance, at Broad Bay, both times entangled in the red seaweed between high and low water marks.

As I hope to have the opportunity of working at the anatomy of the species, I confine myself now to recording the discovery, and giving the sytematic characters of the genus and species.

Genus *Chirodota*, Eschscholtz.

Worm-like; calcareous spicules in the form of wheels imbedded in the skin; tentacles shield-shaped, produced at the edges into finger-like processes *(Tentacula peltato-digitata).*

C. dunedinensis, T.J.P.

Tentacles ten, each with about ten processes, which increase in size progressively from the proximal to the distal end. Integument quite smooth, there being no tentacles or papillæ. Colour yellowish (owing to the bright yellow viscera shining through the translucent skin) with small crimson spots which disappear in spirit; tentacles whitish, with dark spots on the inner side at the base; these spots are unaffected by spirit. Length, in the extended condition, about 4 cm.

Otago harbour: littoral.

ART. LXII.—*Description of a new Species of Lizard of the Genus* Naultinus. By WALTER L. BULLER, C.M.G., Sc.D., F.R.S.

[*Read before the Wellington Philosophical Society, 10th January,* 1880.*]

IN continuation of previous notes on the Lizards of New Zealand, I have now to bring before the Society a very beautiful form of Tree-lizard, for which I propose the name of *Naultinus sylvestris.*

The example on which my new species is founded was obtained in the wooded country of the Wanganui District by Mr. Joseph Annabell, of the New Zealand Survey Department, who kindly presented it to me.

It was alive in my possession for several weeks, and before it died, fortunately for science, gave birth to two young ones, thus enabling me to add a description of the species in this early stage of its existence.

I have already, in a former communication to the Society,† called attention to several remarkable instances of assimilative colouring, for protective purposes, in the members of the genus *Naultinus* in New Zealand. The bright green tints of one species enables it almost to defy discovery amidst the evergreen foliage of the native shrubs; the marbled-brown skin of another is peculiarly adapted for concealment as it clings to the bark of a tree, or hides in the crevices; whilst a third, which inhabits the sulphur-crusted grounds in the Lake District, is of a uniform bright sulphur-yellow.

The form which I have now the pleasure of describing affords another illustration of this law of protective resemblance to natural surroundings. The peculiar markings which distinguish it from the other species, presenting patches of pale-brown and minute granulations of yellow, so exactly resemble the cryptogamic vegetation covering its usual haunts that it might safely defy detection under the very eye of the naturalist!

Naultinus sylvestris, sp.nov.

The whole of the upper surface blackish-brown, beautifully variegated with pale brown and sulphur yellow, the latter colour being dristributed in irregular patches of minute granulations like the spores of a lichen, the whole being very suggestive of the spreading cryptogamic growths that are found adhering, in flat crusts, to the bark of certain trees. Fronto-nasal scales yellowish brown and shining; the upper surface of the head blackish brown, dusted over in an irregular manner with minute punctæ of dull golden yellow or grey. On the nape the yellow assumes the form of a broad transverse patch, and this colour is continued down both sides of the

* This paper should have appeared in last year's volume of the "Transactions," but the MS. was not received in time, and a mere precis was given at page 314. Being in the author's hands it was unfortunately omitted from the proper place in the present volume.—ED.

† "Trans. N.Z. Inst.," Vol. III., p. 9.

spine to the junction of the tail in irregular blotches, alternating with the dark ground colour, and partly covered or hidden by a peculiar disguise of minute fretwork in pale yellow, disposed in irregular patches and crossing the spine at short intervals. The simulation of the delicate ramifications and microscopic sporules of the lichen is simply perfect. The legs and toes on their outer surface are dark brown dusted and speckled with yellow; the whole upper aspect having a very lively and pretty effect. The colours of the under parts are entirely different. The chin-scales are almost white, and the lower labial scales are black and white alternately. The sides of the face pale vinous freckled with white and crossed diagonally, from the eye to the angle of the jaw, with an irregular facial streak of black; throat and all the under parts yellowish-white, thickly freckled and speckled all over with pale brown and yellow, and washed on the throat and sides of the neck with vinous or purplish brown, this colour deepening on the sides of the body, where it blends with the sulphur-yellow fretwork already described, the latter becoming here more determinate and forming small yellow patches in a dark setting, the whole being prettily varied and mottled with velvety black. The tail again differs from the body, being of a vinous brown, paler on the under surface, and obscurely marbled and streaked with darker brown. Under surface of the feet dull yellowish brown; claws horn colour. The eyes which are full and lustrous, with prominent overhanging eyebrows, like fringes, are almost black, presenting, however, on a very close examination, a silvery reticulation with an obscure elliptical pupil. On the mouth being opened, the palate, tongue and lower jaw are found to be of a bright orange-yellow, and the throat dark blue.

Head, ·8; body, 2·4; tail, 2·5.

Young:—Uniform colour, a mottled vinous brown, paler on the under parts, and minutely speckled with grey; not unlike, in appearance, the tail of the adult. Chin yellowish-white; facial streak indistinct.

Hab.—Wooded country in the Wanganui District, North Island.

Note.—Very snappish, opening wide its jaws to bite, curling its body round on being seized, and uttering a peculiar hissing sound like that of the singing beetle, *Æmona hirta.*

As already mentioned, the specimen described above was an adult female. It was captured in August, 1879, by Mr. Annabell, who found it clinging to the lichen-covered bark of an ancient totara.

It gave birth to its young on the 5th December following.

I observed that the orbits of the eyes and the ear-openings were infested with the peculiar crimson parasite which attacks the same parts in *Naultinus pacificus;* and I noticed that two of these insects transferred themselves, after the death of the parent, to one of the young lizards, attaching themselves to the inner junction of the hind legs.

PROCEEDINGS.

NEW ZEALAND INSTITUTE.

Twelfth Annual Report.

Meetings of the Board were held on the following dates:—21st July, 19th November, 1879, and 17th February, 5th April, and 20th April, 1880.

The members who retired from the Board in conformity with the Act were Messrs. Travers, Mason, and Waterhouse. The two former gentlemen were reappointed, and the Hon. G. Randall Johnston was appointed by His Excellency in the room of the Hon. Mr. Waterhouse.

The Gentlemen elected Governors of the Institute by the incorporated societies, under clause 7 of the Act, are Dr. Buller, F.R.S., C.M.G.; Mr. T. Kirk, F.L.S.; and Captain Russell, M.H.R.

The list of honorary members of the Institute having reached the number prescribed by section 4 of the Rules and Statutes (viz., thirty), no nominations took place during the past year.

The number of members now on the roll of the Institute is as follows:—

Honorary members	30
Ordinary members—	
Auckland Institute	274
Hawke's Bay Philosophical Society	78
Wellington Philosophical Society	269
Nelson Association	50
Westland Institute	121
Philosophical Institute, Canterbury	229
Otago Institute	226
	1,277

The printing of Vol. XII. was commenced in January and finished early in May, but, owing to delay in getting the lithographed plates printed, the volume was not ready for issue until the 8th of June.

Vol. XII, contains 59 articles, and several Presidents' Addresses and abstracts of papers which appear in the Proceedings and Appendix. There are 14 plates and 538 pages of letterpress.

The following are the sections of the work, compared with last year's volume:—

	1880. Pages.	1879. Pages.
Miscellaneous	240	186
Zoology	76	216
Botany	84	66
Chemistry	14	26
Geology	6	22
Proceedings	52	66
Appendix...	66	42
	538	624

The volumes of the Transactions now on hand are—

Vol. I., second edition, 430; Vol. II., none; Vol. III., 4; Vol. IV., 2; Vol. V., 70; Vol. VI., 60; Vol. VII., 165; Vol. VIII., 30; Vol. IX., 170; Vol. X., 20; Vol. XI., 100; Vol. XII., not yet fully distributed.

The balance-sheet herewith shows the sum of £4 8s. 3d. to the credit of the Board, to which must be added the sum of £31 2s. 6d. due by the Auckland Institute, making in all £35 10s. 9d., against which there is an outstanding balance of account for printing of £66 6s. 6d.

To meet the deficiency of £30 15s. 9d. it will be necessary to make a call of 1s. per volume on the present issue.

The usual annual reports of the various departments connected with the Institute are appended. (Published in a separate form. See Geological Reports, 1879–80; Museum and Laboratory Reports, 1880.)

James Hector,
Manager.

Approved by the Board, 21st July, 1880.

W. B. D. Mantell,
Chairman.

Accounts of the New Zealand Institute, 1879–80.

Receipts.	£	s.	d.	Expenditure.	£	s.	d.
Balance in hand on 21st July, 1879	140	16	3	Balance due for Printing Vol. XI.	155	13	2
Vote for 1879-80	500	0	0	On account of printing Vol. XII.	504	10	0
Contribution from Wellington Philosophical Society (one-sixth of annual revenue) ..	36	14	2	Miscellaneous items (including woodcuts, Library catalogue, etc.)	17	0	0
From Westland Institute, in aid of Vol. XI.	3	0	0	Balance	4	8	3
Sale of a volume of Transactions	1	1	0				
	£681	11	5		£681	11	5

A. Stock,
Treasurer.

21st July, 1880.

WELLINGTON PHILOSOPHICAL SOCIETY.

First Meeting. 26*th June*, 1880.

Mr. Martin Chapman, President, in the chair.

New Members.—Messrs Rouband, Macdermott, Gerse, and Mrs. John Kebbell.

The President delivered an opening address:

ABSTRACT.

He reviewed the proceedings of the Society during the past year, the results of which appear in Vol. XII. of the Transactions, and on the whole considered that good work had been done. He particularly referred to many valuable papers under sections Ethnology, Zoology, and Botany, and the annual report of the New Zealand Institute, which is a yearly *resumé* of all scientific work done in the colony; also, to the valuable paper on the Meteorology of New Zealand in the appendix, which contains the results, in a condensed form, of all the observations taken throughout the colony during the year by the Meteorological Department under Dr. Hector. He also called attention to a number of additions to the library on the table, including reports and catalogues lately issued by the Geological Survey and Colonial Museum Departments.

PAPERS.

1. "Notice of a new fish, *Hypolycodes haastii*," by Dr. Hector. (*Transactions*, p. 194). (Specimen exhibited.)

2. "Notice of the Capture of a Large Stingaree," by Mr. Seymour George, M.H.R.

The following is a note of a large *Stingaree* (Trygon thalassia), which I harpooned to-day and captured, it being an unusually large one, the length from snout to tip of the tail being 9 feet 11 inches; length of tail, 6 feet; breadth, 4 feet 7 inches; depth, about 1 foot 6 inches. It must have weighed at least 2 cwt. The tail was covered with spines, also a row nearly the whole length of back, and part of two other rows of spines running parallel with the main row of spines on the back. I happened to haul it on the beach on its back, so that the whole of the under part of the fish was fully exposed. While thus lying a young ray was born, which measured from snout to tip of tail 3 feet 3 inches; length of tail, 2 feet 2 inches, with a spine 2 inches long; breadth, 1 foot 4 inches. Another young ray, evidently just born, followed its mother on shore, which I also captured; it was the same size as the one which I saw born. I opened the ray to see if there were any more young inside her, but found none, but seemed to have a number of what I supposed to be eggs; they were about the size of a pigeon's egg, and full of a thick yellow fluid.

Kawau, 5th March, 1880. (Specimens exhibited.)

3. "Notes on Mr. Frankland's Paper on 'The Simplest Continuous

Manifoldness of two Dimensions and of Finite Extent,'" by W. Skey. (*Transactions*, p. 100).

Mr. Frankland replied to Mr. Skey's objections, and said that he was glad this paper had been written, as it would afford him an opportunity of bringing forward his views on the subject more fully.

Dr. Hector exhibited recent additions to the Museum, comprising a series of fishes from Japan, presented by the Hon Mr. Waterhouse; a series of the fishes sold in the Melbourne markets; birds and seals from the Auckland Islands; collection of tapa cloth, showing the process of manufacture; and sugar grown in Fiji, presented by the Commissioner for Fiji at the Sydney Exhibition; a specimen of Molock horridus, the horned lizard of Australia, presented by Dr. Ralph, of Melbourne. Dr. Hector explained that this lizard is probably the living representative of a gigantic extinct dragon, lately found in Queensland, the bones of which he had seen, and recognised their affinity, before they were sent to Professor Owen by Dr. Bennett, in October last. He had just received a copy of Professor Owen's paper containing the description read before the Royal Society, which confirmed this identification. Lastly, attention was directed to the large geological collection made during last year—in the South by Mr. McKay, and in the North by Mr. Cox, among which occurred new and valuable minerals which may prove of great economic importance.

Second Meeting. 20*th July*, 1880.

Mr. Martin Chapman, President, in the chair.

New Members.—Mr. Daniel Maunsell, and Mr. E. H. Williams.

PAPERS.

1. "On introduced trees and plants of economic value to New Zealand," by Dr. Curl, F.L.S., of Rangitikei.

ABSTRACT.

The author gave the result of his experimental culture of a large number of different fruit trees and other plants, the introduction of which he considered of value to New Zealand. He showed that a much greater variety were suitable to the soil and climate than was generally supposed, and that if the settlers devoted attention to such cultivation they would add greatly to the resources of the country, and to the profitable employment of their industry. He has found that a great many kinds of the vine can be cultivated with success, and that even if wine could not be successfully made, the crop of grapes would yield a large profit if converted into raisins by the artificial drying process adopted in California. He has succeeded in growing twelve kinds of fruit trees from Japan, which promise good results. In illustration of the importance of the subject, he quoted the enormous sums of money obtained in other countries by the systematic cultivation of fruits.

Dr. Hector thought the paper valuable and suggestive, and pointed out that in the North Island the settlers coming from Great Britain would have to rely upon many kinds of produce with which they were unfamiliar in the old country, if the best resources of the country were to be developed.

Mr. Lee was glad to know that the cultivation of fruit was attracting some attention at last, as it was a valuable source of income, peculiarly adapted to the circumstances of small settlers.

The Hon. Mr. Chamberlin mentioned, as a curious circumstance, that the Cape goosberry that used to be sold in Auckland for 3d. per pound, could not now be obtained for less than 1s. He considered it a most valuable fruit, but its cultivation did not seem to be successfully achieved.

Mr. Kirk said that the Cape goosberry would grow on any good soil that was suitable to the tomato, and attributed its disappearance to the pheasant. It is not creditable to New Zealand that there should be such an enormous importation of fresh and preserved fruits from other countries, for with ordinary attention this colony should not only be self-supporting but should also be a large exporter of the best kinds of fruit. He looked forward to the successful cultivation of the orange on a large scale. The vine he did not expect to be successful, as far as making wine was concerned, as there is a want of sufficient sun-light in New Zealand at the proper season. The author had not mentioned several important plants, such as tobacco and chincona, from which quinine is made; the latter had been shown by the Auckland Acclimatisation Society to thrive well. He thought it unfortunate that there was not an experimental botanical garden established in New Zealand. Had such been the case ten or twelve years ago, the settlers might now be in possession of several valuable sources of income.

Dr. Hector thought that the author would feel gratified at the reception his paper had met with. He did not agree with Mr. Kirk that there was a deficiency of sun-light, as observations had shown that in the interior of both islands the sun had a power that was unequalled in any other temperate climate, and that in consequence, even in the interior District of Otago, light wines could be produced of excellent quality.

The President agreed with the last expressed opinion, and pointed out that the power of the sun depended on the dryness of the atmosphere, and that, again, on the physical conformation of the country, so that while some parts of New Zealand were unsuited to perfecting the grape other districts were well adapted for its cultivation.

2. "On certain New Zealand plants that have been successfully cultivated in Scotland," by Mr. W. Gorrie, of Rait Hall; communicated by Dr. Hector.

ABSTRACT.

The author described the growth of many New Zealand plants, both useful and ornamental, that he had found would withstand the severity of the Scotch climate, and mentioned the economic uses to which they could be applied. In particular he instanced the application of the ribbon-wood as being better adapted for the manufacture of paper pulp than any other plant at present used for the purpose. In concluding, the author suggested that an association should be formed for the purpose of introducing useful New Zealand plants for cultivation on the West Coast of Scotland.

Dr. Hector was not aware that there was such a deficiency of New Zealand plants in Scotland and England as the author stated. In Venice he had been pleased to find a very interesting collection of the New Zealand vegetation, but the best he had seen was in the Royal Society's gardens at Hobarton, which was probably due to the exertions of Sir Frederick A. Weld, K.C.M.G., when Governor there. It was worthy of note that in all the New Zealand plants of that collection the leaves were very much reduced in size, no doubt owing to the effect of the change of climate.

Mr. Kirk said that the statement that the ribbon-wood was suitable for the manufacture of paper was new to him, and of great importance.

3. "On the Auriferous Cements of the Mount Arthur district," by Mr. J. Park, of the Geological Department.

ABSTRACT.

The author described the occurrence of a deposit of auriferous gravel, under limestone, at an altitude of 4,000 feet above the sea, and stated that it had great extent, and could be worked with facility. It contained gold at the rate of over 1oz. to the ton. Fissures and caves occur in the limestone, from which fine specimens of moa bones were obtained.

4. "On the Distribution of the Auriferous Cements in New Zealand," by Dr. Hector.

ABSTRACT.

The author gave an account of the distribution of the older auriferous gravels, a subject which should excite attention at the present time, and which he thought was very imperfectly understood by the diggers, his remarks being illustrated by maps, diagrams, and specimens. Comparatively little of the alluvial gold obtained was washed directly by the streams from the rock matrix, the greater part of it being derived by the re-washing of old gravels of great antiquity. These gravels were deposited in former drainage channels, which have no relation to the existing river systems of the country and are now represented by isolated patches, generally at a considerable elevation, but in some instances below the sea-level. The earliest of these appears to have radiated from the high lands of Otago as a centre during the cretaceous period. In the eocene period the denudation of the auriferous rocks took place in the North-west District of Nelson, giving rise to the gravels now at great altitude, such as those described in the previous paper. During the miocene period was a third great distribution of auriferous gravel, in a line parallel with the West Coast, from the source of the Buller river (at 2,000 feet altitude) to Ross, where they are several hundred feet below the sea-level, so that the gold has to be obtained by deep sinking. After describing the features of several of the most important alluvial diggings that have been discovered and worked, the author concluded by stating that the original auriferous deposits have a wide-spread distribution and are of the nature of regular geological formations, and not to be confounded with the local alluvia of the existing rivers and streams, and that the bulk of them still remain for the practical prospector to discover. That the gold being less concentrated in these earlier gravels than in the modern re-washes formed from them they will no doubt be more expensive to work; but he was of opinion that there was still a great future for the alluvial miner in New Zealand, and to suppose that the diggings were in any sense worked out was quite opposed to experience in other countries. He was glad to find therefore that there had been lately a revival of enterprise on the part of prospectors, and he was inclined to attach considerable importance to reported discoveries that had recently been made, especially as they were in districts where auriferous deposits might reasonably be expected.

Third Meeting. *24th July*, 1880.

Mr. Martin Chapman, President, in the chair.

PAPERS.

1. "On the Fossil Foramifera of Petane," by Mr. A. Hamilton.

This paper gave the results of an examination of certain fossils, by Mr. G. R. Vine, jun., of Sheffield, which had been collected by the author. (*Transactions*, p. 393.)

2. "On the Tertiary Corals and Bryozoa of New Zealand," by the Rev. E. Tennison-Woods, Pres. L.S., N.S.W.

This paper, which has been published in full by the Geological Department, ("Palæontogogy of New Zealand," Part IV., 1880.) gives the results of an examination of a large series of fossils belonging to this class, exhibited in the New Zealand court at Sydney Exhibition by the Geological Department, and was illustrated by a beautiful series of drawings made by the author. Three genera and thirty species were described as new to science.

Dr. Hector pointed out this investigation confirmed the view that during tertiary times the climate of New Zealand had not been much different from that at present prevailing, if anything it was a little warmer, and was quite opposed to the idea of a glacial period having affected these latitudes. It also confirmed the classification he had adopted in placing the Oamaru beds as upper eocene, and equivalent to the Mount Gambier beds in Australia, and Table Cape beds of Tasmania.

3. "On certain Minerals collected during the past Year by the Geological Survey Staff," by S. H. Cox, F.G.S.

ABSTRACT.

Specimens were exhibited and described, some of which were of considerable value and interest. Among them the following were announced as having been found in New Zealand for the first time:—Crome mica, and *hauerite*, or sulphide of manganese. Both these minerals were collected by Mr. McKay in the highly mineralized district lying to the N.W. of Otago, where he also found lodes containing specular iron, *pyrrhotine* or magnetic pyrites containing nickel, *mispickel* or arsenical pyrites containing gold, and *scheelite* or tungstate of lime, the latter having only been found as rolled fragments hitherto. Several new discoveries of copper ore were also announced, among which was occurrence of metallic copper in the basaltic rocks at the Manukau Heads, Auckland. Also the occurrence in the trachytic dyke rocks at Tokatoka, Kaipara, of the zeolites, natrolite, and stilbite.

Dr. Hector exhibited and explained a copy of the geological map of New Zealand, which he had prepared for the Melbourne Exhibition, giving a particular account of the country geologically examined during the past year, and said that few were aware of the amount of labour and great hardships that had to be undergone in carrying on the survey in the more remote parts of the country. He gave a brief account of the progress of the geological survey from its commencement, and showed that by degrees we have attained a tolerably correct idea of the general structure of the whole country. There is still, however, a great deal to be done towards the accurate mapping of the formations, and particularly tracing those strata which indicate the presence of deep-seated coal seams, and the high level auriferous cements to which he had referred at the last meeting.

Fourth Meeting. 14*th August*, 1880.

Mr. Chapman, President, in the Chair.

New Member.—Mr. John Ralph Rees, M.I.C.E.

On the "Colour-Sense," by Dr. G. Gillon.

This was a lecture on the gradual development of the Colour-Sense in the Animal Kingdom, and the corresponding evolution of the chromatic characters characteristic of species of animals and plants.

FIFTH MEETING. 18*th September*, 1880.

Mr. MARTIN CHAPMAN, President, in the Chair.

PAPER.

1. On the "Industries most suitable to New Zealand." by A. K. Newman, M.B.

This was an able lecture on the undeveloped industrial resources of the colony, describing in detail many processes that could be profitably employed by the settlers.

SIXTH MEETING. 10*th October*, 1880.

Mr. T. KIRK, F.L.S., in the Chair.

New Members.—W. H. Simcox, J. C. Harris.

PAPERS.

1. On " Watershed Districts, by J. R. George, C.E. (*Transactions*, p. 119.)

2. "On the Permanency of Solar and Stellar Heat," by Mr. Martin Chapman. (*Transactions*. p. 97.)

3. "On the genus Rhynchonella," by Mr. A. McKay. (*Transactions*, p. 396.)

SEVENTH MEETING, 4*th December*, 1880.

Mr. Martin Chapman, President, in the chair.

New Members.—Messrs. Noel Barraud, and Gibson.

The President announced that the nomination in October, of Dr. Newman to represent the Society on the "Board of Governors of the New Zealand Institute" for 1881, had resulted in the election of that gentleman.

PAPERS READ.

1. "On a Per-iodide of Lead, also a Carbo-iodide," by W. Skey. (*Transactions*, p. 388.)

This paper described a new salt, a Per-iodide of Lead, and also a new compound salt formed by the combination of carbonic acid with this Per-iodine, which has a striking blue colour similar to that produced by adding iodine to starch, and will prove a very delicate and beautiful test for the detection of minute quantities of carbonic acid.

2. "On the Dimorphism of Magnesia," by W. Skey. (*Transactions*, p. 389.)

In the course of experiments for the detection of gold in sea-water, the author found that magnesia is deposited in a form that absorbs iodine, giving rise to a highly coloured substance, and that the magnesia loses this property on being raised to a high temperature. It is therefore argued that the magnesia is altotropic. Further, that magnesia can be exhausted from ammoniacal solutions by galvanic action, thereby greatly shortening the chemical analysis. These tests combined are also useful in detecting the presence of magnesia, as one ten-thousandth of a grain of magnesium can be recognized in one-half a grain of liquid. Baryta and alumina do not absorb iodine in the same way as magnesia.

3. "On Alotropic forms of certain Zinc and Cobalt Salt," by W. Skey. (*Transactions*, p. 387.)

This paper recorded further additions to the list of dimorphic substances.

4. "On the Relation between Pitch Stones and Quartz Porphyries of the Mount Sumner's District, Canterbury," by S. H. Cox, F.G.S.

ABSTRACT.

This paper gave the results of the microscopic examination of a large series of these rocks, and was beautifully illustrated by means of thin slices of the rocks being thrown on the screen by the oxyhydrogen microscope. The argument of the paper was to show that the primary form of the rock is that of Pitch-stone, and that a gradual passage can be traced from the vitreous Pitch-stones with laminated structure to the massive and crystalline Quartz-phorphyries, by a process of devitrifiation, and further, that it is therefore not necessary to assign these rocks to different periods of eruption.

Dr. Hector stated that this was the first of a series of investigations that would be extended to all the other igneous rocks of the colony, the result of which, when fully published with illustrations, would be of great importance, not only in assisting in geological classification, but also in throwing light on the circumstances under which valuable minerals and metalliferous lodes occur. In giving a general description of the probable causes which have led to the formation of the volcanic rocks, he exhibited Prof. Marcou's recent geological chart of the world, as showing that we are acquainted with the structure of only a very small portion of the land surface, while of the two-thirds of the globe covered by sea we are necessarily ignorant, unless we except recent inferences made as the result of the "Challenger" expedition, which are considered to prove that the great ocean-beds are probably of higher antiquity than most of the geological formations.

At the close of the meeting the chemical tests referred to in Mr. Skey's paper were shown, and the sections of rock alluded to by Mr. Cox were demonstrated by polarising microscopes. Dr. Hector also exhibited a series of lantern views of the scenery of Te Anau Lake and Stewart Island, which he had recently obtained.

Annual Meeting. 12*th February*, 1881.

Mr. Martin Chapman, President, in the Chair.

New Members—H. Hill, Napier, R. S. Hawkins, Masterton.

ABSTRACT OF ANNUAL REPORT.

There have been seven general meetings of the Society held during the past year.

The papers read are as follows: 7 on Geology; 7 on Zoology; 8 on Botany; 3 on Chemistry, and 5 on Miscellaneous subjects, making a total of thirty communications.

Thirteen additional members have been added to the roll, five have either withdrawn or been transferred to other Societies owing to removal, and two have been lost to the Society by death. The total number now on the books being 287, namely 6 in addition to last year's list.

One hundred and one volumes have been added to the Library during the past year.

The statement of accounts shows that the funds at the disposal of the Council for the year amounted to £172 13s. 7d.; that £57 4s. has been spent on the museum and in the purchase of books, and that there is a balance of £45 17s. 9d. to the credit of the Society.

Election of Officers for 1881.—*President*—James Hector, M.D., C.M.G., F.R.S.; *Vice Presidents*—Dr. Buller, C.M.G., F.R.S., and the Hon. G. Randall Johnson, M.L.C.; *Council*—W. T. L. Travers, F.L.S., T. Kirk, F.L.S., Dr. Newman, M.B., J. P. Maxwell, C.E., F. W. Frankland, R. H. Govett, Martin Chapman; *Secretary and Treasurer*—R. B. Gore; *Auditor*—W. M. Bannatyne.

Mr. Chapman then delivered a brief address on retiring from the Presidency.

ABSTRACT.

He remarked that colonists generally were too busily engaged in combating the forces of nature to have leisure for scientific investigation. Only a few had opportunity to labour in the immense field open here, and they were doing so under conditions which were daily becoming more difficult and expensive to obtain results of value. Certain branches of science, however, must be cultivated here, otherwise their cultivation elsewhere would not benefit us—such were geology and chemistry (especially in relation to mining), zoology, agriculture, and botany. Discoveries elsewhere in those subjects would not benefit us, unless we had observations here to compare with them. This had hitherto been recognized by the Government, who had maintained an efficient staff of geologists, chemists, meteorologists, etc. The expenditure on geology had enriched the country so as to recoup over and over the cost incurred. A great deal of scientific work was done in New Zealand by private persons, which would be barren were there not a society able to publish it, and so bring it into relation with similar work done abroad. A very large amount of the matter in the annual volume of the "Transactions of the N.Z. Institute" recounted new discoveries and recorded facts to be found nowhere else, and these volumes were highly appreciated by learned bodies in other parts of the world. A larger amount was published by the New Zealand Institute than by similar bodies in any other of the colonies, and the matter was not inferior. This colony now took a worthy place in the scientific world, and would so long as the Institute, with its affiliated societies, existed. It had been urged against them that their papers were wholly speculative and metaphysical, but the reproach was a most unjust one. The New Nealand Institute received a subsidy of £500 a year from Government. This money was expended in publishing the Transactions for all the societies, nine in number. Some of the societies maintained museums of their own, but the Wellington Society used the museum of the Institute, paying a sixth of its funds towards this purpose. Should the Government subsidy be withdrawn, it would be a most severe blow to scientific research in the colony. It would temporarily stop the publication of the Transactions, with a consequent loss in membership of the societies, and would sever their relations with kindred societies elsewhere. The geological record of the colony represented an amount of skill, labour, and adventure which few could realize. People seeing a number of neat labelled specimens little thought of the months of toil and hardship undergone in getting them. The work done in geological research in New Zealand reflected the highest credit on all engaged, and the same remark would apply to palæontology, and, to a lesser extent, to ethnology. The fields of botany and zoology were so vast that a far larger number of workers than we had must be engaged before they could be fully explored. Meteorology was making great strides all over the world, and he was glad to see that soon New Zealand meteorologists would be able to co-operate with those of Australia. Until that was done they could hardly expect to reduce to laws the storms of these seas. He hoped soon every ship arriving in Australia would bring a record of all meteorological observations of the voyage, as was done with good results elsewhere. Pure and mixed mathematical sciences had yet no foothold here, but he hoped soon astronomy would here occupy the same status as it did in Australia. In conclusion, Mr. Chapman thanked the society for the indulgence with which he had been treated as president, and congratulated them on the selection made in his successor. Dr. Buller proposed a vote of thanks to the chairman for his services as president, and for his address. The year had not been so successful as it might have been, partly through Dr. Hector's long absence. Still the annual volume would be of great interest. Dr. Hector seconded. He thought the society was greatly indebted to Mr. Chapman for his services as president. Carried unanimously.

The following papers were read in abstract :—

1. "Alpine plants of Otago," by J. Buchanan, F.L.S.

Dr. Hector said this paper would describe the results of a botanical exploration of a district in Otago which he first collected from in 1862, and which then yielded many new and interesting species. He accordingly had sent Mr. Buchanan to join the geological survey party this season, which, under Mr. S. McKay, has been at work in this district. Mr. Buchanon had, with Mr. McKay's help, brought from the Otago ranges an enormous collection of 25,000 plants, many of which were wholly new, and about others very little was known. Among others there were some beautiful specimens of the alpine plants, which were brought alive, and were exhibited on the table. Dr. Hector explained these in a most interesting manner, they being a number of specimens of plants not higher than moss, but really miniature shrubs. Seen under the lens, they were remarkably beautiful, being covered with flowers. Dr. Hector said prior to this not five people had seen these plants alive, as they were only to be found in the Southern Alps, and were under the snow nine months a year. Among the plants brought Dr. Knight, F.L.S., had discovered a most interesting new species, of Lichen respecting which he furnishes a separate notice. (*Transactions*, p. 385).

2. "Notes on New Zealand Cetacea, Recent and Fossil," by Dr. Hector.

ABSTRACT.

Dr. Hector explained that the illustrations of this paper would not be ready for the forthcoming volume. The notes on the recent Cetacea give a detailed description of *Neobalæna marginata*, two complete skeletons of which (adult and young) are now mounted in the Museum. The presence of 17 pairs of ribs and the permanency of the remarkable characters, afforded by the expanded and lammeller structure of the ribs and vertebral processes, thoroughly establishes the generic independence of this Whale as a form intermediate between the true Baleen Whales and the Rorquals.

Kogia breviceps: A cow and calf of this miniature sperm whale, cast ashore at Lyell's Bay, have been secured, and portions of the latter preserved in spirit for future examination.

Orca: Two examples of this genus have been obtained ; the first ran ashore at Lyell's Bay, and the second, which appears to be a full adult example of *Orca gladiator*, was cast up on the beach near Wanganui.

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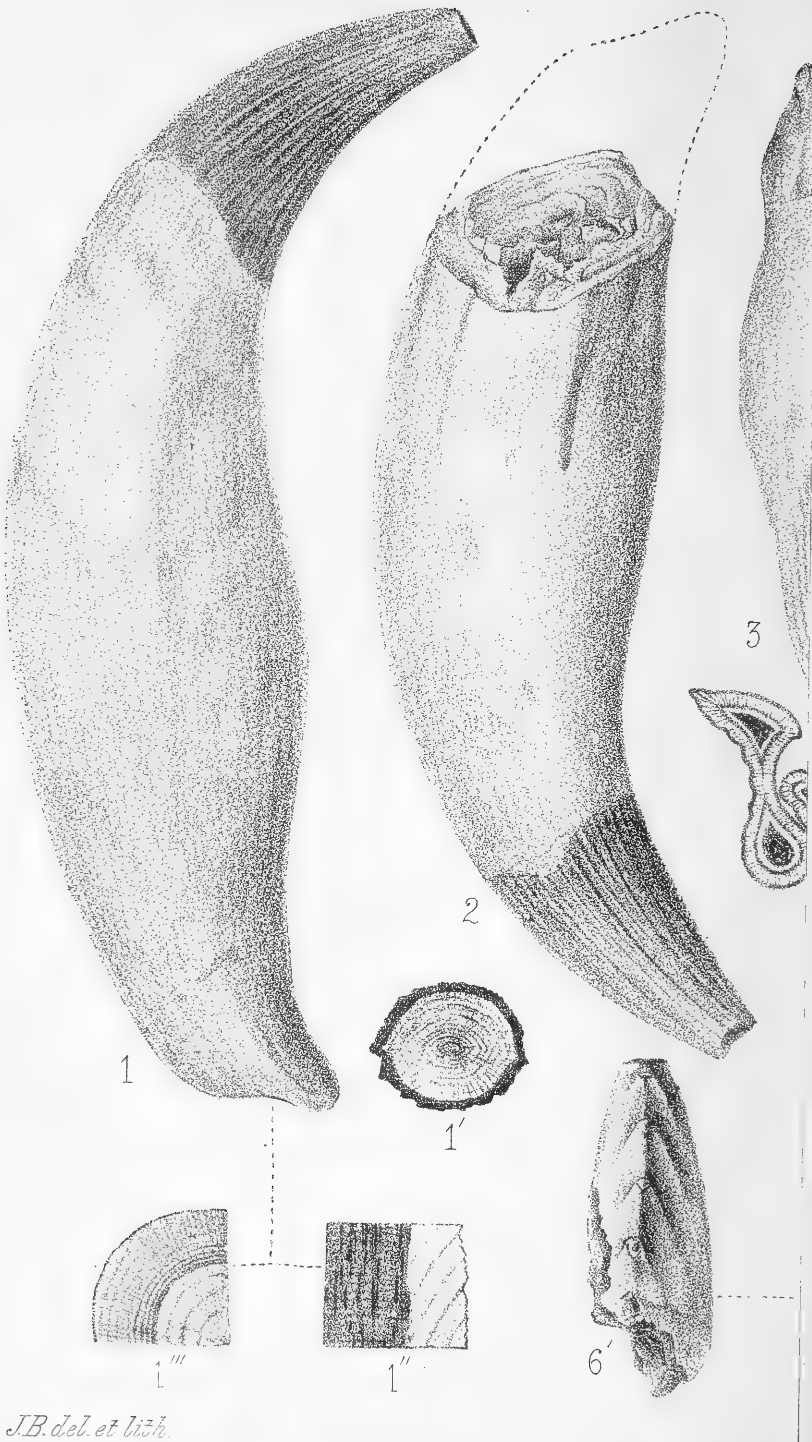


J.B. del. et lith.

Among the fossil Cetacea referred to is a skull of a whale, closely allied to Balænoptera, from the middle miocene formation on the West Coast of the South Island. The matrix which encloses this fossil, is so hard that it is as yet only imperfectly displayed, but it comprises the occipital parietal and frontal bones.

The teeth and bone fragments of a Zenglodont—recently determined from a collection of fossils made by Mr. McKay, during the progress of the Geological Survey in the present season—forms an interesting addition to New Zealand Palæontology. Unfortunately the form of the skull cannot be determined, but the crowns of the teeth agree with that of the great American fossil. They were obtained from the upper eocene strata of the Waitaki valley, in Otago. Fragments of the lower jaw and some ten teeth are preserved, but only a few of the latter are perfect. The teeth are of two kinds, incisors and molars. The largest incisors, probably occupying the position of canines, are 6 inches in length, with a dilated and irregularly curved solid fang supporting a sharp-pointed conical crown 1½ inches in length, and covered with a brown polished enamel having, a fluted surface, and two well marked ridges, so that the section of the tooth presents the same pointed elliptical form as in Mososaurus or Liodon. If only the detatched conical crowns of these teeth had been obtained they might have been referred to such a reptilian type. The molars are from 4 to 5 inches in length, and have compressed conical crowns 1½ inches wide, also covered with polished and fluted enamel, and having the cutting edges serrated by eight obtuse bluntly conical lobes. The crowns are supported on powerful fangs, which are, in some cases, distinctly double-rooted, although the roots are closely appressed, except at the extremities. In one tooth—the smallest and probably the anterior molar—the division of the fangs is only indicated by shallow grooves on the inner and outer surfaces, and it has a somewhat trilobate character, while in another, probably the most posterior, the fang is strongly curved. In this last case the crown of the tooth is triangular in section, and has its cutting edge directed obliquely inwards and forwards. All the teeth are solid, or have only a slight excavation at the points of the fangs, and consist of a lamminated cement layer ·35 inches in thickness, enclosing the massive dentine.

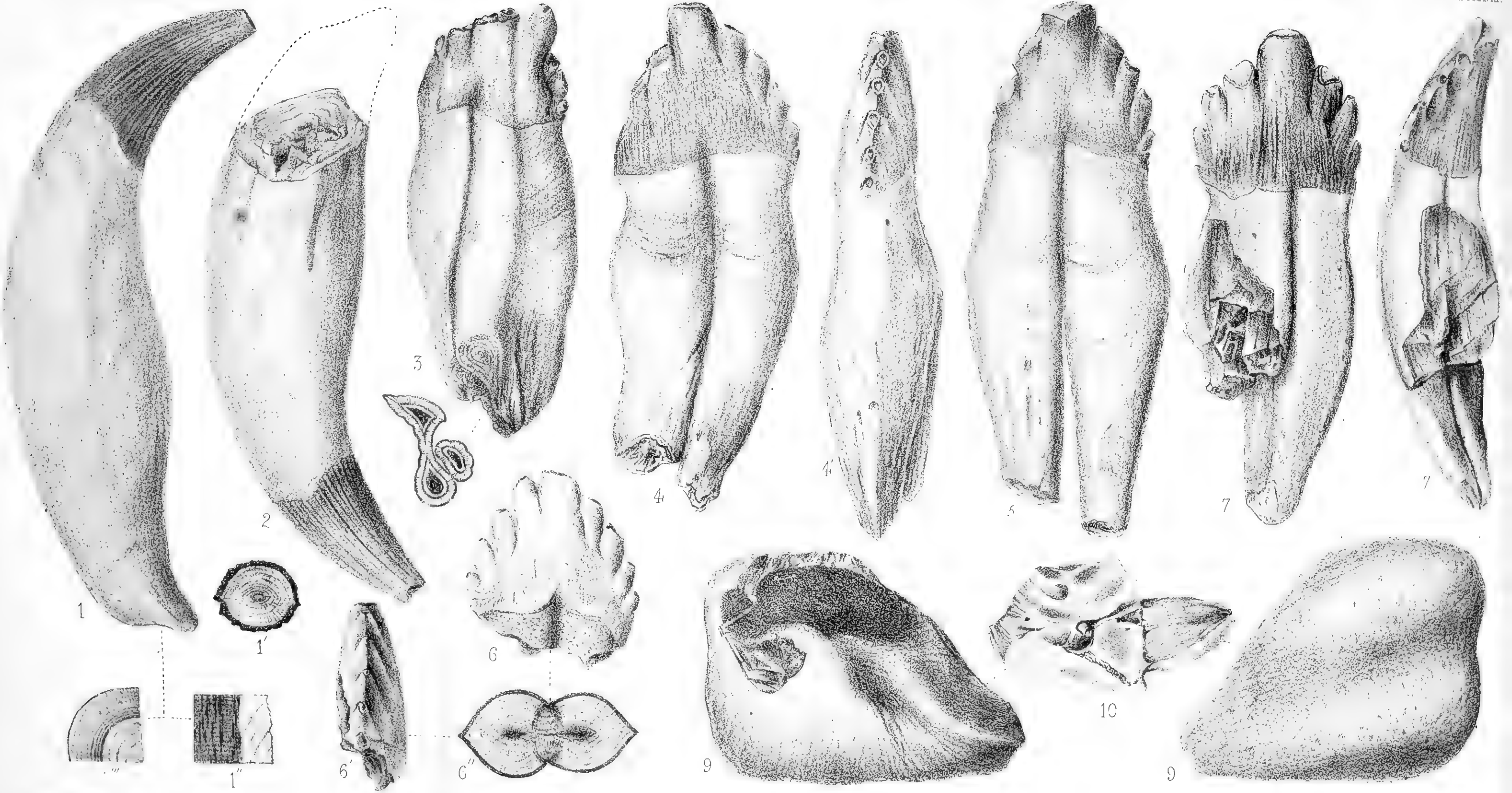
The fragments of bone indicate a massive solid jaw, one portion showing the posterior part of the ramus as having a depth of 6 or 7 inches. One tympanic bulla was obtained. It has the sub-convolute form characteristic of toothed Cetaceans, such as Berardius or Ziphius. The arrangement and number of the teeth cannot be ascertained owing to the imperfect state of the fossil remains, but the general appearance suggests that this huge animal was allied to the earless seals with serrated molars, such as Stenorhynchus, rather than to Cetaceans, but this indication is contradicted by the teeth being solid and by the character of the tympanic bulla. The resemblance to the Zeuglodon is found in the serrated crowns of the double-fanged Molars, but the fangs are not so widely separated, nor do the crowns of the teeth show the hour-glass form in transverse section to the same degree as in the gigantic Zeuglodon, with which it is provisionally associated under the name of *Kekenodon onamata**

Note.—Since the foregoing was written I find that a very similar tooth fragment. from the eocene strata of South Australia, has been figured by Mr. E. B. Sanger, as *Zeuglodon harwoodii.*†—Also that the New Zealand teeth resemble those figured by Gervais and Van Beneden, as the *Phocodon,* from Saint Medard-en-Jalle, Bordeaux,‡ and the

* *Kekeno* (Maori), a seal. *Onamata* (Maori), of long ago.

† Proceedings Linn. Soc. N. S. W., Vol. V. p. 298, 1881.

‡ Ostéographie des Cétoacés, p. 453.



KEKENODON ONAMATA, Hector. Proc. p. 436.

Squalodon, from Dinan, Brittany,* but as these generic names and also *Zenglodon*, appear each to have been applied to several very distinct animals, I deem it advisable to retain the name *Kekenodon* for the New Zealand fossil.

On Plate XVIII., I figure the best preserved portions of this interesting fossil, of the natural size. It will be seen that the molar teeth have not the widely divergent and separately implanted fangs of the *Zenglodon* of Owen, while the enormous development of the fangs in proportion to the crowns of the teeth, at once distinguish them from the genus *Phocodon* of Agassiz, established on the Maltese fossil described by Scilla, in 1652, but which partly on account of this short-fanged character of the teeth, was referred by Owen to Hippopotamus.†

EXPLANATION OF PLATE XVIII.

Fig. 1. Canine tooth (?) lower of right side, showing the roughly fluted inner surface of the conical apex, bounded by the cutting ridges, and the large bulbous solid fang. 1′ is a section of the crown of the tooth, showing the enamel coating the dentine. 1″ is a longitudinal, and 1‴ is a transverse section of a segment of the fang showing the massive cement layer coating the solid ivory of the tooth.

Fig. 2. The upper canine (?) of the left side, showing the comparatively smooth exterior surface of the crown.

Fig. 3. First (?) molar, exterior aspect, showing at the extremity of the fang a trilobate character, illustrated by the transverse section.

Fig. 4. Second (?) molar, exterior aspect, and 4′ a lateral view of the same.

Fig. 5. Third (?) molar, which has the fangs most widely separated of all the teeth.

Fig. 6. and 6′. Two views of the fourth (?) molar.

Fig. 7. and 7′. Two views, interior and posterior, of the fifth (?) molar, showing the strong unequal fangs, and the obliquely triangular crown.

Fig. 9. Interior aspect of the tympanic Bulla, 9.′ exterior surface.

Fig. 10. Interior or opposing surface of the Periotic.

3. "Notes on New Zealand Fishes," by Dr. Hector.

4. "Descriptions of New Crustaceans," by T. W. Kirk. *(Transactions*, p. 236.)

5. "Notes on some recent Additions to the Collection of Birds in the Colonial Museum," by T. W. Kirk. *(Transactions*, p. 235.)

6. "Description of Maori Comb and Arrow Heads," by T. W. Kirk.

Some time since, among the sand-hills at the southern end of the isthmus which connects Miramar peninsula with the main land, accompanied by Mr. Page, I found a tolerably complete skeleton of a man, and portions of several others of much slighter build, probably belonging to women, together with a quantity of chert and obsidian flakes, etc.

Amongst the chert flakes I was struck with the unmistakeable arrow-head-like form of two pieces, that of No. 1, a flint, being most marked; No. 2, a chert, is broken, and may or may not have been a similar weapon.

I believe there are, both in the Christchurch and Auckland Museums, implements supposed to have been used as arrow-heads, but in no case do they possess so decidedly the characteristic features of such implements as in this instance.

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* *l. c.* p. 437, Pl, xxviii. f. 19.

† Odontography, p. 565.

According to the generally received idea, the Maoris were quite ignorant of the use of the bow and arrow; yet remembering the rather lengthy discussion which recently took place between Messrs. W. Colenso and Coleman Phillips on the ignorance, or otherwise, of the Maoris concerning the use of projectiles, I am inclined to think that these two bits of stone are likely to prove more interesting than at first sight would be expected.

The next item (No. 3) is a long and curious four-toothed comb, presented to me by Mr. Page, who picked it up at the same spot where the articles above-mentioned were afterwards obtained.

It is made of whalebone, and measures 7 inches in total length, and 1½ inches in width, the teeth (all of the same size) being long. There is no attempt at ornamentation, with the exception of the curved top which bears a small point inclining to one side, and serves to soften the otherwise very rigid outline of the whole implement.

7. "Notes on Dr. Dudgeon's Experiments regarding the Temperature of the Breath," by W. Skey.

8. "Notes on some species of Diurnal Lepidoptera," by Percy Buller. (Communicated by Dr. Bnller.) (*Transactions*, p. 237.)

9. "Remarks on the New Zealand Olives," by T. Kirk, F.L.S.

10. "On the Occurence of Triodia in New Zealand," by T. Kirk.

11. "A Revision of the New Zealand Lepidia, with description of New Species," by T. Kirk.

12. "Notes on Plants recently added to the New Zealand Flora," by T. Kirk.

13. "Notes on Plants from Campbell Island," by T. Kirk.

14. "Descriptions of New Plants," by T. Kirk. (*Transactions*, p. 384.)

Dr. Hector exhibited several new additions to the Museum, among others rich gold quartz specimens from Te Aroha, coal found at Eketahuna (which he stated to be of good quality, and probably extending through the Wairarapa district), galena and zinc blende found in the Tararua mountains, and auriferous quartz specimens from Terawhiti. With referenceto the latter, Dr. Hector said a new reef had been found in a fresh locality by some bush burners under quite different conditions from the former so-called reefs. The formation was different from that at the old workings, and the new reef was better defined and of a more promising kind of quartz. The specimens showed gold freely, and contained about three ounces to the ton in a very finely-divided form. This was a most encouraging circumstance. The reef was about 1,100ft. above sea-level, and it ran about N.W. Specimens had been brought to him a day or two before, and he could see at once it was wholly a different class of stone from anything previously from Terawhiti. It was exactly similar to the reefs at Golden Point and Cape Jackson, across the Straits. He had gone out to the ground himself and seen the reef, which, however, had not yet been sunk upon sufficiently to reveal its trend and dip. He thought now there was a much better prospect than ever before of testing definitely whether there was payable gold at Terawhiti.

AUCKLAND INSTITUTE.

First Meeting. *18th March*, 1880.

Rev. Dr. Purchas, M.R.C.S.E., President, in the chair.

The Right Rev. W. G. Cowie, D.D., Bishop of Auckland, gave a lecture on "Afghanistan and Central Asia."

Second Meeting. *22nd April*, 1880.

Rev. Dr. Purchas, President, in the chair.

Mr. J. Martin, F.G.S., gave a lecture on "Chromatics."

Third Meeting. *20th May*, 1880.

Rev. Dr. Purchas, President, in the chair.

A lecture was delivered by Mr. E. A. Mackechine on "Edgar Allen Poe, a study in Morbid Psychology."

Fourth Meeting. *21st June*, 1880.

Rev. Dr. Purchas, President, in the chair.

New Members.—T. Ching, J. Coates, W. H. Connell, Dr. Elam, J. B. Esam, C. A. Harris, Miss Harrison, Dr. Honeyman, W. L. Murray, J. Maclean, A. Shrewsbury, Rev. R. Somerville, A. K. Taylor, H. E. Williams.

1. The President, in opening the Proceedings, apologised for not being able to deliver the usual anniversary address. Professional work and other duties had prevented him from obtaining the time necessary for its preparation. He then proceeded to make some remarks on the present position of the Institute and the Museum under its charge, and briefly alluded to the progress made during the last two or three years.

2. "On the Larva of Lasiorhynchus," by Captain T. Brown. (*Transactions*, p. 228.)

Besides giving a full description of the larva and pupa, Captain Broun also alluded to some interesting peculiarities in the habits of the perfect insect.

3. "On the Fertilization of *Thelymitra*," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 291).

4. "On Art and Literature," by Albin Martin.

5. The President called the attention of the meeting to a group of Birds of Paradise recently completed by the taxidermist to the museum. It included specimens of *Paradisca apoda*, and *P. raggiana*, *Cincinurus regius*, two species of *Petilorhis*, and others.

FIFTH MEETING. 1*st July*, 1880.

Rev. Dr. PURCHAS, President, in the chair.

The Hon. Colonel Haultain gave a lecture on "Russia and the Turkomans."

SIXTH MEETING. 19*th July*, 1880.

Rev. Dr. PURCHAS, President, in the chair.

New Members.—Mrs. Chamberlin, W. Leys, M. Rawlings.

1. "On the Larva of *Ceratognathus*," by Captain T. Broun. (*Transactions*, p. 230).

2. "On some new species of Nudibranchiate mollusca," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 222)

Coloured drawings of the species described were exhibited.

3. "On Runes," by Neil Heath, F.G.S.

The author stated that the origin of the so-called Runic alphabets, had engaged the attention of the most distinguished philologists. Some of the characters bore a resemblance to one or more of the older languages—Latin, Greek, or Phœnecian.

He considered that the hypothesis which derived the runes from a Phœnician source, though it might account for some similitude, left many of the characters and matters connected with them, wholly unexplained. The first nine letters of the Roman alphabet bore a striking resemblance to the corresponding runic letters, but the remainder were not accounted for in any way. He was of opinion that if the runes were carefully compared with the Greek alphabet, the whole of them could be traced back to some early Greek forms, or to a combination of forms to be accounted for on well-known principles.

Drawings of the old Runic characters, showing their correspondences and differences, were exhibited.

4. The President said that his attention had been directed to the presence of a species of house-ant in several localities in Auckland, evidently a recent importation from abroad. He wished that some member of the Institute would take the matter up, and give some information as to the habits of this stranger.

SEVENTH MEETING. 5*th August*, 1880.

Rev. Dr. PURCHAS, President, in the Chair.

Mr. J. A. Pond gave a lecture on "Explosives."

Eighth Meeting. 16*th August*, 1880.

Rev. Dr. Purchas, President, in the chair.

New Members.—Miss Dobson, J. Ellingham, C. S. George.

1. The President called attention to several interesting additions to the Museum and Library. Among the most important were a complete set of the publications of the "Novara" Expedition, obtained through the kind offices of Drs. Hochstetter and Fischer; a copy of "Gould's Uranometria Argentina," presented by Mr. Murdoch; 50 European bird-skins, and a large series of European *Hemiptera* and *Hymenoptera*, received in exchange from the Geneva Museum; and a skin of the beautiful Impeyan Pheasant, presented by Mrs. Wallis.

2. "On a new genus of Opisthobranchiate mollusca," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 224.)

3. "Names of Places, their origin and meaning," by the Rev. J. Bates. The author cited Max. Müller and other philologists in support of the theory, that the earliest names of places were descriptive of some peculiarity of appearance, or of some relative comparison or contrast, or of some religious sense. He gave many illustrations drawn from Europe and Northern Asia. Passing to New Zealand, *Wai* meant water—as, for instance, Waitangi, sounding water, and so of similar composite names; *Roto* meant lake, as Rotorua; *Motu* meant island, as Motutapu; *Puke* meant hill, as Pukekohe. Religious feeling was very prolific of such distinguishing names, as in English names compounded of *Kil*, *Wig*, *Sel*—as, for instance, Kildare, Wigton, Selby. Business, trade, and commerce exercised their influence in originating such words as *damask*, from Damascus; *calico*, from Calcutta. The lecturer drew attentian to the silent influences which co-operate in altering, developing, or diverting the growth of names, and even of language itself. The progress of change was much slower in cultivated and civilized nations than among people semi-barbarous or nomadic. These influences might be traced to varied sources, and the origin of some of them was very remote. An Englishman of the present day would have great difficulty in reading the English of the 12th or 13th century. He would not be able to read Chaucer, or possibly Spenser, without the aid of a glossary. The paper was full of varied and interesting information, and the lecturer was applauded at is conclusion.—The President said the derivation of some of the Maori names was very interesting. Rangitoto, for instance, signified "red" or "bloody" heaven, which pointed clearly to a period when the volcano was in active operation. The word *ranga* was usually connected with volcanic appearances. There was a matter of interest much wider. The sounds of the letters *l r d* were convertible. *Ruru* in Maori was *lulu* in the Sandwich Islands. Many tribes of Maoris pronounced *d* for *l.*—Mr. J. B. Russell could not think that Rangitoto was active since the arrival of the Maoris in New Zealand.—The President: But there have been many active volcanos since that period, and the Maoris could hardly mistake that the volcanic mountains had a common origin.—Mr. Mitford bore testimony to the convertibility of the sounds of letters by Maori tribes, particularly the Ngapuhi.

4. "On the Spontaneity or Self-action of the Will, as opposed to all doctrines of necessity," by the Rev. S. Edgar.

The general purport of this paper was as follows:—(1) That the will is spontaneous and self-acting, and not necessitated. (2) The will is for the organism the first cause, as the Deity is the first cause for the universe. (3) The metaphysical data, "I think," "I feel," exist under all physical conditions. (4) Consciousness is distinct from, if not wholly independent of physical conditions, with reason for its guide. (5) The modern doctrine of materialism did not account for the action of the will. (6) To exclude the primal force of the will, was to strike a blow at man's responsibility for his actions. The lecturer proceeded at considerable length, to examine the opinions of Herbert Spenser, Professor Tyndall, and other eminent authorities.

Ninth Meeting. *2nd September*, 1880.

Rev. Dr. Purchas, President, in the chair.

Mr. R. C. Barstow gave a lecture on the "Exodus of Israel."

Tenth Meeting. *7th October*, 1880.

Rev. Dr. Purchas, President, in the chair.

Mr. Neil Heath, F.G.S., gave a lecture entitled "A day on the Ice around Mont Blanc."

Eleventh Meeting. *25th October*, 1880.

Rev. Dr. Purchas, President, in the Chair.

New Members.—Rev. S. Baker, Pierce Lanigan, W. McCulloch.

1. "On a new species of *Loranthus*," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 296.)

2. "On the growth of Sugar Beet in New Zealand," by Dr. Curl. (*Transactions*, p. 142.)

3. "On the Neglected Forest Products of New Zealand," by T. Kirk, F.L.S. (*Transactions*, p. 130.)

Twelfth Meeting. *15th November*, 1880.

Rev. Dr. Purchas, President, in the Chair.

New Member.—Mrs. Stoddard.

1. "Remarks on Dr. Curl's Paper on the Growth of Sugar-Beet, in New Zealand," by R. R. Hunt.

In my opinion the thanks of the colony at large are due to Dr. Curl for his experments, testing the percentage of sugar in beet-root grown in the colony. In all my conversations with shrewd business men about establishing a company to produce sugar from beet-root, the first question which met me was this, "Will beet-root grown in New Zealand produce sugar in it of a percentage to pay?" I could only answer, "That I could speak to its growing well, and to a very large size, but could not say anything of the percentage of sugar." Now this is the very point which Dr. Curl has proved, and which renders his paper of great practical value—viz., that New Zealand not only produces a percentage to pay, but exceeds it by 1 and 2 per cent., and if you will consider that 1 per cent. of saccahrine matter is equal to 7½ per cent. net profit, you will recognize the importance of Dr. Curl's experiments.

'Tis true that in 1875, Sir Julius Vogel caused seed to be distributed, and some beet was analysed, giving percentages 4·9, 5·8, 7·6, 8·4, which would not be encouraging were it not that on examining closely into the report of the soil these beets were grown in, it will be seen that it was not at all suited to beet, viz., swampy land and stiff clay with a hard subsoil, hence these tests go for nothing, or else they prove this, that even on inferior soils and with imperfect cultivation a fair percentage is produced.

Rangitikei, in the Wanganui district, where Dr. Curl's experiments were carried out, is exceptionally rich land, and the high percentage as found by him may be thus explained ; though it should be borne in mind that being on the West Coast, and exposed to the sea air from the South Pacific Ocean, is much against his percentage, because beet readily imbibes saline matter from the air, and 1 per cent. of salt destroys 5 per cent. of sugar in the manufacture. However, this matter will be set at rest by experiments now going on in Waikato to test the percentage. Mr. George S. Graham, the son of an old Aucklander, lately sent out to his brothers, Messrs. S. S. and W. A. Graham, of Tamahere, Waikato, three samples of Belgian beet seed, which they have kindly distributed to Waikato farmers, with directions as to culture, manure, etc.; and when the beet has arrived at maturity; Mr. J. A. Pond has kindly offered to analyze it free of cost, so that next autumn should see us in possession of facts, which will guide business men in investing money in a Beet Sugar Company.

Waikato, I consider, is better adapted for beet than any other district which can be named in the colony. It is at present purely a cattle-farming district, and while they can get 25s. to 30s. per 100lbs. for their beef, farmers there will not grow crops ; but to enable them to fatten cattle for the market early in spring, they find that they must grow turnips or mangolds to feed their cattle in winter, or else it is late in the autumn before their beasts are fat and fit for the market ; and this is just where beet culture would help them, because they would not only have a sure ready-money market for their beet, but could also re-purchase the pulp of beet from the manufactory to feed and fatten their cattle during the winter.

Waikato grows splendid mangolds, and ought also to grow beet of like quality ; and as it is in a huge basin high over which the sea air blows, being protected from it by a chain of hills forming the edge of the basin, hence there would be no trouble with salt in beet in Waikato.

The advantages Waikato possesses over other places being—suitable land, cheap coal, abundance of fresh water, and a district requiring and likely to purchase the beet pulp, with good roads, railways, and water carriage for cheaply transporting the beet.

Profit on manufacturing beet sugar, although Dr. Curl's estimate of profit, 60 per cent., may at first sight seem extravagant. yet when one examines it closely, it is about right according to the best authorities. For example, he puts down the selling value at £36 per ton. Now, a merchant told me last week that he could import and sell wholesale the very best white crystal cane sugar at £43 per ton, duty ½d. per pound being paid by him ; and this sugar is selling retail at £46 13s. 4d. per ton, or 5d. per pound. Deducting the ½d. per pound duty from the £43, reduces the wholesale selling price to £38 6s. 8d per ton, this leaves £2 6s. 8d. in Dr. Curl's favor ; but this you may allow for some inferior grades of sugar which the beet factory would produce, and which would sell at a lower price.

As to cost of production. Dr. Curl sets it down at about £18 per ton, or about 2d. per lb. Here, again, the Doctor is not out of the way, because it is stated that in France sugar at 6 per cent. in the beet costs 2d. per lb. ; 7 per cent, 1¾d. per lb ; 8 per cent., 1½d.

per lb.; and though his New Zealand-grown beet shows over 8 per cent , he puts the cost of production down at 2d. instead of 1½d. per lb., and estimates 60 per cent. profit E. B. Grant, an American, in his work on the subject, estimates the profit on 7 per cent. beet sugar sold at £39 13s. 4d. per ton, or 4½d. per lb., at 52 per cent. net profit. Professor Crookes, in his work, states that 8 per cent. beet sugar sold at £24 per ton, equals about 50 per cent. profit. Baruchson states that 6½ per cent. beet-root, sold at £24 per ton, will yield 24¾ per cent. net profit; if the percentage be 7 per cent., the profit will be 32 per cent.; if 8 per cent., profit 48 per cent. The yield in Germany on an average of 2,500,000 tons of beet-root, is 8·4 per cent. sugar extracted.

Mr. George S. Graham saw in Belgium the books of a sugar company, which showed that for seven years they had averaged 15,372 tons beet used per annum, the percentage of sugar 9.36, and the profit actually paid in dividends 27·5-7 per cent. Though this shows less than all the foregoing estimates, yet included in that there may be trade losses, which are not taken into account in the former estimates.

As to the difference in the cost of labour in New Zealand and on the Continent, I do not think much of that, as our land is cheaper, and hence there is less interest or rent to pay, less taxation, and with approved appliances for cultivation it ought to be as cheap to produce beet here as in Europe, and here 20s. per ton might be paid for the roots instead of 16s., which seems to be the average price paid elsewhere.

Before going further in the matter, I intend waiting to see the result of the Waikato experiments, when I will return to the charge.

Last mail brought the news that Europe had in the past season produced the largest amount of beet sugar on record, viz., 1,600,000 tons, and that the cane sugar, with a Customs duty of ½d. per lb. less than the excise duty on the beet, has been driven out of the market.

I may state that Mr. J. C. Firth offered to give me a written guarantee to grow 1000 acres of beet per annum, and sell the raw sugar to a refinery, if I could get one started in Auckland capable of refining both cane- and beet-sugar. I am afraid that this will not be accomplished, as capitalists will watch with interest the result of the speculation now being tried in Fiji with cane-sugar by the Sydney Sugar Company, who are erecting a refinery there costing £100,000, and intend spending further sums on cane plantations, and the Victoria Sugar Company are about to follow suit, with even more capital. If these companies succeed, it will evidently be of little use starting a refinery in Auckland, but there is no reason why we should not have a beet-sugar company for Auckland refining its own sugar, and if the Government would offer the same bonus that they did a few years ago, viz., £10,000 for the first 100 tons of beet-sugar produced in New Zealand, and sold in the open market, I believe thoroughly that a company could be established so soon as the results of the Waikato experiments are known. That there is room for such a company you may imagine, with the imports of sugar at £525,000 per annum, and yearly increasing.

I have much pleasure in proposing a cordial vote of thanks to Dr. Curl, for his valuable paper. Seconded by Mr. J. C. Firth, and carried unanimously.

2. "On some Indications of Change in the Level of the Coast Line in the North part of the Northern Island," by S. Percy Smith. (*Transactions*, p. 398.)

3. "On Heredity," by E. A. Mackechnie.

Annual General Meeting. 21*st February*, 1881.

Rev. Dr. Purchas, President, in the chair.

New Members.—F. H. Combes, W. F. Hammond, Jas. Stodart.

The minutes of the last annual general meeting, held 16th February, 1880, were read and confirmed.

ABSTRACT OF ANNUAL REPORT.

During the past year thirty additional members have been elected since the last annual meeting. Three names have been removed by death, five have been transferred to other branches of the New Zealand Institute, while seventeen members have either left the colony or ceased to subscribe. The total number on the register is now 277. The ordinary meetings for the reading of papers have been held as usual, and were fairly attended. With the view of attracting attention to the society, and possibly adding to the list of members, the Council arranged for the delivery of a series of popular lectures by various gentlemen, to alternate with the regular meetings. The attendance at the lectures was remarkably good, and much public interest was evinced in them.

Library.—The scientific and reference library of the Institute is fast attaining respectable proportions, and now contains over 1,400 volumes of well-selected works. During the year a grant of £57 10s. has been received under the provisions of the Public Libraries Subsidies Act. The Council have to acknowledge the receipt of £50 from the City Council as some reimbursement for the expense of maintaining the Public Library during the four years that it has been under the care of the Institute.

The balance-sheet showed the receipts to be £601 13s. 9d. including the balance of £17 8s. 10d. carried from last year's accounts. The expenditure amounted to £594 6s. 0d.

Election of Officers 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. Machechnie, 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.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting. *4th March*, 1880.

Professor J. von Haast, Vice-President, in the chair.

New Member.—Dr. Guthrie.

No papers were read.

Second Meeting (additional) *18th March*, 1880.

E. Dobson, President, in the chair.

New Members.—Professor F. W. Hutton, J. Hay.

ADDRESS.

The President read his opening address "On the Progress of Applied Science in Canterbury."

ABSTRACT.

He reviewed the development of public works in the Provincial District of Canterbury, and with reference to railways discussed the merits of the broad and narrow gauges, expressing himself strongly in favor of the former. He reviewed the methods adopted for ordinary road making, surveys, the proposal for the irrigation of the Canterbury Plains and the conservation of the rivers, the water supply, and the drainage of the towns, street tramways, gas lighting, harbour works, and the adaptation of improved agricultural machinery; and, in his concluding remarks, he pointed out that the successful colonization of New Zealand has been in a great measure due to the scientific element which has pervaded the councils of its rulers. He considered it important that this influence should be recognised, so that in the development of our educational institutions scientific training may receive its full share of attention instead of being simply tolerated or altogether set aside in favour of the study of dead languages. The study of Greek and Latin, however valuable as a system of mental training, as affording models for the expression of thought, and as a foundation for a thorough knowledge of the languages of western Europe, has no further result as a preparation for the active duties of life in that world into which man has been sent "to eat his bread in the sweat of his brow," nor can it for a moment be seriously contended that the study of the licentious obscenities of the Roman poets can have other than a degrading influence on the minds of our youths entering upon manhood.

The excellence of the literature of the Greeks and Romans was the natural reflection of their national greatness. Their orators did not rise to fame through writing nonsense verses, nor did their authors perfect their style by translating unmeaning common-places into the disused languages of fallen nations. They spoke and wrote out of the fullness of their hearts of the stirring events passing before their eyes and of the national life in which they played no unimportant parts, and hence the nervous simplicity of the language they employed. If the Greeks as poets and historians have left us in their writings models of compositions which have never been surpassed, they were also the greatest sculptors and architects that the world has produced, as well as being consummate geometricians, whilst they also excelled in astronomical and medical science. The heroes of the Iliad, those especially who had been liberally educated, according to the standard of that day, were not mere fighting men, but skilful mechanics, who prided themselves on the excellence of their work, and spared no pains to bring it to perfection. In that episode in the wanderings of Ulysses which is related in the sixth and seventh books of the Odyssey, and which will be always read with delight on account of the exquisite description of the well-ordered home in Corfu, of which the fair Nausicaa was the brightest ornament; Ulysses is described as being struck with admiration at the sight of the well piled entrance to the harbour, and we have allusions to the systematic division of the waste lands amongst the first settlers in Corfu, the erection of houses and temples for the use of the new arrivals, and the supply of water to the port town, whilst Nausicaa extols her father's thoughtfulness for his household in bringing through the domestic offices a stream of water by means of pipes laid from the springs in his allotment. Even Nausicaa herself shows her mechanical instinct when she asks her father for the loan of the mule-cart with "high" wheels, that she may lose no time whilst taking the family washing to the public washing troughs, erected by the municipal authorities near the beach, at some distance from the town. So again, amongst the ruins of Ephesus, recently laid open by the excavations made under the direction of Mr. Wood; whilst we are struck with the richness of the sculptured decorations of the temple of the great Diana of the Ephesians, we are brought face to face with evidences of the attention paid to geodesy as shown by the boundary stones fixing the widths of the roads and watercourses, and by a decree recorded in one of the inscriptions, that in the division of an estate on the foreclosure of a mortgage, roads must be set out to the homesteads, the temples, and the springs of water. What does all this mean, but that science and art went hand in hand in the training of the Greek, and were inseparably connected with every detail of public and private life.

And when we turn from Greece to Rome in her palmiest days, we find the same state of things to prevail, except that the art was less pure, and that there was a greater development in the direction of the mechanical science. At the bottom of the success of the Romans as conquerers and colonisers, lay the broad fact that they were the greatest engineers of the time. Their harbours, their aqeducts, their bridges, their lines of road through Europe, and the public buildings erected wherever their dominion extended, are simply so many illustrations of applied science in a high state of development. If Virgil wrote his Æneid to the delight of Emperors and the torment of school boys, he wrote also on sowing and reaping, the breeding of stock, and the keeping of bees. Cæsar's commentaries would never have been handed down to us as models of *précis* writing, if Cæsar himself had not been an able engineer officer, whose writings are marked by the clearness of arrangement and precision of detail which characterised his movements for the reduction of the Gaulish fortresses; and Cicero's attack upon the tribune Clodius, in which the latter is accused of desecrating the ashes of his Alban forefathers, had for its immediate occasion, the laying out of the road through Alba, Longa, near Rome, when the engineers employed on its alignment, cut through the ancient necropolis, which even at that remote date, had been buried for unknown ages under the tufas of the long extinct volcano of Mont Albano. If then we would truly follow the example left us by the

Greeks and Romans, we shall, like them, give due prominence in our educational course to scientific studies, bearing in mind that science is but another name for the knowledge of God's works and of His will as expressed in what we term natural laws, and that the better we understand these laws, and the more we live in accordance with them, so in proportion will be not only our natural prosperity, but our success in battling with the ignorance, disease and misery, which must ever be present in this world whilst it is inhabited by sinful men.

And what work can be more noble than this? or how can we pay too much honour to those men who devote their lives to the advancement of science, casting as it were their bread on the waters of public opinion, and content to take for their reward the satisfaction of having worked for the benefit of their fellow men. Let this then be the spirit in which the work of this and of kindred institutions shall be carried on, each of its members, in his own special sphere of action, carefully recording facts and collecting data for future reference, on all points of scientific interest that come within his observation, without thought of personal distinction or consideration of pecuniary gain; and so by our separate, yet united endeavours, we may be able to assist in laying broad and deep, the solid foundations of a natural life, greater and more noble than was that of the classical nations of antiquity, and in fostering the growth of a national literature, which shall continue to bear fruit after the very names of Greece and Rome have faded into oblivion.

THIRD MEETING. 1*st April*, 1880.

E. DOBSON, President, in the chair.

New Members.—W. Malcolm, Major Bamfield.

Election of *Honorary Secretary.*—G. Gray was elected Honorary Secretary in the place of N. K. Cherill, resigned.

PAPERS.

1. "On a Volcanic Dyke in the Heathcote Valley," by A. D. Dobson. (*Transactions*, p. 391.)

2. "Notes or Suitable Subjects for Papers," by C. W. Adams.

FOURTH MEETING. 6*th May*, 1880.

E. DOBSON, President, in the chair.

New Members.—Rev. W. C. Harris, J. R. Gwatkin, J. E. Pickett, R. Schmidt.

VACANCY IN COUNCIL.—N. K. Cherill was elected to fill the vacancy in the Council caused by the resignation of G. Gray.

PAPERS.

2. "On the *Hymenoptera* of New Zealand," by Professor Hutton.

3. "On the Causes tending to Alter the Eccentricity of Planetary Orbits," by Professor A. W. Bickerton. (*Transactions*, p. 149.)

Fifth Meeting. *3rd June*, 1880.

E. Dobson, President, in the Chair.

New Members.—T. Crook, J. Crosby, W. D. Meares, W. H. Pilliet, F. Valentine, Dr. J. Irving.

PAPERS.

1. "On the *Orthoptera* of New Zealand," by Professor F. W, Hutton.

2. "Notes *re* Metereological Stations," by W. M. Maskell.

ABSTRACT.

The author pointed out that owing to the rapid growth of plantations around Christchurch, the situation of the Metereological Observatory has ceased to give a satisfactory average for the climate of the Canterbury Plains, and suggests the establishment of additional stations in other parts of the district.

3. "On Partial Impact," by Professor Bickerton.

Sixth Meeting. *1st July*, 1880.

Professor J. von Haast, Vice-president, in the Chair.

New Members.— C. Clark, W. Sparks, Jun., J. B. Stansell, J. R. Thornton, Mrs. Innes, E. M. Clissold, Professor Haslam, C. B. Taylor.

PAPERS.

1. "On *Harpagornis*," by Professor J. von Haast. (*Transactions*, p. 169.)

2. "On New and Rare New Zealand Plants," by J. B. Armstrong. *Transactions*, p. 335.)

3. "On a New Species of Diatom," by J. Inglis.

Nitzchia novæ-zealandia.

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 extremeties and rounded at the ends. One row of puncta round the margin of the valve. *Puncta.*—There are twenty-four puncta or beads to one thousand of an inch.

I have been unable to make out any striæ or keel under "Becks" one-tenth immersion.

The valves of *Nitzchia novæ-zealandia* resemble *Homococladia 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 Nga Pari, on the side of the North Moeraki Downs, facing the River Ashley.

I am indebted to Professor Hutton for the verification of this description.

Seventh Meeting. *5th August*, 1880.

Rev. J. W. Stack, Vice-president, in the Chair.

New Member.—P. Cunningham.

PAPERS.

1. "Notes on the Best Means of Meeting the Sanitary requirements of Colonial Towns," by E. Dobson. (*Transactions*, p. 84.)

2. "On the Origin of Double Stars, as explained by the theory of Partial Impact," by Professor A. W. Bickerton. (*Transactions*, p. 160.)

3. "On the Study of the French and German Languages," by J. von Tunzelmann.

4. "On an Analysis of Moa Eggshell," by Professor Liversedge, Sydney; communicated by Professor J. von Haast. (*Transactions*, p. 225.)

5. "On the genus *Coralospartium*," by J. B. Armstrong. (*Transactions*, p. 333.)

6. "A synopsis of the New Zealand species of the genus Veronica," by J. B. Armstrong. (*Transactions*, p. 344.)

7. "On some recent criticisms on Partial Impact," by N. K. Cherill.

Eighth Meeting. *2nd September*, 1880.

Rev. J. W. Stack, Vice-president, in the chair.

New Members.—J. B. Mayne, G. Withers.

PAPERS.

1. "On the occurrence in New Zealand of *Morrel morchella*," by J. B Armstrong. (*Transactions*, p. 343.)

2. "On a simple method of Illustrating the Motions of the Earth," by Professor A. W. Bickerton. (*Transactions*, p. 164.)

3. "On a Natural Arrangement of the New Zealand Ferns," by J. B. Armstrong. (*Transactions*, p. 359.)

Ninth Meeting. *7th October*, 1880.

J. Inglis, in the chair.

New Member.—R. C. Bishop.

PAPERS.

1. "On the New Zealand *Desmidieæ*," by Wm. Maskell. (*Transactions*, p. 297.)

2. "On Sericiculture," by F. Adams.

ABSTRACT.

The author quotes the opinions of Mr. Pozzi, formerly a silk grower in Canton Ticino, Switzerland, and now a resident in Christchurch, to the effect that the soil and climate of Canterbury is suitable for the establishment of silk culture, and recommending as a preliminary step, that mulberry trees should be extensively planted.

3. "On the study of the French and German languages," Paper II., by J. von Tunzelmann.

Annual Meeting. *4th November*, 1880.

E. Dobson, President, in the chair.

PAPERS.

1. "On Problems of Cosmical Impact," by Professor A. W. Bickerton. (*Transactions*, p. 166.)

2. "On the Structure of *Hormosira billardieri*," by T. A. Mollet. (*Transactions*, p. 318.)

3. "Contributions to New Zealand Malacology," by Prof. F. W. Hutton. (*Transactions*, p. 200.)

ABSTRACT OF ANNUAL REPORT.

Nine ordinary and two special meetings have been held, at which twenty-eight papers have been read by thirteen authors, being the highest number of papers read in any one year since the founding of the Institute.

In addition to the ordinary meetings the Council organised a series of popular lectures, to which free admission was granted to each member and two friends. These lectures were, by the kind permission of the Board of Governors, delivered in the Science Lecture Theatre of Canterbury College, and were fairly attended. The lectures were as follows:—(1) On the Origin of Living Matter, by Professor F. W. Hutton; (2) on the Rambles of a Carbon Molecule, by Professor Bickerton; (3) on the Progress of Modern Photography, by Mr. N. K. Cherrill; (4) on House and Home, by the President; (5) on Raffaelle and his Contemporaries, by Professor J. von Haast; (6) on the Telephone, by Mr. W. G. Meddings.

Thirty-two members have joined the Institute during the past year, and forty subscribers have withdrawn from subscribing, or have left the district, making the total number on the books at the present time 211.

The accounts show total receipts for the year of £345 0s. 2d., with a balance in hand at its close of £7 6s. 9d., the sum of £195 7s. 8d. having been devoted to the purchase of books and instruments.

Election of Officers for 1881:—*President*—Prof. J. von Haast, F.R.S., *Vice-presidents*—Rev. J. W. Stack, R. W. Fereday; *Council*—Prof. 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. Blackiston, W. D. Carruthers.

OTAGO INSTITUTE.

First Meeting. 11*th May*, 1880.

Dr. Hocken, President, in the Chair.

New Members.—A. R. Ure, H. Carrick, W. Brown.

1. "Notes on the Fertilization of Flowering Plants of New Zealand," by Geo. M. Thomson, F.L.S. (*Transactions*, p. 241.)

2. "Recent Additions to the Crustacean Fauna of New Zealand," by Geo. M. Thomson, F.L.S. (*Transactions*, p. 204.)

Second Meeting. 29*th June*, 1880.

Dr. Hocken, President, in the Chair.

New Members.—Professor Parker, Dr. Maunsell.

The President announced that Professor Parker had been elected to the vacant seat on the Council, in place of Mr. J. S. Webb, resigned.

1. "On the Flora of Stewart Island," by D. Petrie, M.A. (*Transactions*, p. 328.)

Mr. Geo. M. Thomson corroborated most of the statements made by the writer of the paper as to the barrenness of the soil over large tracts of country at the head of Paterson Inlet and round Port Pegasus. He also pointed out the fact that several of the recently discovered plants from the Island were allied to forms occurring in the mountains of Tasmania.

Mr. R. Gillies challenged the opinion that the Island was unsuited for agricultural settlement; he considered that it was well suited for small holders, and would yet carry a considerable population, when its fisheries were properly developed.

2. "On *Donatia novæ-zælandiæ*, with a revision of the New Zealand *Stylidiæ*," by Geo. M. Thomson, F.L.S. (*Transactions*, p. 289.)

3. "On New New Zealand Plants," by Dr. Berggren, taken from the "Journal of Botany," communicated by the Hon. Secretary. (*Transactions*, p. 290.)

Third Meeting. 17*th August*, 1880.

Dr. Hocken, President, in the chair.

New Members.—W. Dymock, E. W. Humphreys.

1. "John Stuart Mill on Mind and Matter," by Mr. A. Montgomery.

Professor Parker exhibited adult and young specimens of the Rock-hopper—*Pygoscelis tæniata*, from the Macquarrie Islands. This bird is new to the New Zealand Avifauna.

Professor Parker also exhibited a skeleton of a Pea-hen, articulated on a plan somewhat similar to that employed by Professor Flower, of London, so that every bone could be detatched and separately examined. Skeletons of all the important types are now being similarly prepared in the Otago Museum.

FOURTH MEETING. 24*th August*, 1880.

Dr. HOCKEN, President, in the chair.

1. "Notes on some specimens of Migratory *Salmonidæ*," by. W. Arthur, C.E. (*Transactions*, p. 175.)

2. "On Periodic Vertical Oscillations in the Sun's Atmosphere, and their connection with the formation of Solar Spots," by H. Skey. (*Transactions*, p. 91.)

FIFTH MEETING. 31*st August*, 1880.

Dr. HOCKEN, President, in the chair.

New Members.—Montagu Pym, George Turnbull, and Hanson Turton.

The Secretary laid on the table the annual report of the Dunedin Naturalists' Field Club.

The chair having been vacated was taken by Mr. W. N. Blair.

Dr. Hocken then delivered a most interesting lecture on "the early History of New Zealand, from the earliest times to the settlement of the first Mission Station at the Bay of Islands."

SIXTH MEETING. 14*th September*, 1880.

Dr. HOCKEN, President, in the chair.

New Members.—Dr. McCaw (Mosgiel), Richard N. Reid (Palmerston), George Harry Gordon (Oamaru), Watson Shennan (Conical Hills), Walter Guthrie, and Thomas Sherlock Graham.

The chair having been vacated was taken by Professor Parker.

Dr. Hocken then delivered his second lecture on "the early History of New Zealand."

SEVENTH MEETING. 22*nd October*, 1880.

Dr. HOCKEN, President, in the chair.

New Members.—Dr. A. H. Neill, Mr. Holland.

Professor Parker then delivered a most interesting lecture on "Modern Histological Methods," which was illustrated by various forms of accessory apparatus, and by the exhibition of numerous microscopical preparations.

The Chairman announced that it had been resolved by the Council to send an address to Mr. Charles Darwin, F.R.S.

1. "On the Venous system of the New Zealand Skate (*Raja nasuta*, Solander)," by Professor Parker. (*Transactions*, p. 412.)

2. "On the new species of Holothurian (*Chirodota dunedinensis*)," by Professor Parker. (*Transactions*, p. 418.)

3. "On some new species of *Carex*," by D. Petrie, M.A. (*Transactions*, p. 332.)

4. "On the History of Fish Culture in New Zealand," by W. Arthur.

Election of 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.

ABSTRACT OF ANNUAL REPORT.

Nine general meetings of the members have been held, at which the average attendance has been very good. At four of these eleven original papers were read, five of which related to Botany, five to Zoology, and one to astronomy. At the other meetings lectures were delivered as follows:—

1. "John Stuart Mill on 'Mind and Matter,'" by Mr. A. Montgomery.

2 and 3. "On the Early History of New Zealand" (two lectures), by Dr. Hocken.

4. "On Modern Histological Methods," by Professor Parker.

5. "On the Study of Landscape Art in New Zealand," by Mr. W. M. Hodgkins.

The amount of interest manifested in these lectures justifies the Council in recommending a continuance of this part of the Institute's work.

Thirty-five additional members have joined the Institute during the year, making the nominal number now on the roll amount to 260; but in accordance with the rule that members' names shall be struck off when their subscriptions are two years in arrears, a considerable deduction on this number will have to be made at the commencement of another year.

An order for several valuable works of reference was forwarded to London by mail of 3rd December, accompanied by a draft for £50.

The balance-sheet shows on current account that the receipts for the year (including balance of £12 17s. 10d. from last year) amount to £204 19s. 4d., and the expenditure to £192 18s. 8d., leaving a balance in hand of £12 0s. 8d. Against this, however, is an overdraft from the Union Bank of Australia of £68 6s. 6d.

The Reserve Fund in the Post Office Savings' Bank now amounts to £121 19s. 1d.

WESTLAND INSTITUTE.

First Meeting. 11*th August*, 1880.

Mr. John Nicholson, in the chair.

Mr. F. E. Clarke read a paper "On a new species of *Trachypterus*, found at Jackson's Bay." (*Transactions*, p. 195).

Second Meeting. 18*th February*, 1881.

Dr. Giles, President, in the chair.

Mr. F. E. Clarke read a paper "On a Bird new to Science, found at the mouth of the Mikonui River."

ABSTRACT OF ANNUAL REPORT.

During the year eleven ordinary and three special meetings have been held. One hundred and eighty-three new books have been received from Mudie and Co., of London, and this addition to the Library increases the number of volumes to upwards of 2170.

The reading-room has been well attended during the year, the number of visitors availing themselves of its advantages being considerably more than for the year 1879.

The sum of £70 17s. 10d. was received, being the society's portion of the amount voted by Government to free libraries, and £25 as share of rent derived from the Government House, Hokitika.

The accounts show:—Balance in the Bank of New Zealand, £77 6s. 6d.; cash in hand, £1 5s.; overdue subscriptions, £15 15s.; rent due for the society's reserve, £6; and subsidies of £15 each due from the Borough and County Council, making a total of £130 6s. 6d.; liabilities, £7 0s. 5d.; thus showing a credit balance to the Society of £123 6s. 1d.

The number of members on the roll for 1879 was 115; and for this year 110, thus showing a decrease of 5 members for the year.

Election of Officers for 1881:—*President*—Dr. Giles; *Vice-president*—Mr. Spence; *Hon. Treasurer*—Mr. Croft; *Council*—R. C. Reid, A. H. King, J. Pearson, M. W. Jack, Dr. James, D. Macdonald, J. Nicholson, R. W. Wade, H. R. Rae, F. A. Learmonth, E. F. Rich, G. A. Paterson; *Auditors*—H. Harvey, J. P. Virtue.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

Annual General Meeting. *2nd February*, 1880.

Dr. Spencer, Vice-president, in the chair.

Election of Officers for 1880 :—*President*—The Right Rev. the Bishop of Waiapu ; *Vice-president*—Dr. Spencer ; *Hon. Secretary* and *Treasurer*—W. Colenso ; *Council*—Messrs. Baker, Bold, Colenso, Holder, Kinross, M. R. Miller, Sturm ; *Auditor*—T. K. Newton.

ABSTRACT OF ANNUAL REPORT.

During the past winter session six ordinary meetings were held, at which seven papers prepared by members were read.

The number of members is 78, being an increase of four on the previous year.

Throughout the year several Zoological, Botanical, and Geological specimens have been collected by the members of the Institute for the Museum.

Books for the Library to the amount of £40 have been ordered from England, and £21 has also been paid for Scientific works obtained in New Zealand; a further sum of £10 has also been remitted to the Manager of the New Zealand Institute, towards defraying the expenses of publishing Vol. XI. of "Transactions of New Zealand Institute."

The audited statement of accounts shows a balance of £193 2s. 1d. remaining to the credit of the Society.

First Ordinary Meeting. *4th June*, 1880.

Dr. Spencer, Vice-president, in the chair.

Dr. Spencer, with the help of his large compound microscope, exhibited several curious and interesting specimens of *Diatoms*, obtained from the ocean-bed of the Atlantic, the West-India Islands, etc.; also some minute microscopic fresh-water *Algæ*, from Napier and its neighbourhood; illustrating the whole with descriptions and explanatory remarks.

The Hon. Secretary showed several specimens of gold ores, and of auriferous quartz and other gold-bearing rocks, from various parts of New Zealand and from Australia.

Second Ordinary Meeting. *12th July*, 1880.

The Right Rev. the Bishop of Waiapu, President, in the chair.

1. "On certain Historical incidents of the Ancient East Coast Maoris ; showing much of their peculiar manner of living and ways of thinking in the olden time,—long before they were visited by Europeans," by W. Colenso, F.L.S. *(Transactions*, p. 38.)

2. "On two newly-discovered curious *Cryptogams*, of the orders *Hepaticæ* and *Lichenes*, viz., *Metzgeria rugulosa*, Col., and *Bæomyces heteromorphus*, Nyl.;" exhibiting also several specimens of the same, by W. Colenso, F.L.S. (*Transactions*, p. 368.)

Third Ordinary Meeting. 9*th August*, 1880.

The Right Rev. the Bishop of Waiapu, President, in the chair.

1. "On the Vegetable Food of the Ancient New Zealanders before Cook's Visit." Part I., by W. Colenso, F.L.S. (*Transactions*, p. 2.)

Mr. Colenso exhibited several indigenous specimens of the classes *Arachnida* and *Insecta*; among them were some remarkably fine ones of the genera *Macrothele*, *Deinacrida*, and *Bacillus*.

Fourth Ordinary Meeting. 13*th September*, 1880.

The Right Rev. the Bishop of Waiapu, President, in the chair.

1. "On the Vegetable Food of the Ancient Maoris, before the Visit of Captain Cook." Part II., by W. Colenso, F.L.S. (*Transactions*, p. 18.)

Specimens of sundry indigenous vegetable articles of food, both raw and dressed, were shown in illustration of this paper. Among them were (1) The superior quality fern root *Pteris esculenta*, used only by chiefs, containing a very large percentage of fecula, obtained from the interior a hundred miles away; and (2) Slices of thick cake or bread, made of the meal obtained from the berries (*drupæ*) of the Hinau tree (*Elæocarpus dentatus*).

Some interesting fossils were exhibited of teeth of several genera of fishes of the family *Squalidæ*, viz., *Carcharias*, *Lamna*, *Oxyrhina*, *Notidanus*, etc., and of spines of various fishes of the family of *Raiidæ*—all in excellent preservation. These were obtained from near Te Aute from the Eocene strata.

Fifth Ordinary Meeting. 11*th October*, 1880.

Mr. H. R. Holder in the chair.

1. "Life and its Physical Correlations," illustrating the same by references to several coloured drawings, by Dr. Spencer. (*Transactions* p. 109.)

2. "On the Ferns of Scinde Island (Napier)," partially illustrating the same with specimens of the rarer ferns from that locality, by W. Colenso, F.L.S. (*Transactions*, p. 370.)

Sixth Ordinary Meeting. 8*th November*, 1880.

Dr. Spencer, Vice-president, in the chair.

1. "Contributions towards a Better Knowledge of the Maori Race, Part III., on their Poetical Genus," by W. Colenso, F.L.S. (*Transactions*, p. 57.)

Some of the very ancient and peculiar musical instruments were exhibited, and described by Mr. Colenso, all of which were also noticed in his paper.

2. "On rare and peculiar New Zealand Insects, of the genera *Scolopterus*, *Rhyncodes*, *Mantis*, and *Hemideina*," by W. Colenso, F.L.S.

3. "On New and Undescribed New Zealand Ferns," by W. Colenso, F.L.S. (*Transactions*, p. 376.)

Council Meeting. 11*th October*, 1880.

The Vice-president, Dr. Spencer, in the chair.

Capt. W. R. Russell, M.H.R., was 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.

Council Meeting. 8*th November*, 1880.

The Vice-president, Dr. Spencer, in the chair.

The books selected by the sub-committee appointed to do so, were considered and approved of by the Council, and £60 voted towards the purchasing of the same.

During the past year there have been held eight meetings of the Council, at which the following *New Members* were duly elected: viz., Messrs. A. Price, G. W. Tiffen, C. P. Winkelmann, H. E. Kenny, W. K. White, H. Wilding, H. S. Tiffen, W. F. Wilson, J. Drummond, E. Leyland, R. Dobson, T. Hallett, J. T. Carr, G. H. Swan, H. Gallien, and Mrs. E. M. Trestrail.

SOUTHLAND INSTITUTE.

FIRST MEETING. *5th July*, 1880.

J. T. THOMSON, F.R.G.S., President, in the chair.

New Members.—Henry G. Mussen, Norman Prentice, T. Brodrick, Thos. Denniston, Hanan.

The President delivered an inaugural address.

ABSTRACT.

In inaugurating a Scientific Society in this most remote city of Her Majesty's Dominions, it becomes me to say something of the rapid and successful progress of similar Institutions in New Zealand, which will be an incitement for the members of this one to persevere.

The Wellington Philosophical Society was incorporated with the New Zealand Institute on the 10th June, 1868; the Auckland Institute on the same day and year; the Philosophical Institute of Canterbury on the 22nd October, 1868; the Otago Institute on 18th October, 1869; the Nelson Association for the Promotion of Science and Industry on the 23rd September, 1870; the Westland Institute on the 21st December, 1874; and the Hawke's Bay Philosophical Institute on the 31st March, 1875. Our incorporation we have taken steps to accomplish.

All these Societies have done good service by promoting intellectual enquiry, and by the bringing of persons engaged in the same studies and observations together, who would otherwise not meet; also, by the discussion of subjects of utility, or of special and general interest,—a record of the proceedings of which is to be seen in the twelve volumes of "Transactions of the New Zealand Institute."

The papers published in these volumes are of a diverse nature, but few can be considered out of place, and many display deep reflection, and laborious investigation; altogether the establishment of such a medium of communication between local as well as distant practical and scientific workers in the colony may be said, to the thoughtful enquirer, to be one of the most auspicious events in the social history of our colony.

That this city should now become a centre for meeting, and for the interchange of thoughts and ideas, as well as for the illustration of applied science in the several and many projects and industries, is not too early. Its ready promotion by so many respectable citizens is confirmatory of this sentiment, and we have a large field before us in the extensive and fertile district to which we geographically belong. Nor need our members' range of investigatton be confined to the land, our extensive sea-board, and outlying islands, yet but little explored, abound with interest for the several branches of scientific enquiry, and if we look beyond this, seeing that we are the nearest city to the Antarctic Continent, it may yet be our fortune to assist in the unravelling of the mysteries of that unknown land; a glimpse of which was given us by Sir James Ross, over thirty years ago.

In perusing the addresses of gentlemen who have had the honour of election to presidencies, I perceive that it is a common practice to confine themselves to one topic with which they are specially conversant, with your permission I shall therefore follow their example and treat on this district before settlement had taken place, following it up by the more enlarged subject to which it naturally leads.

It was in September, 1856, that I started from Dunedin to select the sites for the principal townships of the Southern districts—at that time known by the general public as the Bluff Country, or by Maori experts as Murihiku. There were no metal roads in those days, and at that time of the year the tracks were a continuous mass of quagmire. On arriving at Popatuna, these even disappeared, and the remainder of the journey had to be made over an untrodden wilderness. At Tuturau we came upon a small native settlement, and were thrown on the hospitality of a Maori named Reko. His accommodation was scanty, nor were the usual lively torments of the native hut less abundant; but we made the most of it, and our host, in order to wile away the long hours, enlivened them with a war dance, which yet to my memory appears to be the most horribly savage and revolting episode I have ever witnessed.

We had great difficulty in crossing the Mataura, which was at that time in flood, nor were our difficulties at an end on the plains, spending, as we did a whole day in attempting to cross the long blind swamps which intersected them.

As it turned out, with all the expedition we could use, it took us eight days from Dunedin to reach the embouchure of the Pooni Creek, where it joins the Waihopai estuary, on which point the principal part of the town of Invercargill is now built.

The great southern plains of New Zealand were at that time in a state of wilderness, and it is now curious to note the subjects which were at that time of interest, but which have long since been forgotten, and are now despised as trivial in the more advanced state of our civilization.

In illustration of this state of things, one or two extracts may be made from my old journal:—

Pooni Creek, Waiopai, 15th January, 1857.—Drummond brought me some gold scales, mixed with iron sand, which had been washed out of the sands of the Mataura; the former I tested by *aqua regia*. Various parties have been digging in different parts of the Waiopai Plains, and found earth giving indications of gold. In passing, it may be noted that this was four years before Gabriel Read's great discovery.

Waiopai Plains, 29th January, 1857.—To-day I noticed on the path a Maori oven, and this may be a good opportunity to take notice of the relics of by-gone days, as the kettle and pot of Birmingham have taken their place. The oven consists of a round hole dug in the ground about four or five feet in diameter, and the same depth. Around the edges pebbles and stones are arranged. The system of cooking in these ovens appears to have been the same as often described by voyagers in Polynesia, so need no remarks at my hands. What I have to do with is *the oven*, a remnant of by-gone days. These with the mounds of earth—another feature in the landscape thrown up amongst the roots by the fallen trees of the forest seem to be the only surface monuments of the past of New Zealand, at least in this southern portion of it, and pigmy as they may appear when considered by those who have viewed the collosal monuments of ancient Egypt and Rome, yet to the present occupier of this distant corner of the earth they read a lesson fraught with the most intense interest. The mounds of red earth to be seen all over the prairie lands, in every state of preservation or delapidation, from the freshly prostrate tree with its tons of earth and pebbles sticking to its exposed roots, to the simple mound and companion hole, prove over the whole of the interior of this part of New Zealand that dense massive forests once waved their sombre branches.

The gradual destruction of the forest may be seen to be going on at this present day by any observer. The grass by which the plains are covered catches fire, and spreads to the edges of the forest, when the dense surrounding copse igniting, assists to destroy a fringe of the premival trees.

Now, *i.e.*, at the time I made the notes, Maori ovens are also seen in all parts of the plains, in places where, ten miles around, no bush exists, but also they are found close to it. This is another indication that the extirpation of the forest is gradual, owing to the introduction of man and by his handiwork.

The Maori oven was necessarily placed close to the forest for the sake of fuel. This being the case, we may safely argue that when the ovens were found near the bush these may be accepted as of recent construction, and those that are far distant from the same are of antient date. This, I conceive, will hold generally to the true, though in the case of ovens being found at seven to ten miles distant from the bush, it may be suggested that clumps of trees had been there recently, and of this we saw indications on one ridge in the remnants of rotten roots and trunks.

It may be here noticed that small heaps of white or variegated pebbles, in most cases not exceeding a handful, were very plentifully found in all directions. This feature was a subject of much attention and controversy amongst the early settlers of Otago and Canterbury; many suggesting that they were remnants of the crops of the Moa. My own view is that they had been dug out of the soil by native-rats in making their holes, having myself detected one newly formed in this manner.

Oturumika, 2nd February, 1857.—Wood-hens in great abundance. The Maoris kill the birds, at night, in this manner,—they kindle a fire in the forest, which attracts them, then, taking advantage of their pugnacious propensities, they place a red rag tied to the end of a stick before the bird, this it attacks, when the Maori, unobserved, strikes it down with a stick.

Tomogalak, 13th February, 1857.—Many Moa bones were found about, some having a diameter of fully two inches. It is supposed that these bones are collections of the birds killed by the Maoris. The remnant of their *whatas* (store-houses) are yet to be seen, and do not appear to be more than thirty or forty years old.

Leaving my notes I may say, to-night, that Moa bones were also found abundantly on the Waiau, more particularly in excellent preservation in the limestone-caves near the Gorge; and after leaving Southland and coming to the interior and Northern Districts of Otago, they were in yet greater abundance. On the Maniatoto plains the ovens were literally surrounded by Moa bones and chert-stone chips, which the natives had evidently used in cutting or scraping the flesh from the bones.

At Maruwhenua, on the Waitaki, Moa bones were strewed in all directions, indicating that in this well-sheltered and warm locality the bird had collected in great flocks, and I estimated at the time that many could not have lain over thirty years. And so much was I convinced of the recent occupation of the country by the moa, that when I explored the Waiau district, I half expected to have met with them, and one of my men, an old sealer from Jacob's River, from information derived from the Natives, supported the suggestion.

Before settlement, it may be remarked, that the various native grasses covered the plains in undisturbed luxuriance, while thorns and spear grass choked up the gorges and valleys so much as to make them troublesome to be traversed by horses. The native quail was also at that time abundant, rising before you at every hundred yards. The several species of duck, including the paradise one, were plentiful in all the streams and lagoons, while the pigeon was to be shot in all the clumps of the forest. There were no paths or tracts to be seen, and the explorer in threading his way over the country had to be guided by his own experience—either in avoiding the swamps, or in crossing the fords of the mountain torrents.

Such is a short account of the interior of this district in 1856-7, at which time I undertook the reconnisance survey of Otago, of which at that time Southland formed a part.

The settlers under the Otago scheme, the first of whom arrived in 1848, were at that time locating themselves along the coast line from Oamaru to Popatuna, and in 1856 a few stragglers were finding their way as far as Waiopai and New River. It is true the whalers had, here and there, preceded them by many years, probably dating as far back as the beginning of this century, but these held their locations by sufferance, at the will of the Natives, and not for permanent colonization. Their object was whaling, and all they at that time coveted was in each case, a site suitable for looking out for the fish, and for boiling it down when brought in. In the late Mr. John Jones' settlement at Waikowaite, I know the only exception to this state of things.

In the old maps of Fouveaux Straits (there called Favorite Strait), we recognize the presence and influence of the Sydney whalers and sealers. Thus the Waiau is named the Knowsley River; Jacob's River, Port Macquarie; the Bluff, Cape Bernardine, etc. The Bluff Harbour was not at that time known, and the New River is just indicated.

On this subject, Dr. Arthur S. Thomson, in his story of New Zealand, states of the sealers of this district, that " these men commenced their intercourse with the Natives in the southern parts of the Middle Island about the beginning of the century, being landed from whaleships for the purpose of killing seals, then very numerous all round the coast. Disputes at first arose between the sealers and the natives relative to property and women, and in such conflicts the sealers adopted the New Zealand war custom of slaying the first native they encountered, but both races soon became sensible of the benefits of peace, and the savages, to promote this great object, gave the strangers wives and Codfish Island as a residence. Here they built houses and cultivated the soil, and when their numbers increased they spread themselves round the coasts. Between 1816 and 1826 100 sealers were permanently settled in New Zealand, and in 1814 a vessel of 150 tons burden was built by them at Dusky Bay.

Sealers in character resembled whalers, and Stewart, who first discovered the insularity of the Southern Island, was a good specimen of the sealer class. By birth he was a Scotch Jacobite, who had seen the world and drunk Burgundy. After residing many years in New Zealand, he returned to Scotland to see his forlorn wife; but she, conceiving him dead, had long before wedded another, and now denied his personal identity.

" Danger, long travel, want, and woe
Soon change the form that best we know."

Affected with this reception in the house of his fathers, he returned to New Zealand, took up his abode amongst the natives, and in 1851 died at the age of eighty-five years in a destitute state in Poverty Bay. To the day of his death Stewart wore tartan of his royal clan, and was occasionally seen sitting among the natives passing the pipe from mouth to mouth, and relating tales of his fishing adventures, which in length and variety resembled those of Sinbad the Sailor. The President then proceeded to review at some length the question of the "Whence" of the Maori race.

ABSTRACT OF ANNUAL REPORT.

A preliminary meeting to the formation of the Society was held in April last, and on the 25th May another meeting was held, when it was unanimously affirmed:—(1) That there be formed in this district a Society devoted to the promotion of Science, Philosophy, Literature, and Art; (2) That those present, viz., Messrs J. T. Thomson, J. C. Thomson, Spence, Greig, Lee-Smith, Goyen, Rev. J. Paterson, Dr. Galbraith, are *ipso facto* members of such Society; (3) That the Society be named the Southland Institute.

ELECTION OF OFFICERS FOR 1880:—*President*—J. T. Thomson, F.R.G.S. *Vice-president*—W. Stuart; *Hon. Treasurer*—J. C. Thomson; *Hon. Secretary*—P. Goyer; *Council*—Rev. J. Paterson, Dr. Galbraith, Messrs. Spence, Cuthbertson, Scandrett.

The Society began with 18 members, and it now numbers 66. The first ordinary meeting of the Society was held on the 5th July. Since then three meetings have been held, and four papers read.

In accordance with No. 7 of the regulations, several works of reference and a few scientific journals have been ordered from England.

SECOND MEETING. 3*rd August*, 1880.

J. T. THOMSON, President, in the chair.

New Members.—Dr. Hanan, Rev. James Henry.

PAPERS.

1. "On Orepuki Black Sand," by W. S. Hamilton.
2. "On Mind Stuff," by J. T. Thomson.

THIRD MEETING. 1*st September*, 1880.

J. T. THOMSON, President, in the Chair.

New Members.—T. Wakelin, W. Hay, W. Darley, J. Gurr, R. Tapper,

PAPER.

1. "On the Cause of Gravitation," by T. Wakelin, read by the Secretary. (*Transactions*, p. 122.)

FOURTH MEETING. 13*th October*, 1880.

J. R. CUTHBERTSON, in the chair.

PAPER.

1. "On Improvements in the New River," by J. T. Thomson.

ELECTION OF OFFICERS FOR 1881: —*President*—J. T. Thomson; *Vice-president*—Dr. Galbraith; *Council*—J. R. Cuthbertson, J. H. Kerr, W. S. Scandrett, J. Spence, W. Stuart; *Hon. Treasurer*—J. C. Thomson; *Hon. Secretary*—P. Goyer.

COLONIAL MUSEUM AND GEOLOGICAL SURVEY DEPARTMENT OF NEW ZEALAND.

LIST OF PUBLICATIONS.

A.—GEOLOGICAL REPORTS.

1. On the COAL DEPOSITS of NEW ZEALAND, 1866. By Dr. HECTOR, F.R.S. [Out of Print.]
2. On the LOWER WAIKATO DISTRICT, with Maps and Sections, 1867. By Captain HUTTON, F.G.S. [Out of Print.]
3. On the THAMES GOLD FIELDS, 1867. By Captain HUTTON, F.G.S. [Out of Print.]
4. Progress Reports of GEOLOGICAL SURVEY of NEW ZEALAND, during 1866–67. By Dr. HECTOR. With Sections. Pp. 62. Including Reports on Taranaki (Hector), Westland (Hector), Coal Fields (Hector), Kaikoura (Buchanan), Mount Egmont (Buchanan). [Out of Print.]
5. Progress Reports of GEOLOGICAL SURVEY of NEW ZEALAND, during 1868–69. With Maps and Sections. Pp. 64. Including Reports on Barrier Island (Hutton), Okarito District (Hacket), East Cape, Thames Gold Fields (Hutton), and Kawau Island (Hector). [Out of Print.]
6. GEOLOGICAL REPORT for 1870–71. With Maps and Sections. Pp. 164. Including Reports on Thames and Coromandel (Hutton), Waipara, Amuri, and South Alps (Haast), Malvern Hills (Hector), Thames (Davis), Cape Colville Gold Fields (Hector), Nelson District (Davis), Malvern Hills (Haast), Caledonian Mine (Hutton), Collingwood (Hutton), Kaimanawa and Hawke's Bay (Hector). [Out of Print.]
7. GEOLOGICAL REPORTS for 1871–72, with Maps and Sections. Pp. 200. Including Reports on Malvern Hills (Haast), Southland (Hutton), Northern Coal Fields (Hutton), Mines in the Province of Marlborough (Hector), Coal Mines in the Western District of the Province of Nelson (Hector), Coal Deposits of the Ashburton District (Haast), Malvern Hill Coal (Hector), Shag Point Coal Fields (Haast), Coal Seams at Wangaroa and Mongonui (Hector), Collingwood Mine (Hector), Clutha and Green Island Coal Fields (Hector), Coals of New Zealand (Hector). [Out of Print.]
8. Progress of GEOLOGICAL SURVEY of NEW ZEALAND, 1873–74. By Dr. HECTOR. With Maps and Sections. Pp. 193. Including Reports on Clent Hills and Mount Somers (Haast), Shag Point District (Haast), North-East Portion of South Island (Hutton), Fossils from South-East District of Otago (McKay), Fossils from West Coast of South Island (McKay), Fossils from East Cape District (McKay). 2s. 6d.
9. Progress of GEOLOGICAL SURVEY of NEW ZEALAND, 1874–76. By Dr. HECTOR. With Maps and Sections. Pp. 213. Including Reports on Coal at Wairarapa (Cox), Antimony Mine, Queen Charlotte Sound (Cox), Nelson District (Cox), Raglan and Waikato Districts (Cox), Buller Coal Field (Cox), Resolution Island (Cox), Coal at Shakespeare Bay (McKay), Weka Pass and Buller Districts (McKay), Cape Kidnappers and Cape Turnagain (McKay), Tertiary Rocks at Makara (McKay), Wangaroa North (McKay), Richmond Hill Silver Mine (Cox), Westland District (Cox), Coal at Jackson's Bay (Cox), Country between Poverty Bay and Napier (Cox), Buller Coal Field (Cox), Buller Coal Field (Denniston), Kaikoura Peninsula and Amuri Bluff (McKay), Cape Campbell District (McKay). 2s. 6d.
10. Progress of GEOLOGICAL SURVEY of NEW ZEALAND, 1876–77. By Dr. HECTOR. With Maps and Sections. Pp. 185. Including Reports on Mount Somers District (Cox), Waikato District (Cox), Jackson and Cascade Valleys (Macfarlane), Kanieri and Grey River Coal Districts (Campbell), Oamaru and Waitaki District (McKay), Country between Masterton and Napier (McKay), Whangarei District (Cox), Country between Opotiki and East Cape (Cox), Coal Explorations (Denniston), Comparative Value of Coals (Laird), Otago Coal Fields (Hector), Kaitangata Mine (Hector), Green Island Collieries (Denniston), Richmond Hill Silver Mine (Cox). 2s. 6d.
11. Progress of GEOLOGICAL SURVEY of NEW ZEALAND, 1877–78. By Dr. HECTOR. With Maps and Sections. Pp. 233. Including Reports on Golden Point Reef, Queen Charlotte Sound (Hector), Phœnix Mine, Collingwood (Hector), Richmond Hill Mine (Hector), Mount Solitary Copper Lode (Cox), East Wairarapa District (McKay), Hokonui Ranges (Cox), Fossils from Hokonui District (McKay), Fossils from Mount Potts (McKay), Te Anau District (Cox), Wairoa and Dun Mountain District (McKay), Coal Mines (Cox), D'Urville Island Copper Mine (Cox), Index of Fossil Localities Geologically Arranged, Index of Fossil Localities Geographically Arranged, Index to Locality Numbers. 2s. 6d.
12. Progress of GEOLOGICAL SURVEY of NEW ZEALAND, 1878–79. By Dr. HECTOR. With Maps and Sections. Pp. 141. Including Reports on Tuapeka Gold Cements (Cox), Wakatipu and Greenstone District (Cox), D'Urville Copper Mine (Cox), Hematite at Parapara (Binns), Moa Bones at Taradale (McKay), Country between Waipukurau and Napier (McKay), South-Eastern Part of Wairarapa District (McKay), Country between Kaituna and Queen Charlotte Sound (McKay), Country between Wairau and Motueka Valleys (McKay), Baton River and Wangapeka Districts (McKay), Neighbourhood of Wellington (McKay). 2s. 6d.

13. Progress of GEOLOGICAL SURVEY of NEW ZEALAND, 1879-80. By Dr. Hector. With Maps and Sections. Pp. 200. Including Reports on Kiwaka (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). 2s. 6d.
14. MANUAL of NEW ZEALAND MINERALOGY and MINING, with Digest of all Analyses made in the Colonial Laboratory since 1865. [Shortly.]

B.—PALÆONTOLOGY OF NEW ZEALAND.

I. BELEMNITIDÆ. [Shortly.]
II. BRACHIOPODA. [Shortly.]
III. FOSSIL FLORA. [Shortly.]
IV. FOSSIL CORALS and BRYOZOA. By the Rev. J. E. Tenison-Woods, F.L.S. 2s.
V. TERTIARY MOLLUSCA. [Shortly.]

C.—GEOLOGICAL MAPS.

1. GEOLOGICAL MAP of NEW ZEALAND, 1869. By Dr. Hector, F.R.S. 10s.
2. ,, ,, ,, 1873. 10s.
3. ,, ,, ,, [In preparation.]

D.—MUSEUM AND LABORATORY REPORTS.

1.	MUSEUM and	LABORATORY	REPORT for	1865–66.	By Dr. Hector, F.R.S.	[Out of Print.]
2.	,,	,,	,,	1866–67.	,,	[Out of Print.]
3.	,,	,,	,,	1867–68.	,,	6d.
4.	,,	,,	,,	1868–69.	,,	6d.
5.	,,	,,	,,	1869–70.	,,	6d.
6.	,,	,,	,,	1870–71.	,,	6d.
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